CRC for
Water Sensitive Cities

ORANGE CITY COUNCIL

GEOLYSE

Proven application of urban stormwater to potable supply

Orange Stormwater to Potable:

Building urban water supply diversity

Efficient and effective use of water infrastructure

Case Study

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

Photo credits: Orange City Council and Geolyse

Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme

The context

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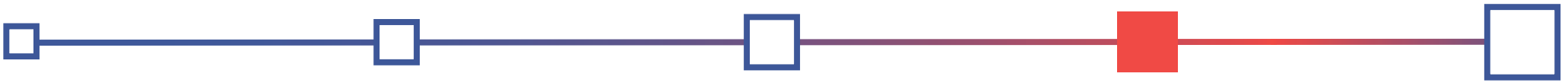
Project location

The regional city of Orange is located approximately 260km west of Sydney in the Central West of NSW.

Project scale

The Orange City Council Local Government Area (LGA) is 287km² and is home to approximately 40,300 people. The city is located at the top of the Macquarie River Catchment and is dominated by rural lands, with expanding residential areas and some industrial and commercial land uses.

The main water supply for the City has been provided by two dams, being Spring Creek Dam of 4,450ML capacity and Suma Park Dam with a capacity of 18,970ML. The City's long term average annual water demand was between 6,000 to 7,000ML per year. The average unrestricted annual demand is now assumed to be around 5,400ML per year.



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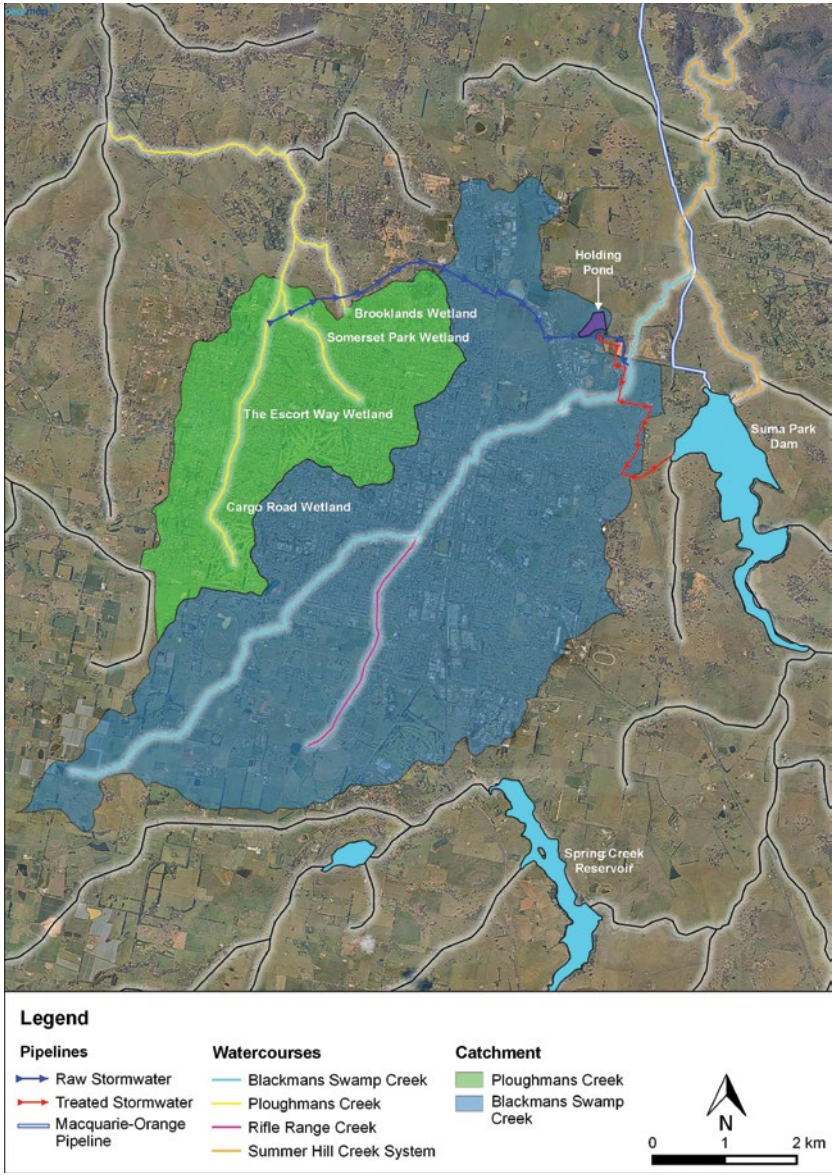
Project site

The urban area of Orange lies within two local creek catchments, Blackmans Swamp Creek and Ploughmans Creek.

The largest catchment is Blackmans Swamp Creek which covers about 34km² to its junction with Summer Hill Creek. Blackmans Swamp Creek rises in rural land south of the city and flows through the central business district, heading in a north-easterly direction, passing immediately west of Suma Park Dam before joining with Summer Hill Creek a kilometre downstream of the dam. Approximately 70% of the city falls within this catchment.

The Ploughmans Creek Catchment covers about 23km² through to the start of the Bell River (not including Broken Shaft Creek) and extends from its headwater on the south western outskirts of Orange through to its junction with Broken Shaft Creek to the north west of Orange.

→ Location of stormwater harvesting catchments and Suma Park Dam.



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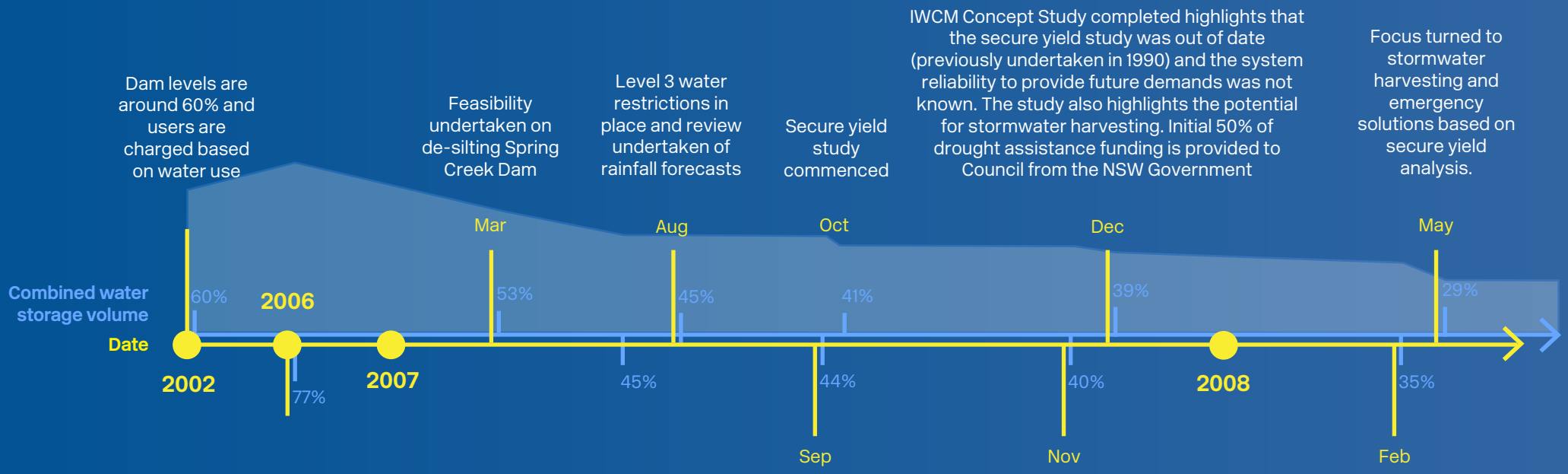
Collaborators and their roles

Local government	Orange City Council is responsible for water supply, wastewater management and stormwater management in the area. Council's role extends from planning and designing capital works, construction and maintenance of on-ground assets as well as engagement with the community (e.g. demand management)
Consultants	Geolyse are a local multi-disciplinary consultancy firm who have worked closely with Council since 2007 to deliver secure and sustainable water supplies for Orange.

State regulator	Department of Industry Water is responsible for the management of the surface water and groundwater resources across NSW. Approval is required from Department of Industry Water for harvesting water from waterways.
Other State government departments	NSW Health provided advice on water quality risk management.

Timeline and milestones



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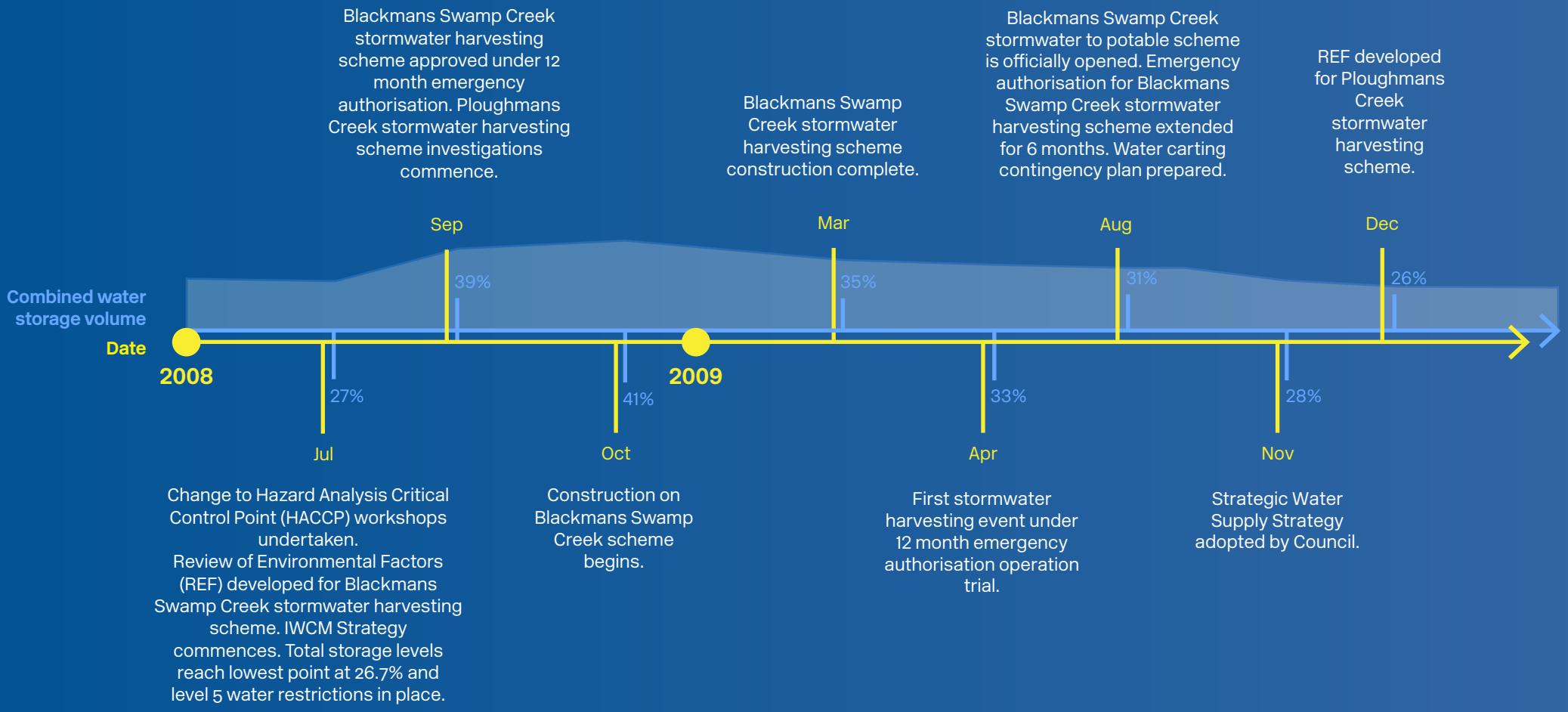
Timeline and milestones



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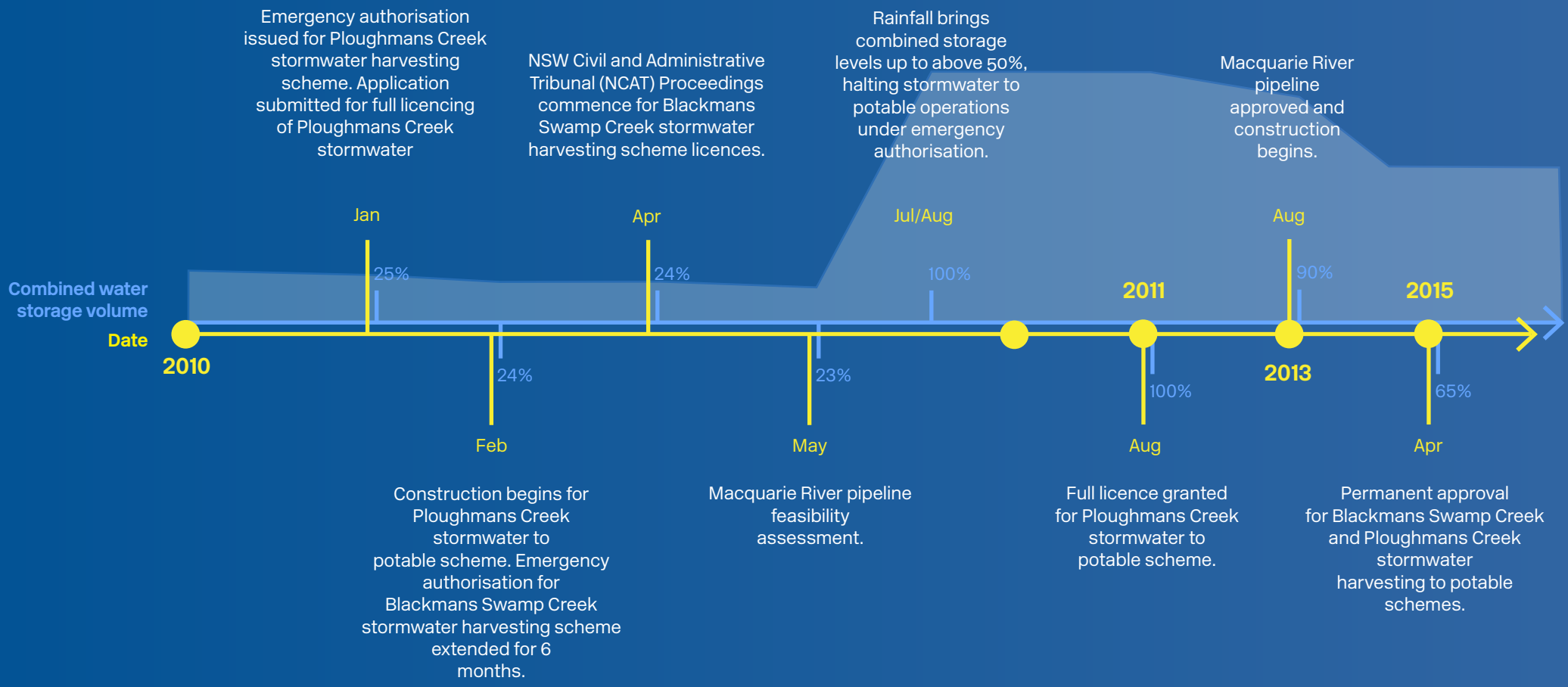
Timeline and milestones



The drivers

1. Critical water shortages

Water supply in Orange was provided by two water storages which captured runoff from predominately rural catchments. While Orange has a relatively high annual rainfall compared to surrounding areas, its location at the top of the catchment limits the volume of water that can be captured.

By late 2007 the city's water storages were below 40% and significant resources were directed to reduce water consumption. However with no predictions of significant rainfall, it was quickly recognised that this would not be enough to cater for current needs, let alone any potential growth of the City. By August 2008, the combined water storage level reached 26.7% and dropped to its lowest level of 23% in May 2010. It was critical that alternative water supplies were identified and used to augment the City's water supply.

2. A willing community

Water restrictions and other water demand initiatives (such as best practice pricing, education programs, water loss remediation strategies and installation of water efficient devices across the city) commenced in January 2003 and helped to reduce water usage in Orange by around 38% to an average annual use of less than 4390ML in 2008.

By May 2008, level 5 water restrictions were in place which meant the community could not use for water for most outdoor purposes (except bucket watering of plants) with the aim to have daily water use at 160L/person/day. By this stage the community were hurting after years of water restrictions and wanted Council to do something quickly to provide more water for the city.

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Suma Park Dam during drought conditions

'I remember standing out the front of the pub when we had some rain during the drought and a community member beside me looked at the stormwater running down the drain said 'why can't we capture and use this?' - Jon Francis - Water Treatment Manager, Orange City Council

3. Local Council leadership and innovation

Despite the need to get a solution quickly, Council didn't just want a quick fix until the next rainfall event. Instead they wanted a water security solution that would provide long term benefits. All options were on the table, including using groundwater, recommissioning Council's original water supply dam, carting water to the city and harvesting stormwater from both rural and urban catchments. The use of recycled water was not an option as the City's recycled water was already fully allocated to Cadia Valley Operations (CVO) which is one of Australia's largest gold mining operations located near Orange.

Orange City Council is responsible for all elements of the local water cycle, which includes potable water, wastewater and stormwater. While capturing and treating stormwater from rural and natural catchments in the local dams was day-to- day practice, harvesting stormwater from urban areas for potable water uses was something new for Council to consider. Despite the fact that this had not been done anywhere across Australia previously, Council were keen to take this option forward in more detailed assessments as early investigations were showing it was a viable option.

> ***"This was an opportunity for local government to innovate and demonstrate how it can use local resources to solve a local problem - which potentially has national if not international application."***
> ***- Chris Devitt*** [1]

[1] Devitt, C (2009) Stormwater Harvesting for Potable Use in Orange NSW. IPWEA NSW Division Annual Conference

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Orange City Council water management

4. Making the most of a wasted resource

During the drought it was observed that despite getting periodic rainfall events during this time, the rural catchments feeding the water supply dams did not generate enough runoff to raise dam water levels. In comparison, the majority of rainfall which fell over the impervious urban areas, generated runoff which was conveyed in the pit and pipe network to enter Blackmans Swamp Creek and Ploughmans Creek, the prior of which discharged downstream of Suma Park Dam.

The Blackmans Swamp Creek urban stormwater harvesting scheme became the preferred option to address Orange's water shortage. This was due to the modelled reliability of these urban flows when compared to the traditional rural catchment harvesting approach. Favourably, Blackmans Swamp Creek is relatively close (within 1km) to Suma Park Dam. Existing infrastructure also made this a cost effective option as it minimised the amount of new works required to get this scheme operating.

5. Risk management and partnership

In deciding to take forward the Blackmans Swamp Creek urban stormwater harvesting scheme as the preferred option, Orange City Council was entering unchartered territory in terms of potable water supply. As there was little precedent, or supporting guidelines or regulations for what Council was proposing, this project needed to demonstrate that it could be delivered safely through detailed modelling, development of risk assessments and frameworks and ongoing monitoring.

Council worked in partnership with the Department of Industry Water, NSW Health and NSW Office of Environment and Heritage through the design and delivery phases to ensure that the scheme could address Orange's water shortage in a manner which did not comprise the health of the public and the environment. Department of Industry Water also played an extremely valuable role by assisting with emergency funding for the Blackmans Swamp Creek project ($2.5m on a 50:50 basis).

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Spoonbill enjoying the Cargo Road Wetland

"The data shows that 63mm of rainfall across two weeks in March 2008 produced no runoff to Suma Park Dam while at least 880ML ran down Blackmans Swamp Creek of which at least 120ML could have been harvested" Martin Haege, Principal Environmental Engineer/ Director, Geolyse.

6. Cost effective operation of water supply options

A key driver in both the development of a solution to address the drought in 2007 and the current management of Orange's water supply scheme is to ensure there is:

- diversity in supply options, and
- cost effective management of this diverse water portfolio.

Council has an Integrated Water Cycle Management Evaluation Study which presents an overview of the diverse water security portfolio managed by Council and also identifies additional works which will be required to continue to meet the requirements of the region's growing population.

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Harvested stormwater entering Suma Park dam for the first time in 2009

The innovations

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1. Urban stormwater harvested for potable uses

Many regions and cities across Australia rely on water supply dams which receive runoff from predominately rural and natural catchments. Having natural and well managed catchments is typically desirable for water supply catchments as it minimises risk and treatment requirements. Urban stormwater can include a range of pollutants and therefore using an urban area as the water supply catchment due to the reliable runoff volumes is a novel approach.

Piped stormwater flows from over half of the Orange City urban area drains to Blackmans Swamp Creek downstream of Suma Park Dam. The remaining urban areas drain to Ploughmans Creek. A detailed hydrological model showed that 15 to 30 percent of the City's annual water needs could potentially be gained through stormwater harvesting from Blackmans Swamp Creek.

The Blackmans Swamp Creek stormwater harvesting solution was also economically viable due to:

- The close proximity of Blackmans Creek Swamp to Suma Park Dam.
- The availability of key infrastructure including road access, power and an existing pipeline between the creek and Suma Park Dam.
- The very high level of treatment provided by Council's water treatment plant which already treats the raw water from Suma Park Dam including the use of ozone treatment and biologically activate carbon filtration.
- The regularity of flows in Blackmans Swamp Creek (average of 53 rainfall events a year which can be harvested).

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Holding dam and batch ponds

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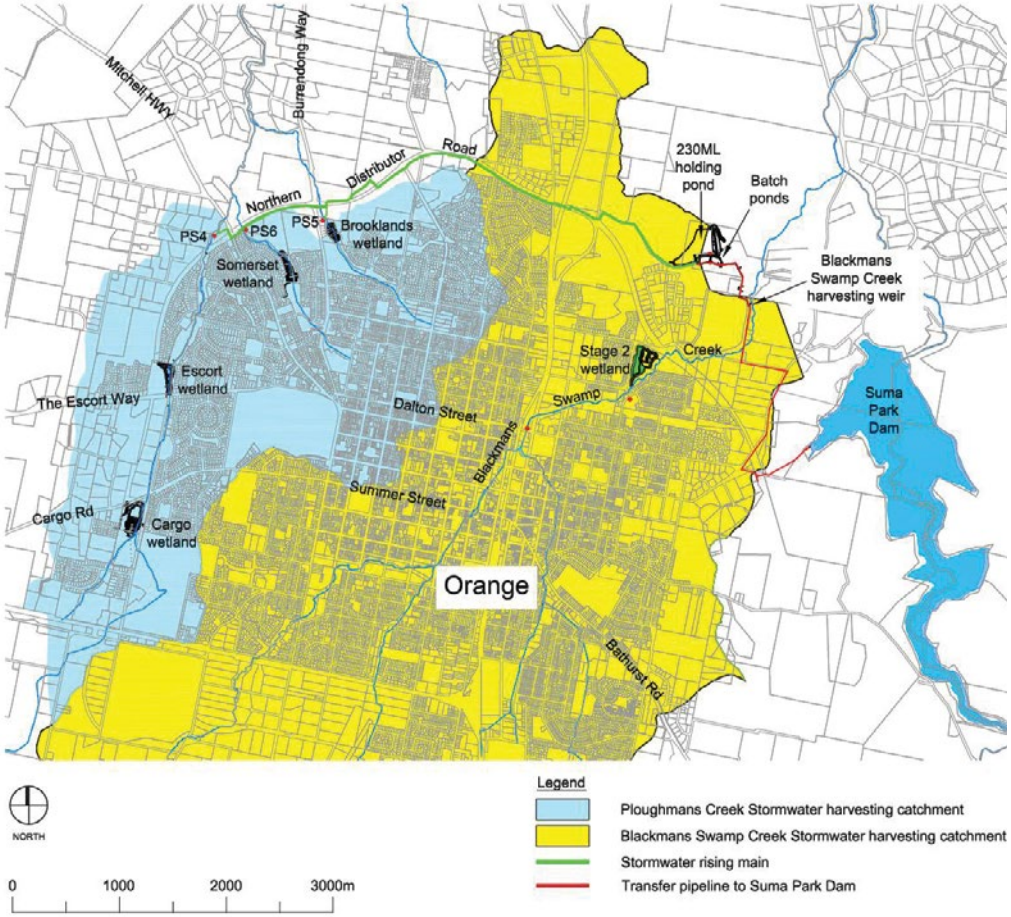

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Plan showing location and connections between Blackmans Swamp Creek and Ploughmans Creek stormwater harvesting schemes (including proposed Stage 2 wetland for Blackmans Swamp Creek)

The Blackmans Swamp Creek stormwater harvesting scheme involves some catchment pretreatment before flows are harvested from the creek and transferred to a holding dam. It is then treated in batch ponds to meet target water quality criteria before being piped into Suma Park Dam to be treated with the other stored water for potable supply.

Following the success of the Blackmans Swamp Creek stormwater harvesting scheme it was expanded to include the Ploughmans Creek stormwater harvesting project. This project involved the retrofit of four stormwater treatment wetlands into existing urban areas before flows are harvested and transferred to the holding dam already used for the Blackmans Swamp Creek stormwater harvesting scheme.

The combined average harvesting potential of both of these projects is 1,350ML/year with 850ML provided by Blackmans Swamp Creek and up to 500ML provided by Ploughmans Creek. This equates to approximately 25% of Orange's annual unrestricted water demand.

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Ploughmans Creek Cargo Road Wetland

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Technology Focus: Blackmans Swamp Creek Urban Stormwater to Potable Scheme

What is it?

This was the first application of harvesting urban stormwater for potable uses at this scale in Australia. The harvesting and treatment process includes:

- **Two large Gross Pollutant Traps (GPTs):** These remove a portion of the larger pollutants from the urban stormwater before it is harvested. One of these is located on the creek itself and the other is located on a major piped drainage line.
- **Rock and gabion harvesting weir:** This is located on Blackmans Swamp Creek just upstream of the Sewage Treatment Plant. The weir is designed to allow low flows to pass through and to create a small (3ML) weir pool during runoff events from which stormwater can be harvested.
- **Pump station 1:** This first pump station is located upstream of the harvesting weir and has three variable speed pumps, each with a capacity of 225L/s. A maximum of two pumps are used, with the role of the two duty pumps being rotated between the three pumps (combined harvest rate of 450L/s). The main harvest pumps activate when flow in the creek downstream of the harvest weir reaches 1,000L/s.
- **230ML holding dam:** This is used to balance harvested stormwater flows with the treatment system and provides some detention time.
- **Pump Station 2:** This extracts water from the holding dam and transfers it to the batch ponds. This pump station has a capacity of 150L/s.
- **Batch ponds:** Before water enters the first of the two in-series batch ponds a coagulant (aluminium chlorohydrate) is added to promote flocculation and settling of suspended solids and attached contaminants. Water then moves to a second batch pond. These ponds partially existed as disused sludge ponds and were cleaned out and deepened to be used as part of the stormwater harvesting scheme.
- **Pump Station 3:** Once the necessary water quality standards have been achieved the water is then pumped, at around 150L/sec (or 13ML/day) into the City's water storage at Suma Park Dam. An existing 250mm pipe was utilised as a large section of this pipe connection between the batch ponds and Suma Park Dam was no longer required.
- **Icely Road Water Treatment Plant:** Water is extracted from Suma Park Dam and treated to drinking water standard at the Icely Road Water Treatment Plant. Treatment includes ozone treatment to destroy pathogens and Biologically Activated Carbon Filtration to consume the remnants of the compounds destroyed by the ozone.

What did it cost?

The Blackmans Swamp Creek stormwater harvesting scheme cost $5M.

What are the benefits?

- **Supplementary potable water supply:** an average of 850ML/yr is provided from this stormwater harvesting scheme
- **Use of existing infrastructure:** this scheme makes use of existing infrastructure which was no longer being used
- **Reduction of excess stormwater in creek:** the scheme will reduce the peak flow volumes in the creek minimising the risk of erosion

→ Treated stormwater in batch pond prior to transfer to Suma Park Dam

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Technology Focus: Ploughmans Creek Urban Stormwater to Potable Scheme

What is it?

This is the extension of the Blackmans Swamp Creek stormwater harvesting scheme on Ploughmans Creek. The harvesting and treatment process includes:

- **Four constructed stormwater wetland systems:** These wetlands have been retrofitted into existing urban areas at locations which were previously identified in a multi-criteria analysis process. These locations were chosen due to land availability, upstream urban catchment size and reliability of flows. The wetlands were sized to maximise treatment given the size restrictions associated with the available land. They are located at Cargo Road, Escort Way, Somerset Park and 'Brooklands' at Burrendong Way.
- **Somerset Park wetland weir and pump station:** A small V-notch weir and pump station is located on un-named creek downstream of the Somerset Park wetland to transfer flows to an existing raw water rising main
- **Burrendong Way wetland pump station:** A pump station is located on the Burrendong Way wetland to transfer flows to the existing raw water rising main.
- **Ploughmans Creek weir and pump station:** Flows from the wetlands at Cargo Road and Escort Way are harvested downstream from Ploughmans Creek (about 200m upstream of the Mitchell Highway) using a small V-notch weir and pump station which transfer flows to the existing raw water rising main.
- **Existing Blackmans Swamp Creek stormwater harvesting infrastructure:** Additional pipeline was required to extend from the existing raw water main to connect to the existing 230ML holding dam which is already used for the Blackmans Swamp Creek stormwater harvesting scheme. From this holding dam the water is pumped to the batch ponds where it is treated and tested before it is finally transferred to Suma Park Dam and treated as part of the drinking water supply.

What are the benefits?

- **Supplementary potable water supply:** an average of 500ML/yr is provided from this stormwater harvesting scheme
- **Improved amenity and function of drainage corridors:** the construction of the stormwater treatment wetlands has transformed previously weedy and underutilised green drainage corridors into valued community assets.
- **Reduced peak flow through the waterway system:** the constructed wetlands capture a portion of the runoff which is either harvested or released slowly following rainfall events. This reduces flow peaks through the system.
- **Improved ecosystem function and habitat:** the scheme removes excess urban stormwater and improves the water quality in Ploughmans Creek and also creates valuable new habitat as part of the wetlands. This is especially the case for the Cargo Road Wetland which has been designed to incorporate Japanese Snipe habitat as part of its design.

What did it cost?

The Ploughmans Creek stormwater harvesting scheme cost $4.1M to construct.

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Somerset Park wetland just after construction

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2. Creating the rules

Given this was the first time stormwater was being harvested for the purposes of potable water use, there was a lack of data and guidance available. It was therefore important for Orange City Council to address these key knowledge gaps, especially related to water quality, to build confidence in regulators and community that the scheme could be successful. Key knowledge gaps that needed to be addressed:

- **Lack of relevant establish data for typical stormwater runoff contaminants –** Council undertook a catchment audit and reviewed available water quality monitoring data to understand stormwater quality.
- **Lack of regulations and guidance for the harvesting and use of stormwater for potable uses -** Other existing documents were used as a guide with the Australian Drinking Water Guidelines taking priority despite the fact that stormwater was being used as a raw water source.

Council facilitated Change to Hazard Analysis Critical Control Point (HACCP) workshops with Council staff and representatives from State Government agencies such as DECC, DWE and NSW Health to develop an agreed framework for the scheme. These workshops systematically identified where and how contamination may arise, how it may find its way to the consumer and how to protect consumers from contamination. These protection measures were captured in a detailed management system to ensure they are fully implemented. These protection measures were identified at catchment, system and operational levels.

The development of the Review of Environmental Factors (REF) for the stormwater harvesting schemes was also important in getting stakeholder agreement and approval for the harvesting and use of stormwater for potable uses. REFs were developed for both the Blackmans Swamp Creek and Ploughmans Creek stormwater harvesting schemes. These documents include a series of operating rules which provide a clear outline of how the project will work.

These rules include:

- flow trigger points when harvesting can commence
- ensuring base flows are maintained
- ensuring water quality is managed, and
- establishing ongoing stakeholder engagement once the project became operational.

The public reaction to drinking harvested stormwater was also tested through a series of community consultations, including on-line surveys. The predominant response to these surveys was not one of concern about water quality but of urging Council to get on with the work as soon as possible.

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Technology focus:
Water quality management

What is it?

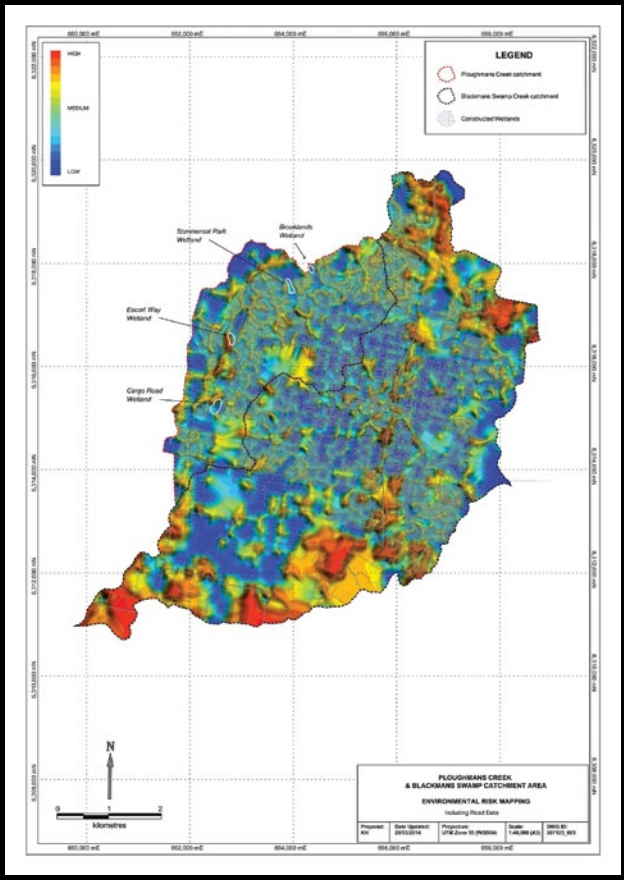
Assuring consistent water quality was a key component in the success of the scheme and managing the risks to the community that accompany the collection of urban runoff for addition to potable supplies was a complex task. To reduce the risk of using stormwater for potable uses, the harvesting scheme was designed with an integrated suite of catchment, system and operational barriers to manage water quality.

Catchment level

The following actions were undertaken, and continue to be implemented, to manage the quality of the water entering the creek and wetland systems from the contributing catchment:

- Development and implementation of plans and policies including Stormwater Management Plan, Sewer Asset Management Plan and Trade Waste policy
- Catchment audit undertaken to identify pollutant hot spots with aligned water quality monitoring
- MOU developed with NSW Fire and Rescue to notify of incidents that generate pollutant runoff e.g. fires, chemical spills
- Minimising the risk and impact of potential sewer overflows (e.g using alarmed man holes)
- TV commercials and other community education initiatives to avoid any potential contaminants being discharged into the creek system
- Regular cleaning of streets and footpaths in high traffic areas
- Sediment control on subdivisions and building sites
- Maintenance of riparian vegetation
- Planning controls to ensure appropriate development within the catchment

Heat map showing pollutant hot spots



System level

The multiple barrier treatment train approach uses a series of different treatment systems which are designed to remove pollutants in the stormwater. This includes the use of GPTs, wetlands, settling ponds and water treatment facilities.

Operational level

The schemes are operated in a manner that optimises the quality of the stormwater. This includes an extensive monitoring program to ensure the water entering Suma Park Dam meets quality targets that have been developed for the scheme. The scheme was initially run in 'batch mode' which meant that each batch (34ML) of treated harvested stormwater was sampled and held until laboratory results confirmed the water met the scheme quality targets. Following the success of this initial batch mode, a continuous approach to treatment and transfer was undertaken to enable greater efficiency in the harvesting scheme. Strict quality targets were adhered to in this phase and in line turbidity meters and ongoing testing are indicative of treatment success in the continuous mode of operation. Water quality samples are collected during harvest events and allow quality comparison between the raw creek water, water supply dam and harvested stormwater following treatment. To allow these comparisons, samples are taken from:

- Blackmans Swamp Creek just downstream of the harvesting weir to establish the raw creek water quality
- Suma Park Dam to establish the existing quality of the water supply
- Holding dam and two depths at each of the two batch ponds to understand quality of treated water

The treated stormwater is analysed for over 240 parameters for which quality targets have been set. These targets have been set according to a hierarchy using existing guidelines that include:

- Australian Drinking Water Guidelines (NHMRC & NRMMC, 2004)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)
- Australian Guidelines for Water Recycling (EPHCet al, 2008),
- Australian Runoff Quality: a Guide to Water Sensitive Urban Design (Engineers Australia, 2006), and
- Guidelines for Drinking Water Quality (WHO, 2008).

Water quality monitoring has shown concentrations of pollutants were significantly reduced in the batch pond samples compared to the raw creek water samples and also are of predominately better quality than the water in the water supply dam. The data has also confirmed that the relatively simple treatment process has resulted in water quality that meets the scheme water quality targets.

What are the benefits?

- **Improved understanding of stormwater treatment performance for potable water uses:** The monitoring is building an important database for the stormwater industry and has built confidence that stormwater can be treated to meet water quality objectives for use in a drinking water scheme.
- **Demonstrated pollutant reductions:** Approximately 182 tonnes of litter, rubbish and organic matter has been removed from Blackmans Swamp Creek in the first year following installation.

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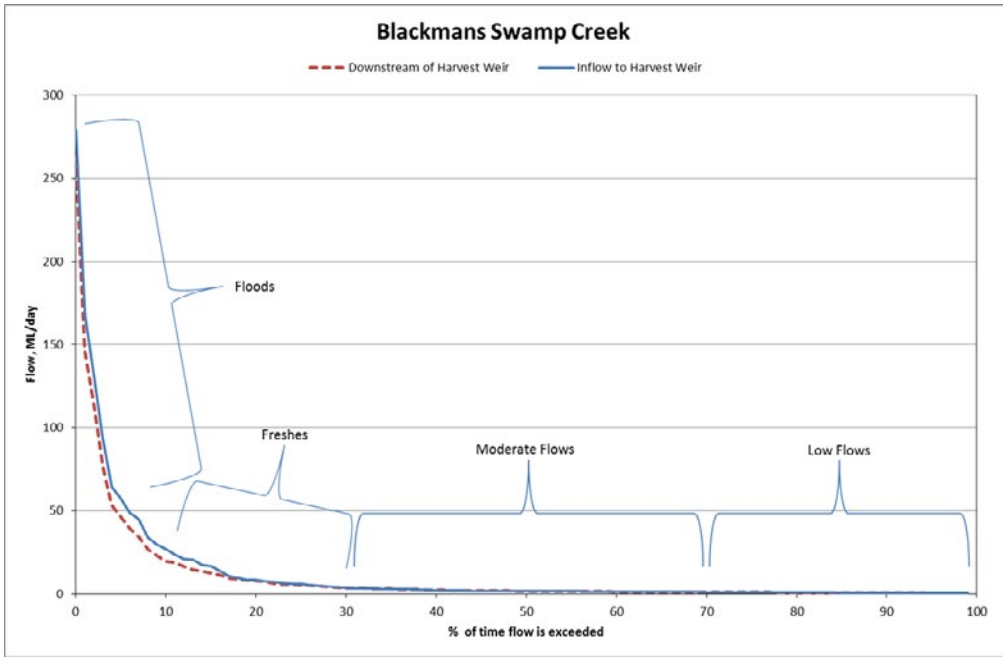
3. Balancing harvesting and environmental flow requirements

Long term modelling estimates that the current average annual runoff from the Blackmans Swamp Creek developed catchment is 9,500ML/yr. In comparison the model estimated the catchment in its 'natural state' (i.e. before vegetation was removed and impervious areas added) would have only produced an average of 2,500 -3,000ML/yr. Typically this additional stormwater generated by the urban areas is seen as an 'urban excess' and could be available for harvesting as removing this water from the waterways would be beneficial in terms of waterway health.

Blackmans Swamp Creek has been receiving these excess flows for many years. In the past the creek was also receiving treated effluent from the wastewater treatment plant (most of this water is now sent to Cadia Valley Operations (CVO)). Concerns were raised from a number of community members at the start of the project that harvesting stormwater from Blackmans Swamp Creek would change the hydrology and have a detrimental impact on the downstream ecology and landholders who have licences for water extraction.

Extensive modelling was undertaken to identify when harvesting could occur to minimise impact on creek flows. The modelling outcomes led to the development of approval conditions to ensure that harvesting only occurs during peak flows and that base flows in Blackmans Swamp Creek remain unaffected.

This was later supported by data collected from flow gauging stations along the waterway to ensure these operating rules were met.



Graph showing slight reduction in Blackmans Swamp Creek high flows associated with harvesting between April 2009 and April 2010.

Technology focus: Weir design

What is it?

Harvesting for the Blackmans Swamp Creek stormwater harvesting scheme is located in a stable rocky section of the creek downstream of the city centre. A 2m high weir with an unrestricted 300mm pipe was designed and constructed at this location. The pipe allows low flows, those that occur for more than 80% and 90% of the time, to pass untouched through the weir structure. The weir also creates a 3ML pool of water during runoff events which floods an adjacent pump well.

These pumps have a combined capacity of 450L/s, or 39ML/day and are designed to quickly extract flows from this pool during peak stormflows. These peak flows only occur 10 to 20% of the time and are the only flows which are reduced by the stormwater harvesting scheme. Despite the lower frequency of these peak events, the stormwater harvesting scheme on Blackmans Swamp Creek can still harvest an average of 850ML/yr, which can supply up to 15% of the City's annual water demand.

Modelling, and subsequent monitoring, of the system has shown that there has been no change to the creek base flows and the maximum peak flows have been reduced slightly.

What are the benefits?

- **Reduced peak flows:** reducing the peak flows is benefiting the creek as it reduces erosion
- **Maintained ecological flows:** maintaining the current base flows and also allowing the system to flush with periodic larger events was identified as important for downstream ecosystem health
- **Viable stormwater harvesting volumes:** despite having to change the original pump designs to accommodate the flow requirements, the harvesting scheme is still able to collect and treat an average of 850ML/yr of stormwater

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Blackmans Swamp Creek weir and harvesting pump station

4. Urban stormwater to dual pipe system

Since the construction of the Blackmans Swamp Creek and Ploughmans Creek stormwater harvesting schemes, Council has also been investigating the best use of its stormwater. Dual pipe systems are becoming more common in new residential developments across Australia to reduce the consumption of drinking water and make the most of all water sources. Typically this dual pipe system is supplied with recycled wastewater and used to supply household uses which do not require drinking standard water (such as garden irrigation and toilet flushing). Given that recycled water was not an option for Orange City Council since it is fully allocated to Cadia Valley Operations, which is one of Australia's largest gold mining operations, stormwater was identified as the alternative water source for this dual pipe system.

The dual pipe systems have been included in all houses built in the Ploughmans Valley and North Orange area since 2005 and will now allow residents to use stormwater collected from the city's wetlands and stormwater harvesting schemes to irrigate their gardens and flush their toilets. The original intention was to supply the dual water system with treated effluent. Prior to December 2017 the dual pipe system had been supplied with potable water.

Households were given a BASIX[2] exemption due to unavailability of recycled water (which was the original intended dual water source). Orange City Council was given permission by the NSW Government to postpone connecting these newly built houses to the dual water system until the following was completed:

- an alternative water analysis (which identified stormwater as the preferred option)
- construction and approval of the Blackmans Swamp Creek and Ploughmans Creek stormwater harvesting schemes
- construction of a second set of delivery water mains.

This work is now complete and the stormwater dual pipe system has been in operation since December 2017.

Before the system could be turned on, Council undertook a detailed audit of all homes to ensure there were no cross connections and that there was adequate signage on taps which will be supplied with treated stormwater in the near future instead of potable water. A brochure was sent to all homes with the dual water system and additional information is available on the Council website. This provides an overview of the scheme and how the water can be safely used around the home. Residents are charged the same amount for both the use of potable water and stormwater in the home.

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Appropriate signage for taps supplied with stormwater


Ploughmans Valley and North Orange Dual Water Scheme

FACT SHEET

Your guide to using water from our wetlands

Orange City Council is about to turn on the Ploughmans Valley & North Orange Dual Water Scheme.

This is an important initiative which aims to reduce consumption of drinking water in the Ploughmans Valley & North Orange area by 40%. Instead of using drinking-water, the change will let residents use stormwater collected from our city's wetlands to irrigate their gardens and flush their toilets.

How is the water in the dual water scheme different?

What you need to do

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Brochure sent to homes with the Dual Water Scheme

[2]The Building Sustainability Index (BASIX) applies to all residential dwelling types and is part of the development application process in NSW. It is an assessment tool which is used to reduce water and energy consumption in homes by checking elements of a proposed design against sustainability targets. For more information visit http://www.basix.nsw.gov.au/iframe/

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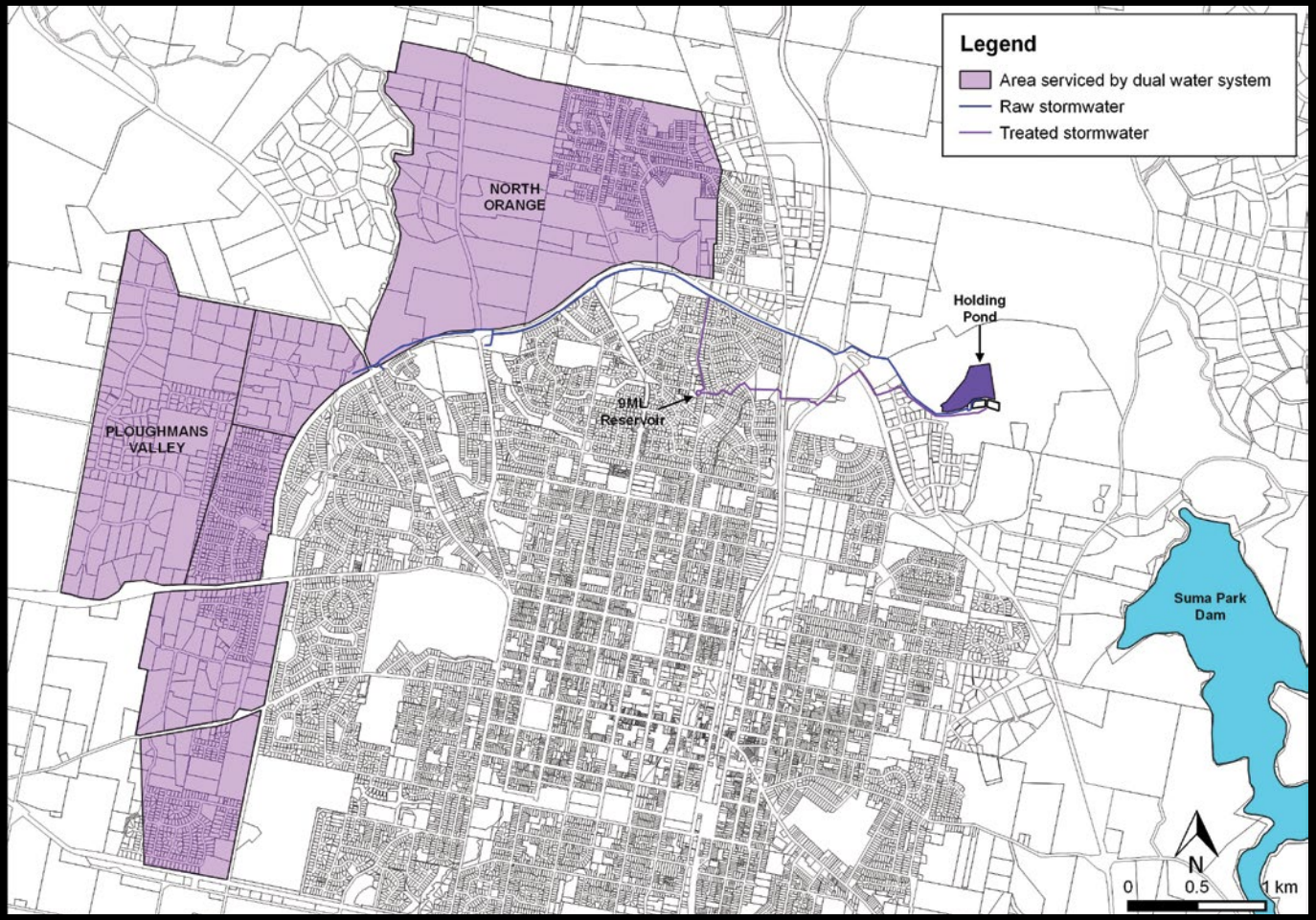
Technology focus:
Ploughmans Valley North Orange Dual Water Scheme

What is it?

All houses in the Ploughmans Valley and North Orange area built since 2005 were required to be equipped with a dual pipe plumbing system. This means that all houses have been designed to have two sets of plumbing: one that supplies water to toilets and outdoor taps, and one for all other uses (drinking taps, hot water, washing machines, showers, baths, etc.). Developers are required to install all non-potable (purple) reticulation mains to lots within their subdivision as part of their Conditions of consent. It is a requirement that at least one outdoor tap is connected to stormwater. Additional outdoor taps can be connected to the potable water supply to support activities which would result in high levels of human contact (such as filling swimming pools).

The stormwater which will supply the purple pipes is sourced from the Ploughmans Creek and Blackmans Swamp Creek stormwater harvesting schemes. The water is pumped from the harvesting scheme batch ponds (where the stormwater has been treated with a coagulant to flocculate and settle out sediments and pollutants) to nearby treatment facilities which further treat the water with ultra-violet (UV) light and chlorine. The treated water is then pumped through a separate system of reservoirs and pipelines to residents in the Ploughmans Valley and North Orange areas for garden watering and toilet flushing.



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Plan showing the extent of the dual water system and connection to treatment and distribution systems

What did it cost?

Treatment system, pipes, connections and audit cost $1.5M

What are the benefits?

- **Reduced potable water consumption:** Using treated stormwater for garden irrigation and toilet flushing can reduce consumption of potable water in the Ploughmans Valley and North Orange area by 29%. When this alternative water use is combined with additional water savings in the household (e.g. use of water efficient fittings), homes will achieve the minimum 40% water saving required by BASIX.
- **Engaged community:** The audit of homes with the dual water system and the supporting community education program has built the awareness of the community of the scheme and its benefits.
- **Reduced stormwater pollutants and volumes entering creek:** The completed dual water scheme (4,500 households) is estimated to use 330ML of stormwater for non-potable household uses which will reduce the volume of stormwater pollutants entering the waterways.

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Homes have two water meters in their front yard, one coloured purple for non-drinking water supply.

The outcomes

BACK TO MENU

1. Award winning demonstration of stormwater to potable uses

Stormwater treatment facilities →

The Blackmans Swamp Creek and Ploughmans Creek stormwater harvesting schemes have demonstrated that despite the lack of existing regulation or guidance, stormwater can be harvested and used safely for potable uses. Due to the lack of available data or guidance, the projects have taken a very conservative approach to treatment using the Australian Drinking Water Guidelines to set the majority of scheme targets. Detailed monitoring of the treated stormwater for over 240 water quality parameters has shown that these scheme targets can be met with a relatively simple treatment train process. Despite these projects being an example of in-direct potable re-use (that is treated stormwater is discharged to the water supply dam before it is treated to drinking water quality), the monitoring has shown that the treated stormwater quality is predominately better than the water quality in the main water supply dam. Therefore it is reasonable to assume that the future might see the treated stormwater sent directly to the water treatment plant as a direct raw water source.

The stormwater treatment schemes have been recognised for their innovation as recipients of the following industry awards:

BLACKMANS SWAMP CREEK STORMWATER HARVESTING SCHEME AWARDS

- Stormwater Industry Association (NSW) – 2009 winner Award for Excellence in Stormwater Harvesting & Reuse
- Australian Water Association (AWA) – NSW Water Industry Awards – Water Environment Merit Award - 2009
- Green Globe Awards (Department of Environment and Climate Change NSW) – Public Sector Water Award (for outstanding environmental achievements in the development and delivery of water saving initiatives in NSW) - 2009
- Institute of Public Works Engineering Australia (NSW Division) (IPWEA) – 2009 Engineering Excellence Awards – New and/or Improved Techniques
- Engineers Australia – Engineering Excellence Awards – Engineering for Regional Communities – Excellence Award 2009
- Engineers Australia – Engineering Excellence Awards – President's Award 2009
- Stormwater Industry Association (Aust) – Winner National Excellence Awards 2009 - Excellence in Stormwater Harvesting & Reuse
- Engineers Australia – National Environmental Engineering Excellence Award – winner 2009
- AWA National Awards - Infrastructure Project Innovation Award 2010 – Highly Commended (runner up)
- International Water Association Project Innovation Awards (Asia Pacific) – Honour Award in small project division – 2010
- Institute of Public Works Engineering Australasia – Sustainable Solutions in Public Works – Winner 2014 Sustainable Communities Category
- Tidy Towns Sustainable Communities Awards 2011 – Water Conservation Award – Population Category F

PLOUGHMANS CREEK STORMWATER HARVESTING SCHEME AWARDS

- Stormwater Industry Association (NSW) – Award for Excellence in Infrastructure 2011 - Highly Commended

'I am pleasantly surprised by the water quality achieved by a relatively simple treatment process' – Martin Haege, Principal Environmental Engineer/Director, Geolyse.

2. Effective and efficient delivery of projects

Timing was critical for the stormwater harvesting schemes as Orange was running out of water. The Blackmans Swamp Creek stormwater harvesting scheme evolved from concept to operational reality within 18 months. This short timeframe was possible as the consultation and approvals process was undertaken simultaneously to the design and construction process. This parallel process allowed the design to continue to develop and respond to the outcomes of the approvals and consultation process.

Construction took 5 months under Council's project team. This delivery project team included a mix of experienced staff, trainee engineers and the project designers from Geolyse. The involvement of Geolyse was critical to link the detailed design and on-site construction. Council's handpicked construction team for this complex major project had a clear mandate to focus solely on project delivery. The team included 8 separate major sub-contractors from bulk earthworks to complex electrical and pump installations and worked together to the $5.0 million project, on time and on budget, with no major contractual, OH&S or environmental issues.

"This was a great project for the Council team as it provided an excellent learning opportunity for our trainee engineers and enabled Council to refine its methods of delivery of key infrastructure projects." Wayne Beatty, Water and Sewer Manager (Strategic), Orange City Council

3. Empowered team under strong leadership

Strong leadership within Council during the drought created an environment which fostered innovation and empowered the team to investigate all possible solutions. Regular brainstorming sessions were undertaken with staff from across multiple Council departments and with key consultants which led to the optimisation of designs and re-use of existing infrastructure. Goals were achieved efficiently through setting of clear vision and removal of barriers to enable staff to apply their strengths in an environment where hard work was the norm and an appreciation of the need to improve the level of service for the community was clearly understood.

Construction of stormwater harvesting schemes

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4. Turning waste into a resource

Orange City Council has demonstrated that urban catchments provide value in water supply solutions as they provide reliable runoff volumes from the vast areas of impervious surfaces. The Blackmans Swamp Creek and Ploughmans Creek stormwater harvesting schemes are capable of providing an average of 1,350ML/year of additional water into the Orange's raw water supply each year. This results in up to 25% of the city's water needs being supplied stormwater collected from the urban area. The addition of the dual water system will also help to reduce the volume of highly treated drinking water consumed in the Ploughmans Valley and North Orange area by 40%.

5. Community acceptance

Community resistance to the concept of drinking stormwater was initially thought to be a significant challenge for the projects. However, community acceptance was achieved relatively quickly through a combination of community education campaigns which focused on the requirement for secure water supplies and the details of how the water would be treated to reduce risk to the community. The community education campaign included local and national media coverage, community information sessions, tours, on-line surveys and explanatory signage at key locations. Overall, the response from the community during the development and implementation of the stormwater harvesting schemes was one of wanting to see Council get on with it as quickly as possible rather than concerns about water quality.

'We got back from a site tour of the stormwater harvesting schemes and the community thanked us with clapping and cheering' Jonathan Francis, Water Treatment Manager, Orange City Council

Summary of the outcomes

Cities as water supply catchments

- Solutions harness the power of large impervious surfaces in urban environments for generating more reliable water supplies
- Up to 25% of drinking water in Orange can be supplied by stormwater harvested from the urban areas.
- 29% of drinking water can be replaced with treated stormwater via dual water systems in homes in Ploughmans Valley and North Orange.

Cities providing ecosystem services

- Creation of 4 stormwater treatment wetlands which slow and treat stormwater flows as well as provide important urban habitat
- Peak flows reduced in creeks reducing risk of erosion
- Conversation of weedy drainage corridors into constructed wetlands has created high amenity landscapes which are now valued by the community.

Cities comprising water sensitive communities

- Community engagement programs built confidence and support of stormwater harvesting schemes to supply drinking water
- Extensive engagement with residents with dual water systems has built an understanding of the fit-for-purpose use of stormwater and drinking water in home
- Signage is included in key infrastructure associated with the stormwater harvesting scheme to inform residents and visitors.

The challenges

1. Critical timeframe

Orange was quickly running out of water and its residents were running out patience. Timing was therefore critical to identify, design, construct and implement a solution. Initial investigations were showing stormwater harvesting solutions from the urban areas to supplement the drinking water supply were the preferred option. This presented a risk to Council as this was a largely unknown and unproven solution which would require the design, approval and operation of a unique solution that had not been done before. Despite this risk, Council moved forward with the design and approvals processes for the stormwater harvesting schemes. By undertaking these processes in parallel, Council was able to streamline the timing as the approval process was being fed into the design as it was happening.

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Community tour of the dual water scheme

BACK TO MENU

2. Reluctance from regulators to approve the unknown

The lack of existing guidance and requirements for the harvesting of stormwater for drinking water purposes meant that regulators were cautious to approve the solutions. This was a risk to Council given the critical timing of the stormwater harvesting schemes. Extensive engagement was undertaken with the many state government departments to provide input and build confidence in the solution. Taking a conservative approach to the development of the water quality targets by using the Australian Drinking Water Guidelines as a priority helped to build this confidence. The optimisation of the weir and pump design to ensure target flows could also be achieved to protect downstream ecosystems and licenced water holders also assisted in the approval process.

However, despite this extensive consultation and conservative approach to the harvesting scheme design and operation, only emergency authorisation was initially given for the Blackmans Swamp Creek project. This meant the stormwater harvesting system could operate, but only for 12 months or until the combined volume of Spring Creek and Suma Park Dams was 50% full. This emergency authorisation was extended for 6 months two times during the drought until the dam levels reached 50%. Council started the process to get a permanent licence for the scheme at the same time as the emergency authorisation. This approval process took over 5 years in order to reach agreement with downstream stakeholders with permanent approval finally being provided in 2015. In contrast, the Ploughmans Creek stormwater harvesting scheme was given a full licence for operation relatively quickly in 2011 but the operation of this scheme was stalled as it required approval to use the Blackmans Swamp Creek stormwater harvesting holding pond which was part of the original approval process.

The emergency approval enabled Orange City Council to supplement the City's drinking water with treated stormwater which helped to ensure there was water available during the drought. During the long delay in getting the permanent approval for the stormwater harvesting schemes, the approval and construction of the Macquarie River pipeline (which links the Macquarie River to Suma Park Dam) was also necessary to satisfy the existing shortfall in the secure yield needed to satisfy the current needs of the City.

Council uses a decision support tool to forecast and operate the different elements of the diverse water supply portfolio using a cost benefit approach. Stormwater harvesting is key to this secure yield as it has a lower operating cost in comparison to the Macquarie River pipeline.

"I am not sure that the harvesting scheme would have been approved and built if Orange was not in a drought crisis as we would still be trying to convince the regulators. Despite the approvals we did get, we still need to go through a long process of trial production before Water NSW will allow full production." – Martin Haege, Principal Environmental Engineer/Director, Geolyse.

3. Concerns from downstream stakeholders – removal of flows (in addition to what was lost when effluent was removed)

While the majority of Orange residents were happy to see the stormwater harvesting schemes implemented, there were some downstream stakeholders that had concerns with the solution. This included concern from creek care and environmental groups about impacts on creek ecology associated with changes in flow regimes and water licence holders downstream of the scheme who were concerned that stormwater harvesting would compromise their ability to access their water entitlement. A community reference group of concerned downstream stakeholders was developed early in the process once these concerns were raised in an attempt to talk through these issues and develop operating rules which would satisfy all parties. Despite this process and the successful operation and monitoring of the Blackmans Swamp Creek stormwater harvesting scheme under the emergency authorisation, a Land Board hearing was required to obtain a permanent licence agreement for the scheme. This process took over 5 years to obtain the permanent licence.

Suma Park Dam

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The lessons

This project demonstrates...

1. **Be open to all options at the beginning:** Even though stormwater harvesting from urban areas for potable uses had not been done anywhere else in Australia, Council was rewarded with taking this initiative forward as it was a cost effective solution for them as they were able to make use of existing infrastructure. The water quality and flow data it has collected through the operation of the schemes can help pave the way for this to be done in other locations.
2. **Helps to have management of the entire urban water cycle under one organisation:** Orange City Council is the manager of water supply, sewerage, recycled wastewater and stormwater and therefore the design, construction and operation of the stormwater to potable schemes was more efficient as it was all done within the one organisation.
3. **Need to be nimble and adaptive in design and delivery:** Due to the critical timing of the project, it was important that the approval and design process occurred in parallel. This meant that the design had to be able to respond quickly to issues and opportunities identified through the approval process.
4. **Leadership and a good team is critical:** Strong leadership in a critical time fostered an innovative working environment which empowered staff members. Key to the effective and rapid change was setting a clear vision and removing barriers for key staff and consultants to apply their strengths in achieving necessary outcomes.
5. **Water assets can provide multiple outcomes:** The stormwater harvesting to potable solutions in Orange were feasible as they optimise the use of existing infrastructure including proximity advantage, plus existing pipelines, water storages and pump stations. The constructed stormwater treatment wetlands also provide multiple benefits including water quality improvement, flow management, habitat, improved amenity and passive recreation.

Reflections and what to work on next time...

1. **Downstream landholder engagement:** Submissions against the Blackmans Swamp Creek stormwater harvesting scheme from downstream stakeholders prolonged the permanent licence approval. Stormwater harvesting schemes which extract water from waterways from which downstream landholders also have existing water extraction licences are likely to raise concerns. Time needs to be allowed for engagement with these stakeholders.
2. **Would help to have supporting guidelines and policies:** In the absence of existing targets and guidelines, approval agencies were quite risk adverse. Conservative approaches were taken to set targets and monitoring requirements. However this has led to a good set of data which can help to generate targets and guidelines for future projects like this.
3. **What would happen if there was no crisis?** It is recognised that a key reason for the stormwater harvesting to potable schemes being delivered in Orange was that there was a water shortage crisis. However, demonstrations like this and ongoing research and development of supporting guidelines and policies will hopefully help make stormwater to potable standard practice in the future.

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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