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# OPERATIONAL REVIEW: OPTIMISATION OF POLYMER IN THE COAGULATION PROCESS



*Paper Presented by:*

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# OPERATIONAL REVIEW: OPTIMISATION OF POLYMER IN THE COAGULATION PROCESS

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## ABSTRACT

The polymer system linked to a DAF process at the Wangaratta Wastewater Treatment Plant (WWTP) has been identified for an upgrade to address ongoing inefficiency issues. These include safety concerns raised with regards to dust exposure and manual handling, as well as ongoing reliability and operability limitations involving blockages and dust infiltration into nearby equipment.

Led by Operators, initial trials have focused on the potential of an alternate polymer to be used. Whilst considerations such as effluent quality and cost are vital, the suitability of the DAF plant with chemically different polymer products has revealed the benefits of optimising a process from both a theoretical and usability perspective.

These trials will lead to a decision on the feasibility of adapting an alternate polymer into the plant; however, the opportunity has encouraged the team to apply skills learnt from LEAN training for personal development, and in turn train a new operator in the process of optimisation.

## 1.0 INTRODUCTION

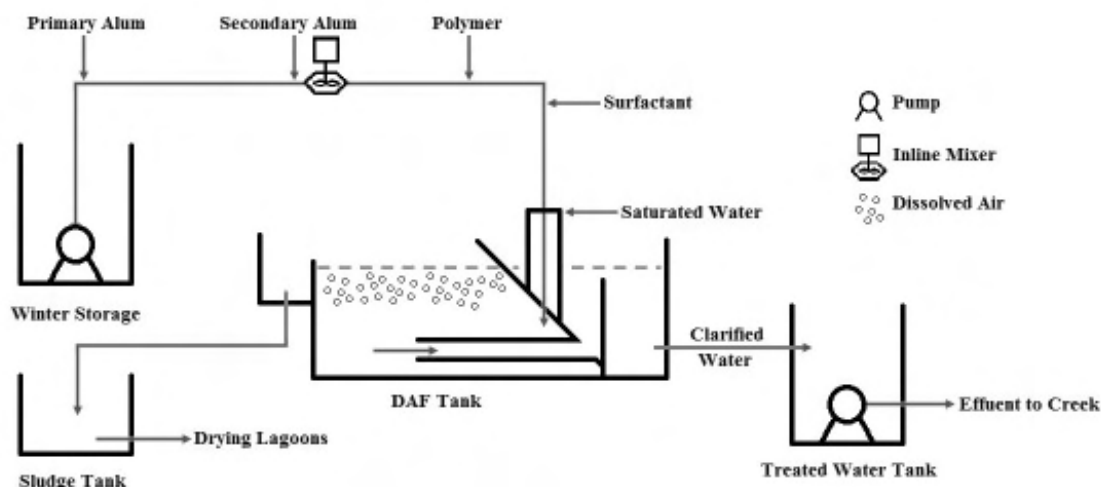
North East Water's (NEW) Wangaratta wastewater treatment facility has undergone some fundamental design changes since commissioning in 2000 and now exists in a Dissolved Air Flotation configuration. The plant runs for an average of six months, treating almost 1000ML of wastewater with storage and reuse irrigation during the warmer months. Effluent is then directed to nearby Reedy Creek at a dilution factor of at least 1:10 based on creek flow.

Currently, the chemical treatment process after influent is passed through aerobic and facultative ponds utilises aluminium sulphate (alum) to reduce phosphorous and suspended solids. Also, powdered polymer ensures these salts flocculate, and surfactant is added to assist the floc blanket to rise in the DAF tank (Figure 1).

This process is successful in producing effluent within EPA specifications, but not without operational shortfalls. In particular, the powdered polymer system, which consists of a heated vacuum and wetting head that batches into a mixing/aging tank, is reaching its end-of-service-life. The system is vulnerable to blockages due to moisture infiltration and the batching sequence frequently fails to initiate which results in callouts and lost production time. However, these problems are compounded by the fact that the powdered form of polymer releases to the atmosphere as a dust.

NEW has a zero-risk appetite for safety across the organisation, so the hazards associated with powdered polymer are worth minimising. Polymer is both an irritant and attracted to moisture in solid form. Release to atmosphere coats surfaces with a slippery and resistant film, which will shorten the expected lifespan of nearby equipment. As a solid product, operators are also liable to manual handling when material cannot be accessed with lifting apparatus.

In response to these setbacks an analysis was requested concerning the viability of upgrading the polymer system. Recent LEAN training (which teaches participants to increase efficiency with less resources), has prompted the operators to consider a proactive maintenance solution by replacing the current rig with one designed for liquid polymer products.



**Figure 1:** *Configuration of DAF Wastewater Treatment Plant*

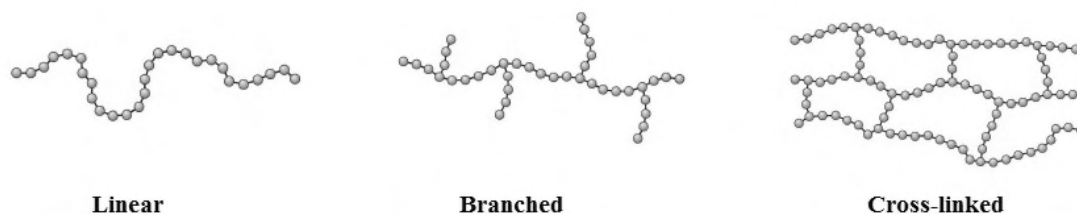
## 2.0 DISCUSSION

Participating in a LEAN training program encourages operators to think of optimisation projects from the perspectives of usability, product quality, and also with regards to how a return of investment can benefit the business. With this in mind, the Wangaratta team approached this trial with anticipation that to build a business case, the focus needed to be beyond eliminating safety hazards at the WWTP, but to identify other benefits including improved effluent quality. This was an opportunity to review current procedures and chemical consumption, run trials focussing on water quality, explore DAF performance with alternate polymers, and determine with data that enhancements could be made.

### 2.1 Linear Polymer Optimisation

A series of trials began with liquid polymer batched manually at 0.5% concentration. This allowed for experiments to ascertain, with no other variables adjusted, whether the treated effluent quality using liquid flocculants was better than with the powdered product. For the purpose of comparison the feed rate was kept equivalent to the normal rate required to keep the flocculated blanket stable (around 2mg/L). This feed rate would then be reduced to the point where the DAF tank could not form distinct sludge blankets, and proved that chemical consumption of poly could not be significantly reduced. These trials were first conducted with a cationic ‘linear’ form of liquid polymer and showed only some deviation in quality from the powdered product with a small improvement in DAF tank clarity.

The lack of substantial change in DAF conditions prompted a reassessment of the type of polymer may best suit the plant. As per Figure 1, the clarified water is drawn into a separate chamber via pipes underneath the sludge blanket. The flow of water in this particular area can be quite high in velocity and assertions were made following jar tests that perhaps the linear polymer was not maintaining large ‘macroflocs’ and stabilising alum particles in the sludge blanket. At this point a stronger, more ‘structured’ liquid polymer normally reserved for centrifuge conditions was introduced for trial (Figure 2).



**Figure 2:** *Modified diagram demonstrating chemical configuration of different types of polymer (Groover, 2010); increasing in both ‘structure’ and strength from left to right*

## 2.2 Structured Polymer Optimisation

As opposed to the linear liquid trial, the structured liquid polymer proved to change the behaviour of the system entirely. It is important to explain that under normal operating conditions at the WWTP, a gradual build-up of alum particles referred to as ‘carry over’ will coat the tank at interfaces and a minimal amount will float. This requires plant shutdown for three hours every week for cleaning. However, running on the structured product reduced this build-up substantially (see Figure 3 for comparison).



**Figure 3:** *Carry-over present operating powdered polymer vs structured polymer*

The main tools used for internal monitoring are turbidity and reactive phosphorous (Ortho-P). While running the new flocculant these parameters were consistently indistinguishable to the current powdered product. Turbidity averaged between 3-4 NTU, whilst Ortho-P ranged between 0.20-0.30 mg/L over the trial (with similar influent water quality across the tests). This provides confidence in the structured product delivering effluent within EPA licence limits.

In-house results were also verified by external NATA analysis of samples running with both powdered and structured polymer to certify our conclusions.

## 2.3 Procedural Optimisation

Over the course of the trial the same methods were employed to ensure internal data stayed consistent. Each time a change was made to dosing, drop down tests were performed on the dosing pumps. In order to prove that practices were precise, these tests were performed three times on the polymer rig to find a percentage standard deviation between times.

In addition the trials were carried out under controlled conditions with all effluent returned to the facultative lagoons.

As part of the trial other chemical reagents such as primary and secondary alum and surfactant doses were modified to test for potential reductions with different flocculants (by measuring the target water quality parameters). What was discovered was that pump doses were different in reality to that shown on SCADA and the consumption of the coagulant and surfactant could not be reduced based on the type of polymer used. However, increased monitoring of the raw influent to the plant resulted in refined daily dosages. This is a simple principle, but has huge long-term implications for cost reductions to operations and could be applied to many aspects of the water industry.

Notwithstanding this cost reduction, another procedural change provided important insight into operational outcomes. While observing the sludge blankets on the top of the DAF during each run (especially when intentionally modifying feed rates to test for failures), it became important to the operators to recognise that any change to a flocculant may reduce the effectiveness of sludge removal. If alum is not being sufficiently flocculated and sent to the sludge tank, then phosphorous locked to the alum is also carried over and measured in the monitoring tests.

## **2.4 Indirect Gains from the Trial**

A key part of the optimisation project has not been about the results, but the actual process of completing a trial. Understanding the role of each component of the plant, and reviewing a system has been as much of a project in applying experience and LEAN problem solving, but also about teaching an operator in their new position and finding a fresh niche for previously acquired knowledge.

For Bridey, the experience has built upon her theoretical training in chemistry in order to be able to apply her experience with scientific experiments on an industrial scale. With John as a mentor and a team of experienced operators at hand, her lack of insight into machinery and process systems has been enhanced, and the task of attempting to optimise a plant that is unfamiliar has actually helped her learn how to be an operator. For example, John was able to teach Bridey how to recognise the difference between flocculation blankets by recording observations on clarity, floc size and blanket consistency, where to the untrained eye it might all look the same.

As a mentor figure, John brought his skills in commissioning and operating trade waste facilities to a new field. This has had great implications for the optimisation process as experience has given John the foresight to realise that ‘every change is going to result in another’, and he can reason beyond what has historically been routine procedure at the plant. NEW think this mentoring exercise is something that others could benefit from, especially given the advantages of sharing knowledge with less experienced operators.

## **2.5 Building a Business Case**

Another advantage gained from LEAN training has been to view this project from the perspective of the Executives who will decide on its eventual direction. This process has enabled us to set realistic goals in relation to both safety and product quality (as detailed above), but also considered a justification as to the cost of replacing the powdered polymer rig at the end of its economic life.

We will be presenting our pitch to invest in this project with the following principle cost savings:

- Reduction in labour due to decreased cleaning of DAF tank and dust infiltration equates to a saving of 108 hours over 6 months of operation
- Increased analysis and feed rate control can result in a 2% annual cost saving for each 10 mg/L reduced alum dose
- A return on investment for the project can be achieved in 66 weeks

## **2.6 Future Directions**

Further investigations have been highlighted as to the effect carry-over might have upon reactive phosphorous testing, and whether a shift to structured polymer would improve accuracy. However, since the treated water is already within specified targets despite small alum impurities incurred during collection, this is not a significant matter. Instead, the focus will remain upon continuing to collect data and further use of the structured polymer to increase confidence in the business case.

## **3.0 CONCLUSION**

As far as the flocculant optimisation is concerned, the viability of a structured polymer is clear: treated effluent can be achieved within the same specifications as the current EPA licence, and the cost of the project can be negated by savings in labour and optimised chemical dosing. Also, the act of conducting these trials has developed the Wangaratta team's understanding of system controls at the WWTP and built a mentoring relationship between staff.

Nevertheless, it is the improved safety aspect for our operators that eclipses all other benefits when considering a switch to liquid polymer and this will be the basis of our investment proposal.

## **4.0 ACKNOWLEDGEMENTS**

A huge thank-you is in order for the Wangaratta Treatment team who with the leadership of Jeff Roscoe have each contributed to the optimisation project and demonstrated the advantages of professional collaboration.

We would also like to thank Grant Waite for his support and guidance in the process.

Finally, we wish to show our appreciation to Jason Mullins for his input into the development of this paper.

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Groover MP. *Fundamentals of modern manufacturing: materials, processes, and systems*, 4<sup>th</sup> edition, John Wiley & Sons (2010)

# TAKE YOUR TABLETS – OUTCOMES OF THE POMONAL CHLORINE TABLET DOSING FACILITY TRIAL



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# TAKE YOUR TABLETS – OUTCOMES OF THE POMONAL CHLORINE TABLET DOSING FACILITY TRIAL

**Chris Baker**, *Senior Project Engineer, GWMWater*

## ABSTRACT

Pomonal is a small town with a population of 350 people located on the east side of the Grampians National Park approximately 20km SW of Stawell. Since 2001, a potable water supply has been provided from the Halls Gap Water Treatment Plant (WTP) via a 12km trunk main to the Pomonal 450kL Clear Water Storage (CWS) Tank. Initial disinfection is by Chlorine Gas at the Halls Gap WTP.

Due to the long and relatively large diameter trunk main (DN250/200/150), there has been an ongoing issue of maintaining an effective free chlorine residual in the Pomonal CWS tank and reticulation.

At GWMWater, the most common method of disinfection is via a Chlorine Gas Chlorinator.

The Pomonal CWS Tank site has certain limitations that made the installation of a Chlorine Gas Chlorinator facility difficult. These factors include:

- There is no mains electricity available on site
- Relatively small plot of land available on site (Difficult for bulk chlorine delivery trucks)
- Budget limitations
- Closest house only ~100m away

GWMWater trialled a Chlorine Tablet (Calcium Hypochlorite) dosing facility which is solar powered.

The system has been running for approximately one (1) year now with mixed results.

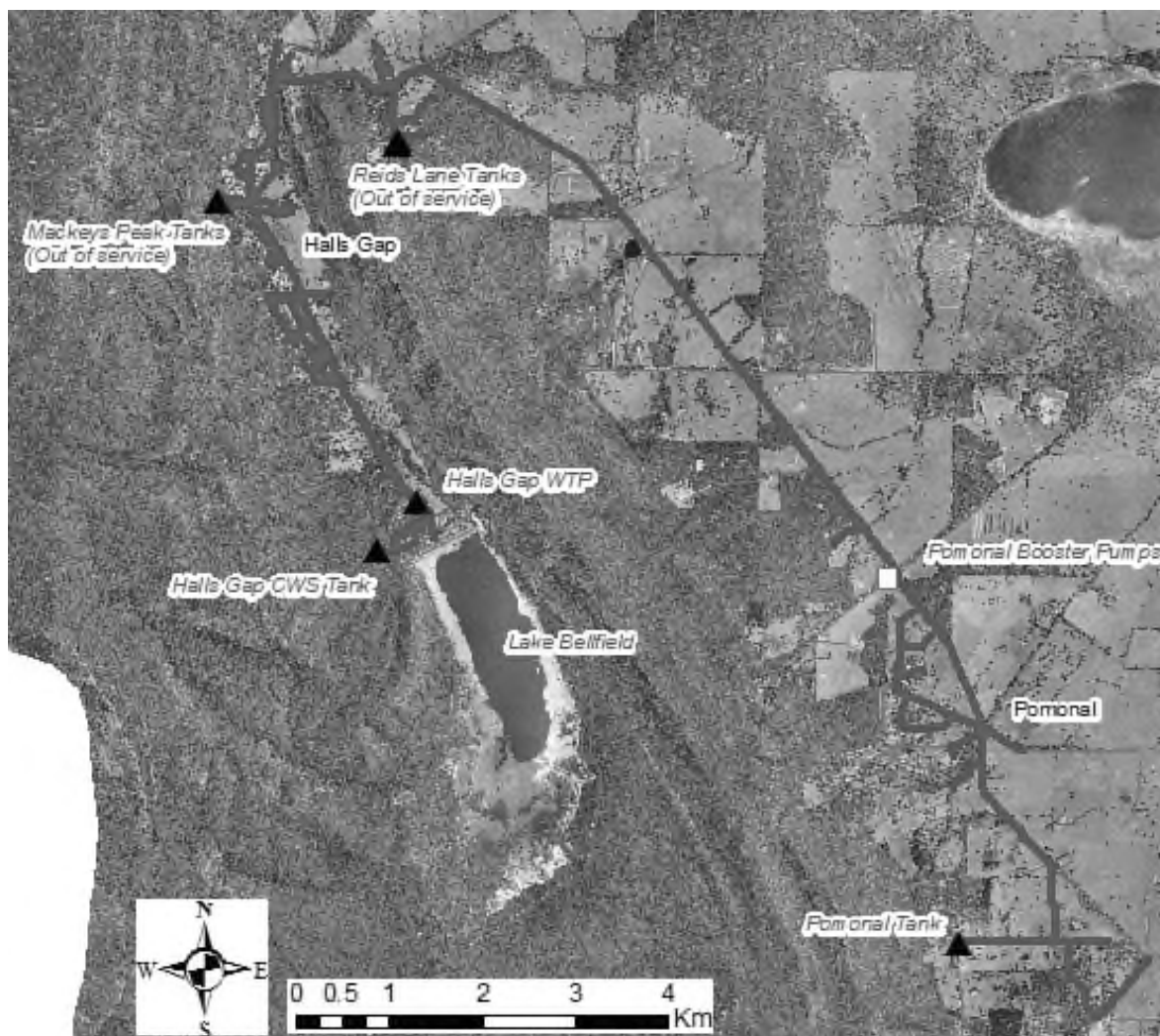
## 1.0 INTRODUCTION

Pomonal receives a chlorinated water supply from Halls Gap Water Treatment Plant (WTP) via a 12km long pipeline. The Pomonal 450 kL elevated storage is located at the far end of the network and is kept full with the assistance of pressure booster pumps.

Pomonal consumes approximately 25ML/year of potable water.

GWMWater's weekly *manual* sampling results indicated on multiple occasions that chlorine residuals especially at the far end of the network, were lower than optimum. There was no chlorine analyser in the system, restricting the ability to effectively monitor the chlorine residual.

Initially it appeared that the network is fed from the elevated CWS Tank, however detailed analysis of the system confirmed that it is split in two parts. The *lower* portion of the township receiving supply from the Booster Pump Station, and the *higher* level of the township receiving water from the CWS tank.



**Figure 1:** *Halls Gap and Pomonal Potable Water Supply System*

Testing showed that the low chlorine residual was actually being caused by the additional detention time in the CWS Tank and therefore a Chlorine Booster arrangement was required at this location.

#### **Pomonal Potable Water Supply Timeline:**

**<2001:** Chlorine Gas Disinfection of Raw Water taken from the *Tunnel Pipeline* via creek diversion upstream of Lake Bellfield and Chlorine Gas disinfection only.

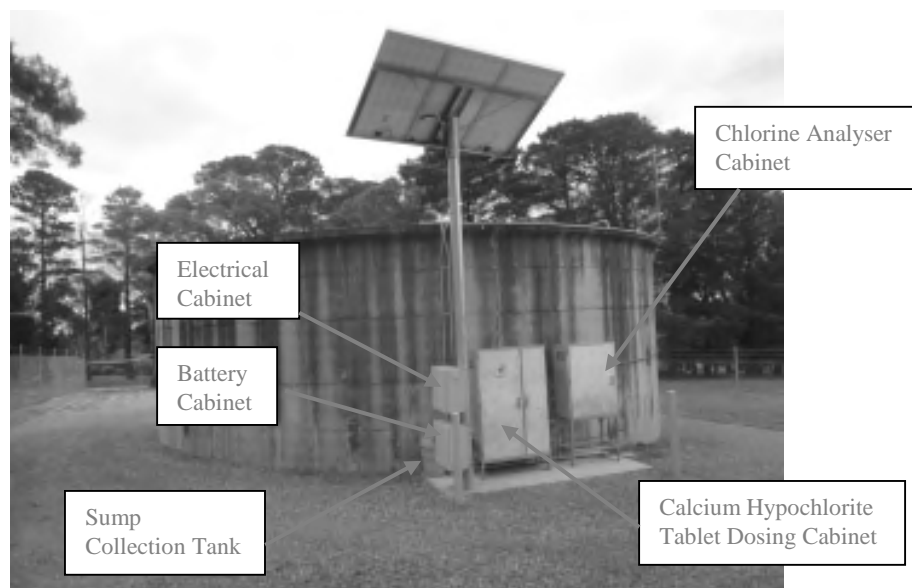
**2001 -> Aug 2016:** Potable Water sourced from Halls Gap WTP via new pipeline extension to the township of Pomonal. Chlorine boosted at Pomonal CWS Tank via Chlorine Tablets in floating baskets on the water surface inside the CWS tank. The dosing of these chlorine tablets was a manual process where generally four (4) tablets were added once a week, combined with weekly township sampling that was independently tested.

**Aug 2016 onwards:** Utilisation of the *automated* Chlorine Tablet Dosing System complete with Chlorine Analyser, in conjunction with weekly township 'manual' sampling which is independently tested.

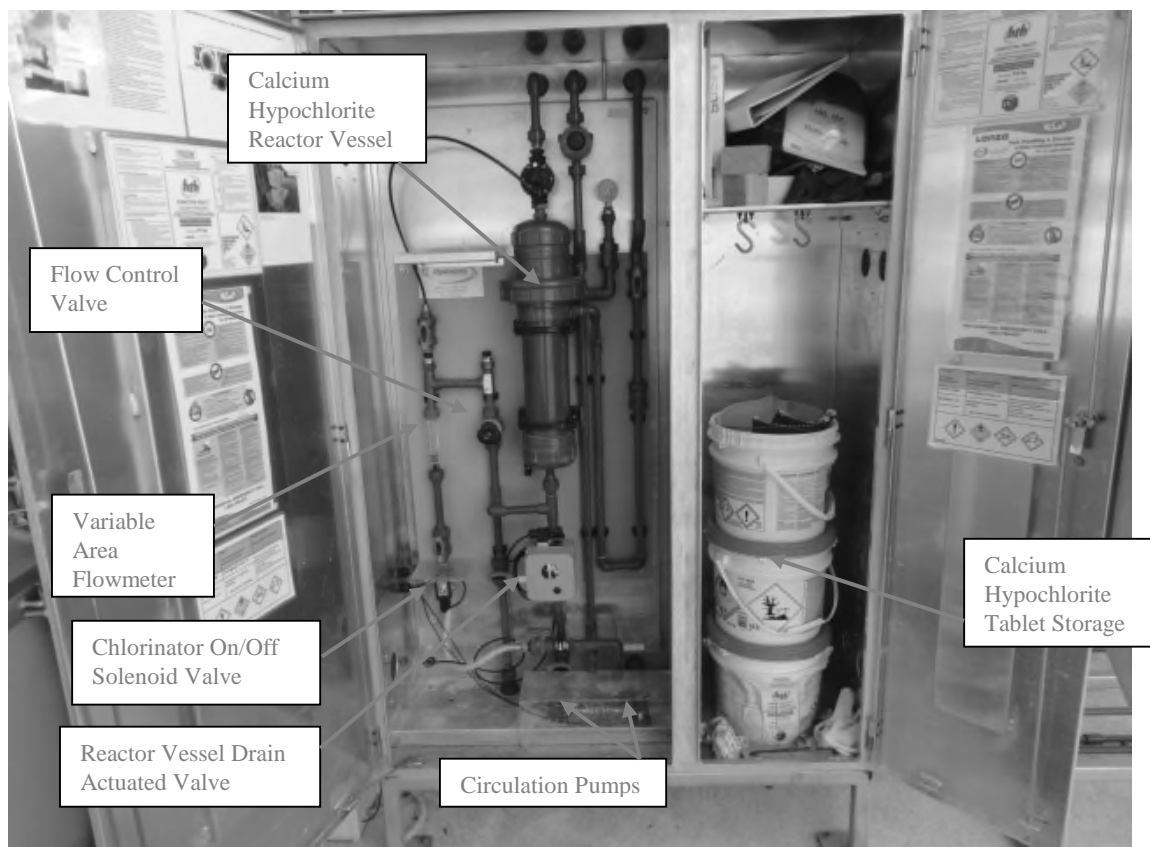
## 2.0 DISCUSSION

The Calcium Hypochlorite Tablet Dosing System was recommended for Pomonal for the following reasons:

- Tablet dosing system can operate from solar power. It is difficult and expensive to connect the site to mains electricity with a distance of ~500m from a suitable point of connection.
- Chlorine Gas (the most common method of disinfection at GWMWater) utilises a solution water pump that would typically require mains electricity due to a relatively high energy requirement.
- Existing system utilised Chlorine Tablets. (Baskets containing tablets that float on the surface of the tank). The new arrangement was viewed as an *automation* of this existing process.
- Small site that would make bulk chlorine gas bottle delivery in trucks difficult. Well suited to tablet delivery in 14kg buckets.
- Tablet system relatively safe from an OH&S perspective. Requirements when operating and maintaining dosing unit:
  - Chemical Gloves
  - Face Shield
  - Operators required to have undertaken an accredited General Chlorine Handling Course
- GWMWater interested in trialling a new (innovative) approach at this location.
- New tablet dosing system was cost effective. The capital cost for the Pomonal chlorine tablet chlorinator was \$42k + GST. This included: Dosing system, chlorine analyser, solar system, civil works, and SCADA integration



**Figure 2:** Pomonal CWS Tank and Chlorination System



**Figure 3:**      *Chlorinator - Calcium Hypochlorite Table Dosing System*

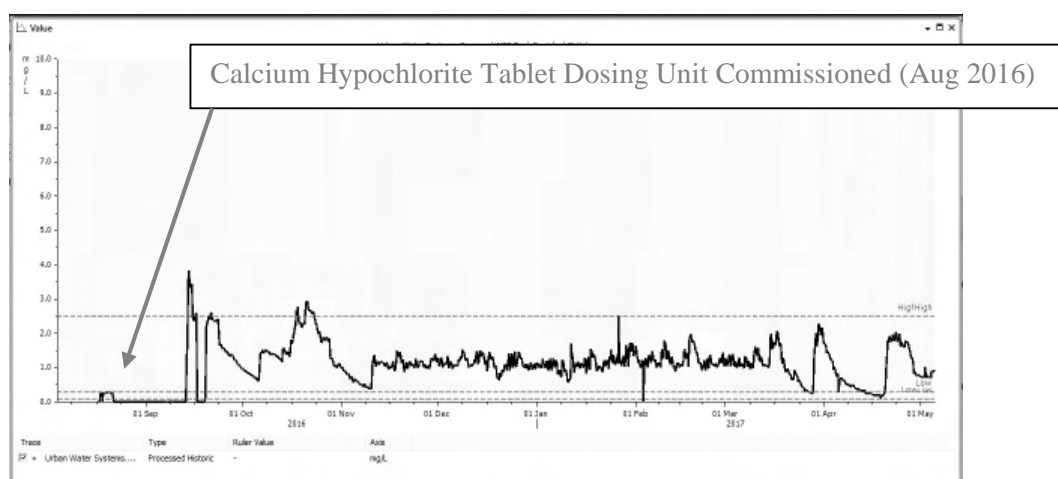


**Figure 4:**      *Loading Tablets into the Canister*

## 2.1 Issues Encountered

1. The reaction vessel drainage system requires regular cleaning to either clear blockages or to prevent blockages which is messy and an environmental issue. The inside of the cabinet is splattered with solution water staining, and the Perspex covers fitted over the electrical equipment have proven to be vital. The wash down from cleaning has resulted in some of the chlorine solution being discharged onto the ground. The original Auto drain (diaphragm type valve) that operated when feed water supply pressure was reduced (ie. when dosing stopped), continually blocked with Tablet *slurry*. This valve was replaced with an actuated ball valve which has proven to be more reliable with a reduction in blockages occurring.
2. The *Auto-Drain* drains the left over water that is surrounding the tablets into the *blue* Collection Drum. This drum has float switches that trigger pumping of the chlorine solution water into the CWS Tank. A lower than desired dosing rate set point is utilised in order to create a buffer for the Collection Drum *carry over*. If this chlorinated water is not drained from the reaction vessel, it will become a supersaturated solution and result in future over-dosing issues. Feedback from the tablet dosing unit supplier was that these units have been typically set up in the past on much larger CWS tanks that have had negligible impact from the vessel drain down solution water *carry over*.
3. The actual *top-up* of the Tablet Dispenser requires a detailed procedure to be followed which is time consuming and awkward. Also the Chlorinator is required to be taken offline during this process. The tablets (Calcium Hypochlorite) are generally *topped up* weekly in summer and fortnightly in winter.
4. It is not possible to tell how many tablets are left (either locally or remotely) without removing the vent pipework and taking off the reactor vessel lid. Utilisation of a *dip-stick* is then utilised to check tablet level.

## 2.2 Chlorine Residual Performance



**Figure 5:** *Pomonal CWS Tank – Chlorine Residual SCADA Trend*

The Pomonal CWS tank chlorine residual trend indicates the difficulty we have had with the system to maintain a steady residual.

## 2.3 Summary

The Pomonal Chlorine Tablet Dosing Facility Trial system initially appeared to be simple, cost effective, and safe.

The overall results of the trial were as follows:

- Chlorine residual that was difficult to maintain in a steady state condition
- Topping up of the tablets is a relatively high maintenance activity that is awkward to undertake
- Handling of the tablets is relatively safe from an OH&S perspective
- The solution water return from the Sump Collection Tank (which is sourced from the reaction vessel drain down) has proven to be a source of unwanted chlorine residual *top ups*. We have had to lower the Chlorine residual set point (when the dosing units stops operating) to allow for a buffer margin to allow for these unwanted and uncontrolled top ups.
- The Reaction Vessel drain down pipework requires regularly cleaning to prevent the solution water scaling the pipework and clogging the drainage system.

An investigation and assessment report has been undertaken by GWMWater for this facility with the trial deemed unsuccessful. The facility most likely will be retrofitted with an alternative chlorine boosting arrangement that can still be solar powered. This will most likely be a liquid Sodium Hypochlorite dosing arrangement.

## 3.0 CONCLUSION

The Pomonal Chlorine Tablet Dosing Facility Trial initially appeared to be simple, cost effective, and safe. After approximately one (1) year of operation the following issues emerged:

- Difficult to maintain a steady chlorine residual in the CWS tank
- Topping up of the tablets is a relatively high maintenance activity that is awkward to undertake
- Reactor Vessel drain down water proven to be difficult to manage
- The Reaction Vessel drain down pipework requires regularly cleaning to prevent blockages in the drainage system.

GWMWater plans to retrofit an alternate disinfection system in the future. This would most likely be a liquid Sodium Hypochlorite dosing arrangement.

## 4.0 ACKNOWLEDGEMENTS

GWMWater Staff: Chris Faulkhead, Michael Hutchison, Ivan Wild, Chay Tokekar, and Graeme Dick.

Lonza Water Treatment: Chris Smith

# ENERGY EFFICIENCY OPPORTUNITIES AT WASTEWATER TREATMENT PLANTS



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# ENERGY EFFICIENCY OPPORTUNITIES AT WASTEWATER TREATMENT PLANTS

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## ABSTRACT

The energy intensity of wastewater treatment plants (WWTP) is dependent on multiple factors: the process design, technology used, its treatment capacity, and how it is operated. We have conducted energy audits and studies at over 27 wastewater treatment plants. Based on our work on an energy efficiency guide for the wastewater treatment industry, and our audit experience, we present some common opportunities, with short payback periods, for WWTP to improve energy efficiency and reduce cost. The opportunities we present can be broadly categorised into 1) Energy management systems, 2) Energy efficiency, and 3) Energy cost reduction.

## KEYWORDS

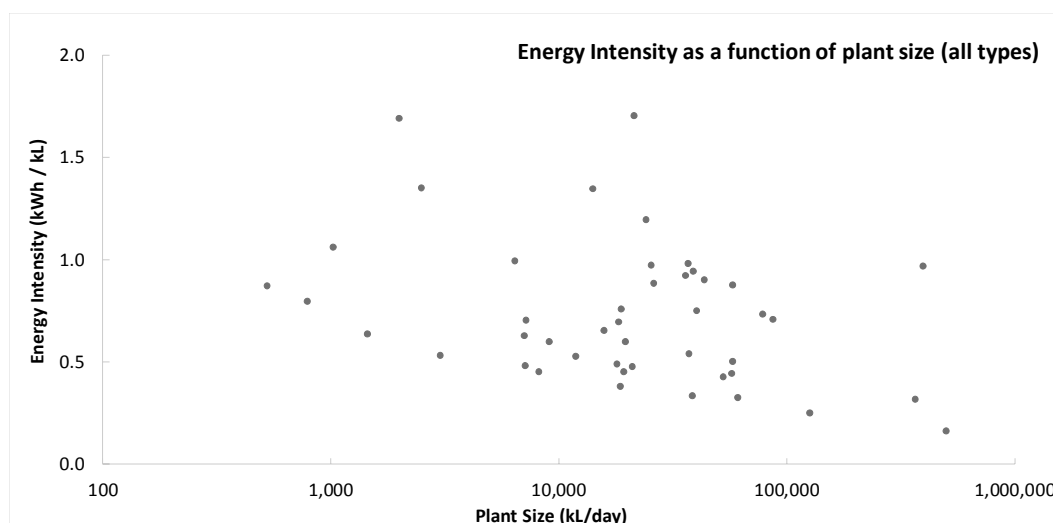
Energy Efficiency, Benchmarking, Wastewater treatment plants, Energy Management System, Pumps, Aeration System, Blowers, Energy Cost Reduction

## 1.0 INTRODUCTION

The energy required to treat Australia's sewage, on centralised networks, is estimated to be 1,000GWh a year (Kenway, 2008), which is about the same power as that consumed by 170,000 households in NSW (Ausgrid, 2017).

The energy required to treat sewage varies greatly from plant to plant. Based on published data and data collected during energy audits, the energy required to treat 1000 litres of sewage typically range from 0.30 kWh to 1.70 kWh. Some plants can be significantly outside this range.

The WSAA 2013-2014 benchmark study (de Hass, 2014) indicated that larger plants are more energy efficient. However, there is still a range of efficiencies at any given plant size (see Figure 1).



**Figure 1:** *Australian and international energy intensities for WWTPs.*



With increasing energy costs and a growing need to reduce greenhouse gas emissions, there are more reasons than ever to reduce both energy costs and consumption at WWTPs.

We present some common opportunities with good financial return (short payback) at WWTP for improvements to energy efficiency, cost reduction, and moving towards carbon-neutrality.

## 2.0 DISCUSSION

The common opportunities, with short payback periods, at WWTPs can be broadly categorised into:

- (1) Energy management systems
- (2) Energy efficiency
- (3) Energy cost reduction

The opportunities under each of these categories will be discussed in detail below.

The topic of embedded renewable generation – generating energy using solar, biogas and/or biosolids – which has the potential for significant cost reduction and enables a WWTP to become effectively carbon neutral, will be reserved for another paper.

### 2.1 Opportunity Category 1: Energy Management Systems

An Energy Management System (EnMS) is based on a continuous improvement cycle that will ensure savings are continuously achieved.

Key components of an EnMS are:

- **Energy policy:** that sets corporate targets and objectives, allocates required resources and budget, and engages staff at all levels of an organisation in energy management
- **Energy planning:** which is a structured approach to determine baseline energy use, establish benchmarks and Energy Performance Indicators (EnPIs), and set improvement targets with action plans
- **Implementation and operation:** implement action plans, operating procedures, modifications, and maintenance activities to meet objectives
- **Monitoring, measurement and analysis:** monitor and measure major energy consumers, determine appropriate indicators, compare actual against expected energy consumption
- **Internal auditing:** ensure compliance to the plan, and report regularly to senior management
- **Management review:** management review of the EnMS and updating of policies, and procedures as appropriate.

With the appropriate operator engagement and training, reductions in energy consumption may result from behavioural changes alone, typically reductions of 10–15% are observed in all industries (Renssen, 2016).

In one example, one WWTP plant benchmarked their pump performances, and was able to identify pumps where valves were partially closed. Opening the valves, and using the installed VSDs to reduce pump speed by 30%, allow savings of ~60% in energy.

**Table 1:** *Suggested EnPIs for two largest power consumers on WWTPs: pumps and aeration blowers*

Equipment	EnPI	Description & Data Requirements
Pumps	Power per volume pumped per unit of differential pressure (head) (e.g. kWh / m <sup>3</sup> / m)	A pump performance indicator that allows direct comparison between different pumps and different pumping pressure (head) requirements. Real power, flow rate, and suction and discharge pressures are required. Power can be inferred and extracted from some VSDs. Power from a pump system can be included in the EnPI if multiple pumps are employed for a common duty.
Aeration blower	Power consumed per mass BOD (or COD) destroyed (e.g. kWh / g BOD)	This EnPI will indicate overall aeration system efficiency, and does not require an air flow meter. Real blower power and site inlet and outlet BOD (or COD) data required.

## 2.2 Opportunity Category 2: Energy efficiency

### 2.2.1 Optimise recycle stream flow rates

**Likely Payback: 0-3 months**

Most activated sludge WWTPs have a Mixed Liquor Recycle (MLR) and/or a Return Activated Sludge (RAS) stream.

The MLR pumps recirculate mixed liquor from the outlet of the aeration zone back to the inlet, allowing longer residence time in the aerobic zone. The RAS is drawn from the clarifier and mixed with bioreactor influent to seed biological processes. In many plants, the MLR and RAS flow rates are set to design flow rate when the WWTP is operating at full capacity. Yet, most WWTP operate only at a portion of full capacity. There are many options to control MLR and RAS flows to the minimum required to maintain effective sewage treatment:

#### ***MLR flow control options***

- Fixed rate—often excessive in low load conditions.
- Flow paced—set as ratio to total influent flow, allows flow rate to reduce during low load periods.
- Nitrate setpoint—Allows for optimisation of biological nutrient removal.

#### ***RAS flow control options***

- Fixed rate—can contribute to variability in waste sludge solids content, impacting performance of sludge thickeners.
- Flow paced, 30-125% of influent flow rate (depending on plant design)
- Sludge blanket measurement—maintains sludge depth to ensure clarifier stability.
- Where possible, change control set points slowly to avoid major disruptions to the system.

### 2.2.2 Install and Use Variable Speed Drive

**Likely Payback: 1-2 years**

Using a control valve to reduce flow rate will result in more energy being consumed than is required.

Using Variable Speed Drive (VSD) instead of a control valve reduces system friction losses and can significantly reduce energy consumption due to the cubic relationship between friction losses and power consumption.

### **2.2.3 Select suitable replacement pump and Assess      Likely Payback: 2-4 years**

#### **Total Cost of Ownership**

Often when a pump or motor fails, replacement is often selected on a like-for-like basis, and can be dictated by what the local distributor has in stock. The original equipment was likely specified during the design of the plant, with allowances for uncertainty around operating conditions. Like-for-like replacement is a missed opportunity to select equipment based on actual observed operating conditions as well as to take advantage of new technology.

Premature failure of any component of a pump system may also be an indicator that the pump is poorly matched to the required duty. A 'pump autopsy' to inspect a damaged pump can identify operating issues and prevent future problems.

Selection should always be based on total cost of ownership over the operating life of the equipment. This includes costs for purchase & delivery, installation & commissioning, maintenance, energy (consumption, capacity and environmental charges) and other relevant costs.

In some cases, it may be economical to replace an existing pump with a well-selected, efficient pump.

### **2.2.4 Install a Jockey Pump next to a larger pump      Likely Payback: 1-3 years**

Peak influent flows to a WWTP can be infrequent events demanding flow rates much greater than average throughput. A pump that is selected to handle the highest required flow rate will be significantly oversized for normal operating conditions.

Installing an adjacent pump, selected for efficiency under normal operating conditions, will greatly reduce the energy consumption while still maintaining the capacity of the larger pump for peak events.

### **2.2.5 Optimise blower sequencing & control      Likely Payback: < 1 year**

Regardless of the number, size and type of blowers in your aeration system, there will be an optimum configuration where air is delivered to the aeration tank for the minimum energy spend.

Consider which combination of available machines can deliver the required aeration rate most efficiently at different output levels. Configure the control system to select the most efficient configuration and smoothly manage the transition between operating modes as aeration demand ramps up or down.

### **2.2.6 Optimise blower outlet pressure by using dynamic control based on Most-Open-Valve logic      Likely Payback: 1– 2 years**

In centralised blower systems, the control system must calculate the required flow rate to different areas of the plant. The flow rates are achieved by modulating a control valve on the supply line to each zone. Blower controls respond by varying blower output to maintain outlet, or header pressure according to a pressure setpoint.

Most-Open-Valve logic, instead of maintaining a constant pressure, will control blower output to deliver the required air flow to all aeration zones. If air flow to individual zones exceeds the target flow rate to that zone, flow will be restricted by the control valve. The system pressure is now the minimum pressure required to deliver the target flow rate to the zone with the most open control valve.

#### **2.2.7 Reduce blower inlet temperature (passive only) Likely Payback: 2–6 years**

Blower efficiency increases when the inlet temperature is cooler. If a blower is in an enclosed space—consider increased ventilation (e.g. replace part of a wall with ventilation).

Note: active cooling, e.g. using an air conditioner, will not provide a net benefit.

#### **2.2.8 Blower control with DO sensor Likely Payback: 3–6 years**

Dissolved oxygen (DO) sensors can provide live indicators of the amount of oxygen in the aeration tank.

Using online DO monitoring to control blower output can ensure the rate of aeration matches the requirement of the process only, avoiding excessive aeration which is lost to the atmosphere.

Maximum savings from this opportunity will be realised when coupled with optimum blower control (#2.2.5) and a VSD blower (#2.2.2).

### **2.3 Opportunity Category: Energy Cost Reduction**

These efficiency opportunities are those that reduce electricity cost without reducing overall consumption:

- **Pay bills on-time (or early):** some electricity retailers will charge interest if your bills are paid late - pay bills by the due date to avoid interest charges. Or at least, compare the retailer's interest charges to the company's internal cost of capital and make an informed decision. Some energy retailers will also provide discounts if you pay your bills early.
- **Bill checking:** Don't assume your electricity bills are correct and have no errors. Some sites have found errors totalling tens-of-thousands of dollars over a year. For larger sites, the bill checking process could be automated using an energy intelligence software platform
- **Shift usage to off-peak:** The cost of electricity, both energy and demand charges, during off-peak times can be 40–60% that of the cost during peak period. For services that are less time-critical, consider operating at the minimum throughput required during peak periods and “catch-up” off-peak, e.g. recycled water pumping.

- **Demand reduction:** Usually a site's demand charge is based on the maximum kVA in a 15- or 30- minute interval in the past twelve months, rolling; this differs for each contract.  
For one site as an example: a 100kVA demand reduction is equivalent to ~\$7,000 in savings p.a. For this site, the top 400kVA of demand occurs in 0.01% of the time, i.e. in less than 10 hours a year.  
Strategies to reduce demand include:
  - load management: run non-essential services outside peak times
  - load shedding: turn off or ramp down non-essential services, e.g. reduce effluent pump load when site demand is elevated
  - install power factor correction
- **Shop around & negotiate a better contract:** Just like buying a new car, shopping around and negotiating what works best for your site will result in the best deal for your electricity costs. If you are considering using a broker, ask upfront how their fees will be paid.

### 3.0 CONCLUSION

We have presented some common opportunities, with short payback periods, at WWTP for improvements to energy efficiency and cost reduction. The opportunities we presented can be broadly categorised into 1) Energy management systems; 2) Energy efficiency; and 3) Energy cost reduction.

### 4.0 ACKNOWLEDGEMENTS

Thanks to all the WWTPs that allowed us to use their data for Figure 1.

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*Winner of the Best Operator Paper and Best Paper Overall at the  
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## **CURLEWIS PUMP STATION CHLORINATION UPGRADE**



***Paper Presented by:***

**Brock Stone**

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**Brock Stone, Water Quality Officer,**

**Gunnedah Shire Council**



***80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
Conference and Exhibition  
Bendigo Exhibition Centre  
6 September to 7 September, 2017***

# CURLEWIS PUMP STATION CHLORINATION UPGRADE

**Brock Stone**, *Water Quality Officer*, Gunnedah Shire Council

## ABSTRACT

In 2016, Gunnedah Shire Council planned a major upgrade to the Curlewis Pump Station and chlorination site.

We had to take into consideration that this site is the only water source for Curlewis so an uninterrupted supply would have to be maintained during the build. These bores will more than likely be discontinued in the future due to the hardness of the ground water and a proposed pipeline extending to the village from Gunnedah. The pipeline will be a long term project as it will require pipeline over 15 km in order to provide the village with Quality water however we needed to fix the current problem of the dilapidated building and aging chlorination system regardless of future plans. We also had to recognise and overcome the limited budget that was given for this project.

## 1.0 INTRODUCTION

Curlewis lies on the Kamilaroi Highway, 17kms South of Gunnedah. Water for the village is pumped from the Liverpool Plains Bore field located approximately 5km from the town. I mentioned before the hardness of the water. If you were to ask anyone in Curlewis how their water tastes the standard reply would most likely be **“Don’t know, don’t drink it”**. The hardness is some 2.5 times the Guideline Value of 200mg/L and high in Sodium and Chloride and in the range specified by the World Health Organisation as “unpalatable”. Drinking water mostly comes from private rain water storage tanks. This inherently creates health risks through lack of maintenance of rainwater collection systems, water age issues and lack of disinfection in the tank supply. As mentioned, there is a future proposal for a water pipeline from Gunnedah to alleviate some of these issues.

The problem was the state of disrepair of the dosing site and the building. The building was established in 1970, made of brick and mortar with a tin roof. It was a sturdy construction at the time and it kept the weather out. With the introduction of disinfection in 2004, extra funds were not available to support an upgrade to the asset and so year after year the project was put on the back burner as other concerns were dealt with.

Gunnedah Shire Council employed one Water Quality Officer at this point in time, Greg Ellis, affectionately known as ‘Slim’. He had to cover 16 bore sites, 6 dose sites, 12 reservoirs, 31 telemetry sites over 4 townships spanning a distance of some 250kms. Effective time management was a fantasy, and as it was, a lot of jobs were put aside as priority was given to break downs, DAL sampling and Chlorine Monitoring.

In 2014 I was a Water Meter Reader, but also being trained in Water Quality so I would be ready to perform relief duties for Slim as they arose. I was first made aware of the issues at Curlewis during a training day with Jill Busch from Aqualift. Jill had been extremely helpful to me as I had limited knowledge about the Water Quality role and with the new Safe Drinking Water Guidelines that Gunnedah Shire Council (GSC) had adopted both Slim and I were fast learning that this thing called ‘Water Quality’ was going to eclipse all previous understanding of our roles within council.

Jill was taking me through the various issues of the Curlewis plant and making a few discoveries that she thought would have to be preserved for posterity. As her camera started clicking away, Jill could be heard saying “Do you mind? I just have to get a photo of that!”.

Some of the issues discussed included:

- Corrosion to the block work and slab
- Rusting supports to the bore perch
- Leaks to the bunding under the hypo tank
- Aging dose pumps and lines with rusted and corroded support brackets
- General housekeeping and maintenance

With Jill’s help, patience and guidance we were able to get on top of the basics and were provided with options and recommendations for an upgrade to the site.

August 2015 was a tough month. Slim passed away in a tragic car accident while coming back from Mullaley after completing DAL samples that morning, he was out doing some field work and never made it home. I was now thrust into a position I didn’t expect to be in, and the next few months would prove to be one of those ‘sink or swim’ scenarios as one thing after another would either break down, stop working or just get struck by lightning as I was adjusting to this new role without my mentor. My respect for Slim only grew during this time considering what he was able to accomplish day in and day out.

It wasn’t until the summer of 2015 when Curlewis Pump Station suffered one of those lightning strikes which fried one of the bore pump cables, one of the dose pumps, different boards in the telemetry cabinet and the electrical switchboard. We were promptly motivated to act on some of the recommendations Jill had previously provided as we had to rebuild so much at the site after the strike.



**Figure 1:**      *Curlewis Pump Station and Dose Site 2014*



## 2.0 DISCUSSION

After much discussion and number crunching concerning the replacement of lightning affected components, it was decided that we would attempt a complete upgrade during this process with the exception of the previously reconditioned bore pumps.

The proposed new plant would get the full treatment up to \$85,000.

The upgrade would include:

- Dose plant;
- Two new dose pumps;
- Hypo storage tank;
- Two new mag flow meters;
- New electrical switch board and cabinet; and
- Security fencing around the site.

In addition to this consideration had to be made for the plant to be easily relocatable to accommodate the plans of the future. We looked into various solutions to the 'easily relocatable' aspect of the work and realised pretty quickly that a pre-fabricated module designed for dosing was well out of our price range due to the strict budget constraints. Finally after researching and brainstorming ideas we decided a cool room was our best option.

### 2.1 Not Quite a Cool Room

Gunnedah is a small community and we like to buy locally when we're able. GSC approached local business owners H & M Refrigeration & Air-conditioning and discussed the idea of a small plant for our dose pumps with them. They thought the build wouldn't be a problem and began to design what would become our own version of a pre-fab Dose Plant. The unit size is 2.4m x 2.4m with a solid skid base that can be lifted by crane or forklift. Using the lightweight cool room materials the internal walls and ceiling are poly vinyl lined and the floor has a 2 pack resin coating so that none of the alloy panels could be affected by the Hypo. Ventilation windows were cut into all sides of the room and designed to keep out weather, vermin and insects and an inclined corrugated roof finished off the design. The construction of the building cost just under \$20,000.

**Table 1:** *Breakdown costs of Curlewis project*

Description	Cost
Pre-fab building on skid	\$ 19,922.73
New Dosing Pumps & installation	\$ 24,244.00
Electrical & Switchboard upgrade	\$ 13,809.09
Fence	\$ 8,337.91
Demolition, Labour & plant hire	\$ 12,662.38
Total build cost	<b>\$78,976.11</b>

### 2.2 Demolition

The demolition of the old building was challenging for the fact that we still had to provide disinfected water to the reservoir during the process.

Local contractors lifted the roof and once removed started knocking down the walls one block at a time careful of dose pumps and lines, control boxes, bore and pipes all housed and attached to the walls inside the structure.

During this process our electrician was starting to set up temporary power to a timber framed stand to support the dose pumps and control cabinet that were previously mounted to the block walls. We then wrapped it in plastic to keep the elements out of the electrical components as it would spend the next few weeks with only that for protection during the build. It wasn't pretty but it worked.

## **2.3 Completed Works**

Once all the components were delivered to the site the build came together quickly. As soon as the plant was in place the electrician and Prominent moved in. Dose pumps and pipes were installed in one day and tested the next. Some work between the two contractors to get the pumps and bores talking to each other was quickly undertaken. The fencing went up just as quick and the painting and bore perch repairs were done in between other projects over the next few weeks. It was great to see the finished product from concept to completion.



**Figure 2:**      *New Curlewis Dose Plant*



**Figure 3:**      *Completed internal works*



**Figure 4:**     *Completed external works*

### **3.0 CONCLUSION**

By thinking outside the box and receiving input from members external to our organisation we achieved a result that has met all of our requirements.

We came in under budget, not by much, but with the need to upgrade switchboards, dose pumps and flow meters it increased the build cost considerably. The sharp, clean and professional looks of the Dose Plant reflects the Gunnedah Shire Council approach to water quality management. We can relocate the plant in the future

The site is now an asset that our organisation can be proud of and in the future it will be relocated to a new site where it will ensure the small community of Curlewis has safe drinking water piped direct from Gunnedah.

This project has shown that you can achieve a lot even if the budget is quite small. You just have to keep an open mind when exploring all options.

### **4.0 ACKNOWLEDGEMENTS**

Thanks to Gunnedah Shire Council's Kevin Sheridan (Manager Water Services) and Mick Ludlow (Water Project Officer) for the ongoing support of Water Quality, Lester Watterson (Water Meter Reader/Water Quality Officer) for the great paint job, Doug Barr (Water Operator) for his great work with the perch rebuilds.

Appreciation is also extended to H & M Refrigeration and Air-conditioning, ProMinent Fluid Controls for the internal fit out and Thomson Electrical Gunnedah for the 24 hour support and their 'we can do it' attitude.

# RESOLVING CASTERTON'S MANGANESE PROBLEM



*Paper Presented by:*

**Stuart Silvester**

*Author:*

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Wannon Water



*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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Bendigo Exhibition Centre  
6 September to 7 September, 2017*

# RESOLVING CASTERTON'S MANGANESE PROBLEM

**Stuart Silvester**, *Water Treatment Officer, Wannon Water*

## ABSTRACT

Casterton's water is supplied by four bores with the issue of consistent soluble Iron and Manganese present in the raw water. The water is then pumped 14 km to the water treatment plant. Prior to the upgrade, pre-treatment was by chlorine (liquid) for oxidation and ferric chloride for coagulation directly prior to gravity and pressure filtration. A post chlorine dose maintained residual in the onsite 3 ML storage.

Small amounts of manganese that remained in soluble form were further oxidised within the bulk storages. This caused dirty water issues throughout the four towns reticulated from the primary treatment plant at Casterton. Treatment operational staff also needed to maintain a regular intensive reticulation scouring program, combined with contracted air scoring that increased operating costs for the region.

The solution was to build a clarifier to allow increased oxidation and settling time prior to filtration. Two Lamella clarifiers were constructed and have proven to be a success. Filter run times have been extended to 40 hrs for gravity and 50 hrs for pressurised. There is also a lower chlorine demand to maintain stable chlorine residual within the bulk storages and associated retic systems.

## 1.0 INTRODUCTION

Wannon Water's tender for design and construct was secured by FILTEC a water and wastewater specialist company. The overall objective of the contract was to design, procure, supply, manufacture, install, construct, test and commission a new Lamella clarifier upstream of the existing gravity & pressure filters. GHD, Wannon's consulting engineer, had determined that Lamella technology was a good fit for the application. A minimum flowrate of 23 L/s (2 MLD) up to a maximum of 75 L/s (6.5 MLD) was required with raw water quality having the following characteristics,

- |                   |                |
|-------------------|----------------|
| • pH              | 6-9            |
| • Total Iron      | up to 5 mg/L   |
| • Total Manganese | up to 0.1 mg/L |
| • Turbidity       | up to 300 NTU  |
| • Water Temp      | 10-25 C        |
| • True Colour     | < 40 (TCU)     |

Clarified water quality specified was,

- < 3 NTU (95% of the time)
- < 5 NTU (100% of the time)

Based on the Casterton application requirements, Filtec chose to partner with Parkson, USA to locally manufacture their patented EcoFlow™ Lamella technology under license.

The EcoFlow™ design changes the orientation of the Lamella plate feed slots to allow the influent to flow over the top of the solids front. Elimination of the mixing zone allows for 100% utilisation of the plate settling area. The increase in settling area allows for up to 25% more flow to be processed in a given Lamella® tank with traditional plates. The overall result being a much more compact design for the Casterton retrofit (refer to Figure 1 below).

Two 50% Lamella units meet the specified duty, each fitted with 316 SS plates within painted carbon steel structures.

Wannon is very pleased with the engineering quality of the delivered Filtec plant and the ability of the Lamella system to be easily operated on an intermittent basis with very high start-up turbidities from the bore field.



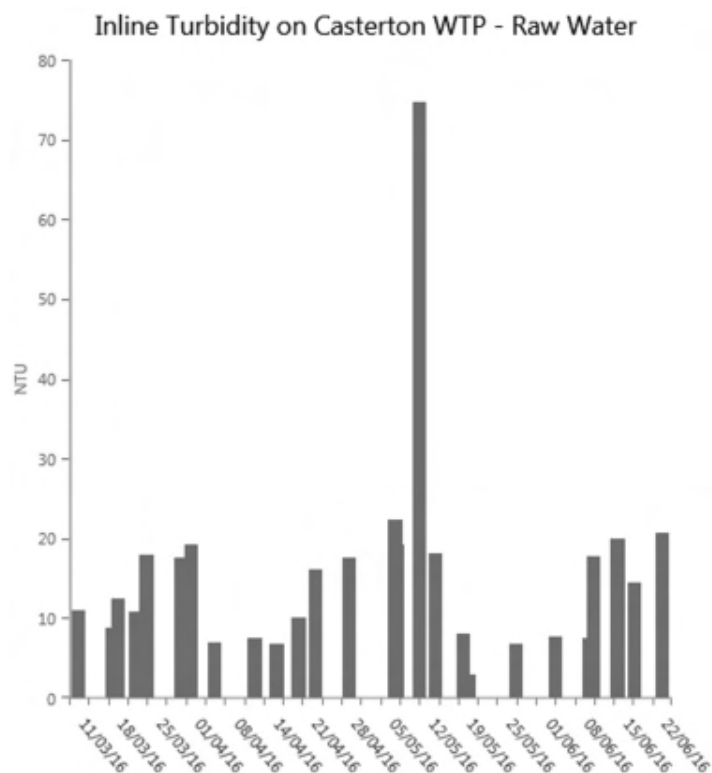
**Figure 1:**     *Casterton Water Treatment Plant Clarifier Installation*

## **2.0     DISCUSSION**

### **2.1     High Raw Water Turbidities.**

Due to the nature of Casterton's water supply, and the bore field's distance from the WTP, high inlet turbidities above 40 NTU are often experienced (refer Figure 2). This high turbidity consists of iron and manganese that has come out of suspension and formed a heavy floc.

In this case the heavy floc has a detrimental effect on the three water treatment fundamentals of oxidation, flocculation, and filtration.



**Figure 2:** *Inline Turbidity on Casterton WTP – Raw Water*

## 2.2 Removal of Soluble Iron and Manganese

The current method of chlorine pre-dose to oxidise the soluble metals prior to filtration was hindered by the higher turbidities (floc particles). The nature of the floc, being iron and manganese out of solution, meant that the ‘free chlorine’ pre-dose was not being used as an oxidiser until the inlet flow turbidity reduced to between 2 and 10 NTU. The lower turbidity signifies relatively fresh bore water that has not had time to oxidise in the long supply main. The site operator is required to constantly adjust the inlet oxidation dose to match the raw water quality. Without constant adjustment the ideal metals oxidation is not achieved and excess available free chlorine hinders the polymer added prior to filtration.

## 2.3 High Turbidities = Loss of Filter Production

With the high turbidity raw water at the start of production runs, operator vigilance is crucial regarding filter run times. Inlet flow volume with turbidity must be monitored to prevent solids overloading and clear water quality issues occurring. The filters on site being two older pressurised units and two open to air gravity units.

By their nature the gravity filters had the shortest run times at high load, often alarming out as head pressure loss or turbidity break through at 18 hrs or less.

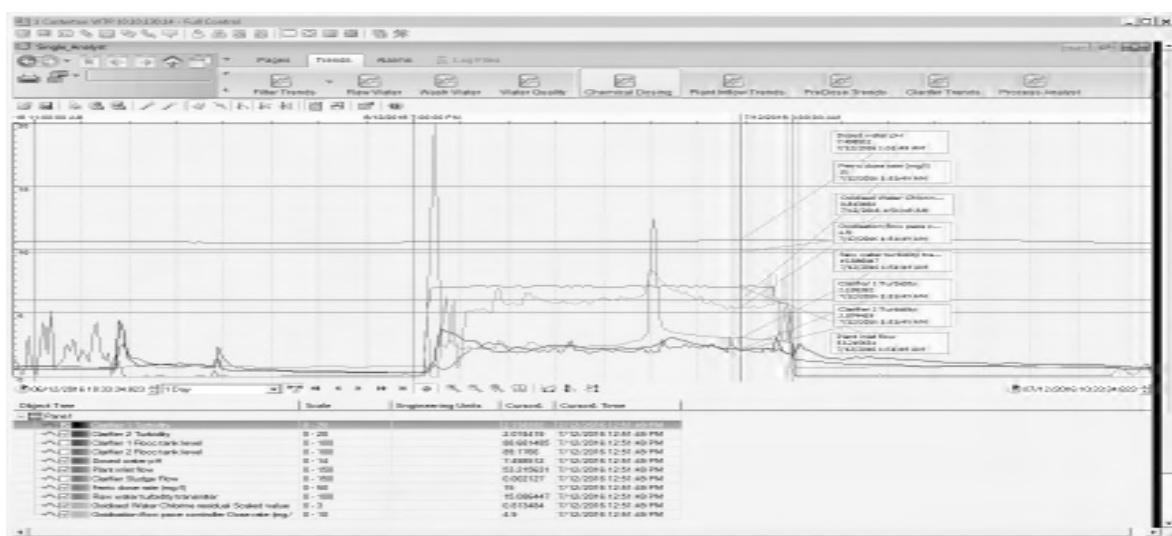
## 2.4 Raw Water Flow Rates

The Casterton WTP is the primary provider to four Western district towns, each with individual supply demands. At times of high usage the WTP must run at flows of 60 L/s to maintain supply.

Compared to slower times of the year when 20 to 40 L/s are maintained for many months. Each change in season or flow rate guarantees a raw water quality change. This in turn required constant adjustment to the critical chemical dose rates pre and post filtration. Filtration cycles were also impacted as the solids load varied with the varying flowrates.

## 2.5 Introduction of Up Flow Clarifier's

Once FILTEC completed the installation of the two clarifiers they were put into commissioning and production. The treatment team was able to run raw water flows between 15 to 60 L/s. The pre-chlorine oxidation dose was optimised to make use of the extra contact time in the clarifiers. The clarifiers reduced the turbidity to much lower levels allowing for the polymer dose rate to be reduced. These two factors greatly improved the filter run times.



**Figure 3:** Plant SCADA Trend

## 2.6 Solids and Waste Removal

The volume of solids collected and run to waste had to be determined. Onsite testing using an infrared desiccator allowed operators to determine sludge volumes and density. This was an important factor in optimising the individual clarifier's operation and auto wasting of sludge to the waste water reclamation system.

#Note to operators: The sludge volume created was unexpected and a geotextile bag that is normally in operation for 2 years was filled in 6 months (better get a bigger one!)

Results are:

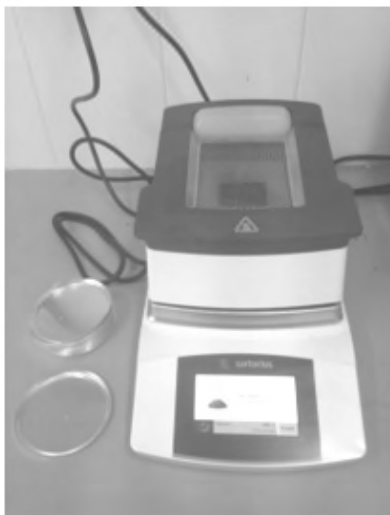
Clarifier 1, sample 1 = 7692mg/L

Clarifier 1, sample 2 = 2288mg/L

Clarifier 2, sample 1 = 9752mg/L

Clarifier 2, sample 2 = 4248mg/L





**Figure 4:**     *Infrared Desiccator*

### **3.0 CONCLUSION**

Outcomes of installing the clarifiers,

- The introduction of the clarifier system to treat raw water prior to filtration has significantly improved the plant's production of treated water.
- The increased oxidation contact time via the clarifiers has further reduced soluble iron and manganese prior to filtration.
- The chlorine dose, prior to storage, to maintain disinfection has reduced. As the filtered water has less soluble metals present creating demand on available chlorine.
- Filter run times have now been safely extended to 50 hrs. For pressure filters and 40 hrs for gravity filters.
- Raw water inflows fluctuating between 15 to 60 L/s with changing turbidities from 2 to 100 NTU no longer impact upon the plants run times and produced water quality.

### **4.0 ACKNOWLEDGMENTS**

To the Filtec staff that installed the facility and assisted treatment staff running up the clarifiers to full production.

To Wannon Water in house Treatment Support engineers for testing and technical support.

To GHD technical staff for their assistance across the project and for recognising that Lamella technology was a good fit for the Casterton application.

Special thanks to Craig Atwell who collated hundreds of hours of trends and test results to facilitate proof of performance.

# **BARWON DOWNS BOREFIELD REFURBISHING WORKS**



***Paper Presented by:***

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**Barwon Water**



***80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# BARWON DOWNS BOREFIELD REFURBISHING WORKS

**Gwyn Hatton**, *Asset Coordinator - Headworks, Barwon Water*

## ABSTRACT

The Barwon Downs Borefield consists of six production bores ranging from 500m – 600m deep, with the capacity to produce up to 12 ML/d each. Four of the bores were constructed in 1982 of epoxy coated steel and were partially relined in 1998 to repair some corroded sections of the bore columns. Two additional bores were later constructed in 2001.

The Barwon Downs Borefield was last operated as a supply source over the period of 2006 to 2010. With recent dry conditions the bores needed to be re-commissioned within a short timeframe.

A condition assessment of the bores identified a range of remedial works required to ensure their integrity and maintain production capacity.

These works included:

- Mechanical cleaning of bore intake screens and columns.
- Chemical treating (disinfection) of bore intake screens.
- Relining of the four older bores columns.

With the following future works planned as part of the upgrade:

- Conversion of the four older bores to a more efficient riser-less pump system.
- Upgrading of electrical switchboards and installation of variable speed drives.

An overview of these works will be provided in this paper along with lessons learnt on the asset management requirements for bores to reduce the need for remedial works. These lessons can be used by other authorities in the management of their borefields.

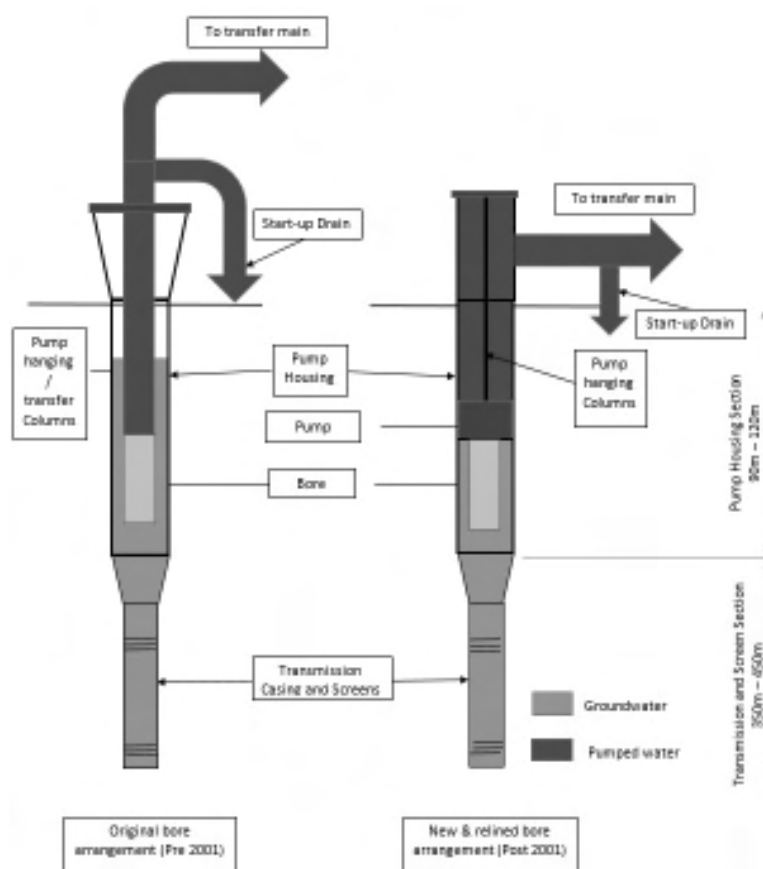
## 1.0 INTRODUCTION

The Geelong Region water supply system has a diverse range of sources available to it to ensure a secure water supply in all conditions. Historically Geelong has relied entirely upon surface water to meet these needs, but with declining inflows and an increasing regional population, alternative sources have had to be incorporated. It was the drought period in the early 1980's that brought about the construction of four production bores at the Barwon Downs Borefield to supplement Geelong's supplies.

These bores typically consisted of 500mm steel casing up to 600m deep to reach the aquifer below. Depending on groundwater levels at the time, water could be anywhere from 40m below the surface to artesian. Bore pumps would be lowered on 250mm pump columns 90-120 metres into the bores to ensure they remained submerged within the drawdown cone when pumping. The bore pumps would pump up through these columns at 9.5-12 ML/d each into a collection main. The collection main would transfer the groundwater to a pre-treatment plant to predominantly lower the high iron content of the water. In 2001 two more production bores were constructed to take the total number of bores to 6. These bores were constructed differently to the original four bores constructed in the early 1980's.

Constructed using stainless steel and fibreglass, these bores use the bore casing itself to pump the groundwater to the surface. Here the pumps are connected to the underside of a “packer” (type of bladder) and lowered on smaller hanging columns into the groundwater. The bladder is inflated to seal against the bore casing and the pump pumps the groundwater up through the middle of the packer into the ‘discharge’ side of the packer of the bore casing. The bore casing then transfers the groundwater to the collection main and on to the groundwater treatment plant.

The corrosive nature of the groundwater required relining the lower portions of the original bores in 1998 in fibreglass to ensure the integrity of the bores. This allowed the bores to remain in service until camera inspections in 2012 identified significant corrosion beginning to appear in the upper 120m of these bores. However, the bores were again called into action in April 2016 due to dwindling surface water levels whilst relining preparations commenced.



**Figure 1:** *Original and new bore arrangements*

## 2.0 DISCUSSION

### 2.1 Camera Inspections & Condition Assessment

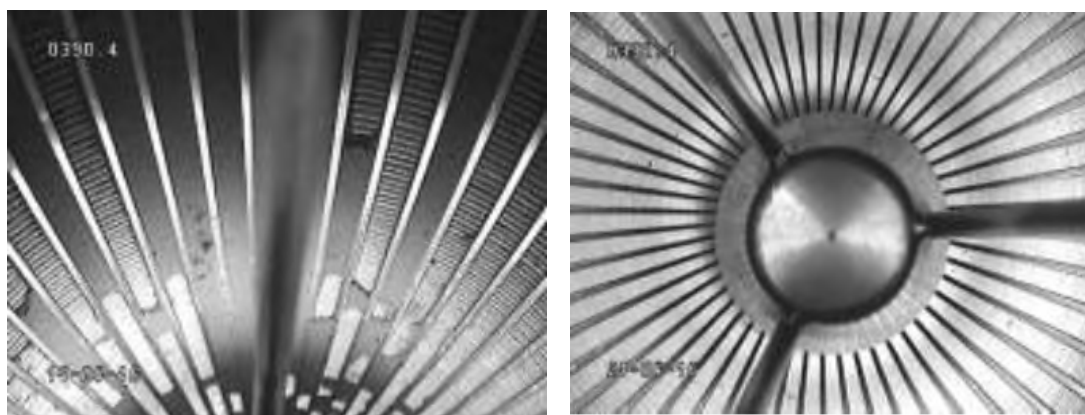
In 2012 a condition assessment of the four older bores was carried out to determine the life expectancy of the remaining sections of bore casings not relined in 1997/98. The inspections identified increasing corrosion that, if left unchecked, could result in casing failure, bore collapse and the loss of the bores requiring a new production bore to be drilled. The camera inspections also identified a build-up of iron bacteria on some of the bore screens which would restrict the capacity of the bore output.

The remedial actions recommended from the condition assessment included cleaning and disinfection of all six production bores, relining of the four older bores and conversion of them to the riserless packer systems similar to the two bores constructed in 2001.

## 2.2 Cleaning and Disinfection

Cleaning of the bores was carried out to remove rust build-up on the bore casing as well as screen blockage caused by iron bacteria. Large brushes were lowered and raised in the bore casing and screens to dislodge the build-up whilst airlifting of the water below the brush ‘vacuumed’ the dislodged material to the surface. This was captured in tankers and transported to the settling lagoons at the groundwater treatment plant.

The bores were again inspected via CCTV to determine the effectiveness of the cleaning and repeated where necessary until clean. The bores were then disinfected to prevent the re-occurrence of iron bacteria which can block the screens and reduce the pumping capacity of the bore.



**Figure 2:** *Bore screen before and after cleaning. Note iron bacteria build-up on left*

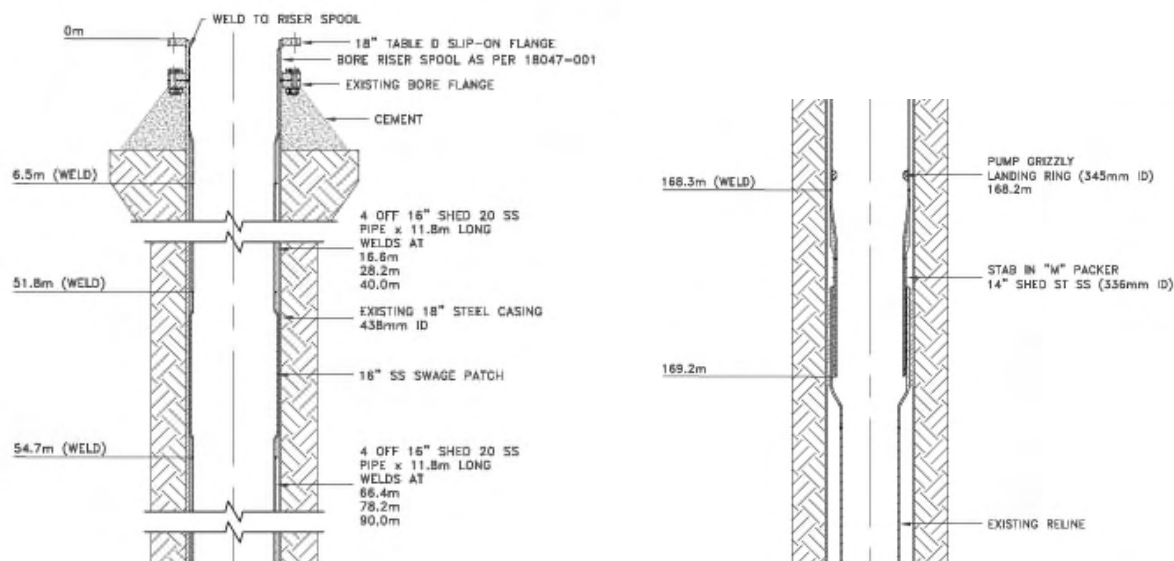
## 2.3 Relining Works

The relining works consisted of inserting 12m lengths of schedule 20 stainless steel casing (387mm ID, 8mm thick) into the pump housing of each bore being relined. This section of casing houses the submersible pump and rising main. Each length of SS casing is welded to the next length before lowering into the bore. Every fourth length of the SS relining casing has a 3.0m length of criss-crossed rubber sheet vulcanised onto the outside of it. Once the SS casing has been inserted into the top of the pump housing the final step of the relining is undertaken. This involves swaging the stainless steel at each of the 3.0m rubber seals. Swaging involves inserting an expansion tool connected to an airline and pumping in compressed air at very high pressure until the stainless steel is expanded over the 3.0m section - forcing the rubber patches against the original casing to form a water tight seal.

A landing ring is welded onto the inside of the sleeve at the interface to house the pump catcher (grizzly). This is incorporated into the well to prevent the pump from falling the full depth to the bottom of the bore should it disconnect from the hanging columns for any reason.

At the interface between the previously relined casing and the new stainless steel sleeve a packer is used to connect the two sections. The packer comprises rubber ribs that are stabbed into the top of the previously relined transmission casing thus forming a seal.

Once the full length of the sleeve has been installed, the new lining is welded to a matching piece at the wellhead to complete the relining.



**Figure 3:** *Upper and lower sections of the relining works*



**Figure 4:** *CCTV inspection (left) and relining works (right)*

## 2.4 Conversion to Riserless Packer System

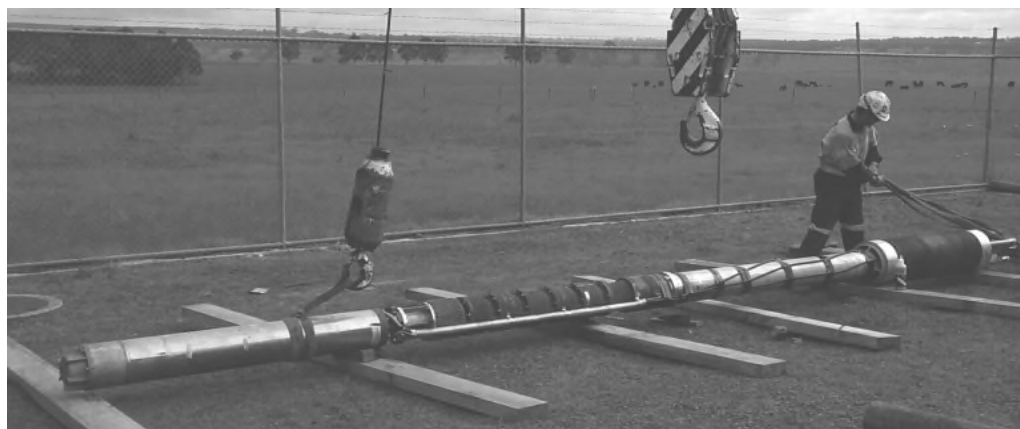
With the bores relined, the pump housing section of the bore can now be used to pump the groundwater to the bore headworks (refer Fig 1). This requires a pump packer system to be used within the bore as is used in the two newer bores constructed in 2001. The bore headworks are reconfigured to suit the riserless system and the bore pump columns are replaced with hanging rods.



**Figure 5:**      *Original bore wellhead arrangement (GW5, built 1982)*



**Figure 6:**      *More compact riserless bore wellhead arrangement (GW8 built 2001)*



**Figure 7:**      *Pump and packer set up – pump and motor at bottom left, packer at right*

## **2.5 Electrical Switchboard Upgrades**

The switchboards of the older bores are becoming increasingly unreliable and difficult to maintain. With no variable speed drives (VSD), pumps can only be run at full power. With the variable drawdown of aquifer levels, this means the outflow from the pumps has to be throttled via valves to both ensure extraction limits are not exceeded but also that the pumps are not operated beyond their efficiency points.

As a trial a VSD has been fitted to one of the newer bores (GW6) and shown that the pump can be operated at significantly lower power outputs saving both money and valve wear at the wellhead. It is planned to install VSD's at remaining bores as part of the ongoing electrical upgrades.

## **2.6 Lessons Learnt**

Whilst the Barwon Downs Borefield is not a regularly used asset, the importance of an inspection program has proved vital in identifying emerging problems, especially in an asset that is up to 600m below the surface. With Barwon Downs only being called upon during drought conditions, the uncertainty of knowing when the asset will be used again presented a business decision on when to expend the capital to refurbish. With good rainfall from 2012 – 2014 the refurbishments works were placed on hold, however another extended dry period emerged in 2015. This led to fast tracking the relining works in 2016 in parallel to operational readiness preparations and Borefield operation.

Lesson learnt: Mother Nature does not always follow modelling predictions!

The relining works themselves then lead on to further works requiring the pumps and wellhead pipework to be converted to a riserless system to make them operational. This is because the inside diameter of the relined bores can no longer fit the old pump columns that the older pumps are supported from. These works are yet to be carried out, leaving the Borefield with only two operational bores – the ones constructed in 2001.

With a dry 2017 again straining surface supplies, the importance of continuing with the pump, wellhead and switchboard upgrades as part of the asset management approach has been highlighted. Good practice though has ensured that the most critical component of the assets – the bores themselves - have been protected and will remain viable for many years to come. Ongoing inspections will still be required to ensure no further casing or screen deterioration is occurring.

Lesson learnt: Ensure all components of an upgrade are considered and completed to meet operational requirements (although complete most critical items first).

## **3.0 CONCLUSION**

The Barwon Downs Borefield provides an important alternative supply for the Geelong region. It was most recently relied upon heavily from 2006 – 2010 and again in 2016. CCTV inspections in 2012 revealed significant bore casing corrosion and screen blockages that could lead to bore collapse or reduced capacity. Relining of the bores with stainless steel sleeves was carried out in 2016 to ensure the security and viability of the borefield. Progressive upgrading of the older bores to a riserless packer system along with electrical upgrades will continue to provide a more efficient and reliable borefield operation. An ongoing asset management approach will be required to ensure the viability of this vital asset for Geelong.

## **4.0 ACKNOWLEDGEMENTS**

Cam Giddings and the Delivery team for managing the construction of the relining works. Trevor Ingram and Jacobs Ltd for providing guidance and insight into the Barwon Downs Borefield. The Barwon Headworks team for their on ground support during the relining process.



# PROTECTING CONCRETE STRUCTURES – REAL LIFE EXAMPLES FROM A COATINGS INSPECTOR



*Paper Presented by:*

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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
Conference and Exhibition  
Bendigo Exhibition Centre  
6 September to 7 September, 2017*

# PROTECTING CONCRETE STRUCTURES – REAL LIFE EXAMPLES FROM A COATINGS INSPECTOR

**Justin Rigby**, *Principal*, Remedy Asset Protection

## 1.0 INTRODUCTION

Our experience is in refurbishment of structures with a focus on protective coatings over many different industries and substrates. From steel to concrete whether it is weir walls, oil pipelines, gas networks, sewer mains, water tanks and so on.

However for this paper we will focus on Concrete structures and their protection.

I am here today to tell you, ‘painting is difficult’ and if you have been in the water industry for long enough you will already know some horror stories.

So why does this happen with painting or more appropriately ‘application of protective coatings’?

## 2.0 THE PROCESS OF CONCRETE DETERIORATION

Concrete is an alkaline substrate that has great compressive strength however to increase its poor tensile strength designers introduce ‘reinforcing’ steel. The reinforcing steel does not have a coating, they just get new steel mesh and place it in the concrete cross section, so why doesn’t it rust?

Well concrete has a pH value above 11.5 and steel in a PH above approximately pH 10 will develop passivation and protect the steel from corrosion.

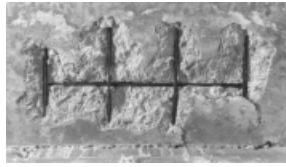
This works fine until the pH value of the concrete is lowered towards neutral or the concrete is dissolved in acidic conditions. These occur in a variety of ways;

### 2.1 Carbonation

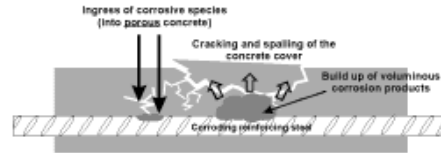
Concrete will continue to cure in the presence of carbon dioxide (CO<sub>2</sub>). This ability helps concrete to ‘self-heal’ in micro cracks as a fine crack will present a fresh concrete surface for the CO<sub>2</sub> to diffuse into thus the fresh surface will undergo additional cure and thus grow its crystalline structure in the crack.

Carbon dioxide will continue to be absorbed by a concrete structure. This carbonation of the concrete simply results in a continued cure and ongoing durability of the concrete structure. This can be seen by many ancient roman concrete structures that still stand such as the Pantheon dome.

The result of carbonation is a lowering of the concrete pH. However in reinforced concrete structures, when the pH of the concrete is reduced below 10, steel in concrete is no longer being passivated thus enabling corrosion of the steel to occur.



**Figure 1:** *Corroded reinforcing steel*



**Figure 2:** *Process of concrete spalling*

## 2.2 Spalling

Additionally, concrete being a porous substrate, enables contaminants such as chlorides to migrate to the reinforcing steel. This further encourages corrosion.

As the steel reinforcing commences corroding the corrosion products swell the size of steel and push the rigid concrete away from the imbedded steel. This is commonly referred to as; spalling concrete or concrete cancer and presents as concrete delaminating and falling off the structure along with visible rust stains from the corroding steel.

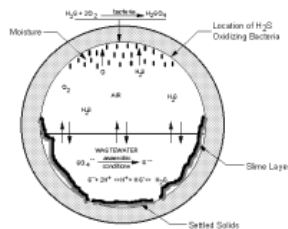
## 2.3 Acid Attack and Concrete Erosion

Concrete being an alkaline substrate is suitable in alkaline service conditions however when exposed to acidic solutions concrete will readily dissolve.

The use of protective coatings will protect the concrete from acid attack.



**Figure 3:** *Acid attack of concrete structure*



**Figure 4:** *Process of acid attack on concrete*



**Figure 5:** *pH testing of concrete to determine the depth of carbonation*

## 3.0 COMMON COATING DEFECTS

We recommend you spend some time at the early stages with a Coatings Professional to assist you in aligning your project specification rather than relying on manufacturer and contractor warranties.

Warranties are a reactive method of ensuring project quality and if you need to enforce a project warranty it will mean there are;

- Defects that should be avoidable.
- Extra costs associated with site set up and access.
- A risk to your Company reputation for great project delivery.

## 3.1 Road Map to a Coating Failure

If you haven't engaged a coatings inspector and must manage on your own, here's a roadmap to coating failure that you can use as a tool for 'what to avoid'.

*Concrete assessments* - Need to be specific for each structure since concrete deterioration is a function of the micro-climate it is exposed to. The micro-climate will also determine which contaminants have been absorbed into the concrete.

*Getting advice* - Often project managers will interview a field of Contracting and Material companies and ask for their strategy. This information is loaded with self-interest and may not be specific to the project needs.

Consider;

- What is the pH of the concrete?
- Has it been exposed to chlorides, oils or grease?
- What is the moisture content in the concrete, and how is it to be measured?
- Use an expert to provide the assessment and identify the root cause of the failure mechanisms.

*Specification & Materials* – It is drastically important that you provide a written document describing the Project, Scope of works, Standards to be met, Workmanship, Quality testing and Repair strategies.

*Limiting your choices* – Whilst requesting quotations ensure you have at-least 3 pre-qualified tenderers. This may mean you need to approach 5 companies to receive 3 proposals. By including this step, you protect your options and have alternatives if disputes and disappointments occur.

*Post tender interview* – When selecting the winning tender ask them;

- To provide a list of key employees to be used onsite, and ;
- To attend a post tender interview with the Foreperson that will coordinate the site works. This is the person that is onsite every day.

*Choosing the lowest price tenderer* – Do not accept the lowest price tenderer until you have completed the above step. Still do not accept the lowest price tenderer if they are more than 20% below the nearest competitors' price.

No matter their good intentions, the cost pressures will force them to change their focus from customer to survival with negative project outcomes.

*Surface preparation is king* – 85% of all coating failures can be attributed to improper surface preparation.

We are talking;

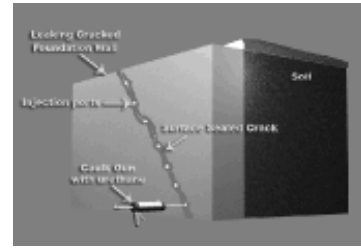
- Pre-cleaning – Don't let Applicators tell you dry methods of surface preparation will remove contaminants. It doesn't! Abrasive blasting, grinding or sanding will only spread the contamination and ensure they are trapped within subsequent coating layers.  
Wet surface preparation such as Hand scrubbing, Degreasing, High pressure water cleaning (10k psi) or wet abrasive blasting (WAB) will ensure contaminants are removed.
- Surface preparation –Will require removal of concrete laitance and exposure of the concrete surface. Most coating systems will require removal of all existing coatings however there are a few exceptions.

*Repair strategies* - All repair works should result in an improvement of the structure rather than merely arresting excessive deterioration.

Concrete repair needs to be detailed to restore original structural qualities of the concrete.



**Figure 6:** *Cementitious mortar being placed over reinforcing steel*



**Figure 7:** *Resin injected crack repair system*

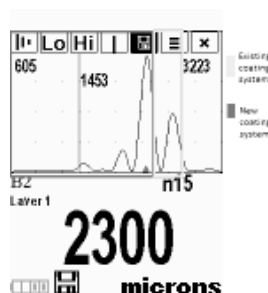
*Inspections* – Quality Control should be conducted by the Applicators manager and must be a documented procedure including Daily Report forms and Inspection Test Plans (ITP). Key data should include a surface preparation inspection ‘Hold’ point prior to coating application, weather monitoring but also surface temperature (ST) monitoring, and traceability to include dates, times, batch numbers, inspector name.

*Weather Conditions* - Coating application must be timed perfectly to ensure great quality, as follows;

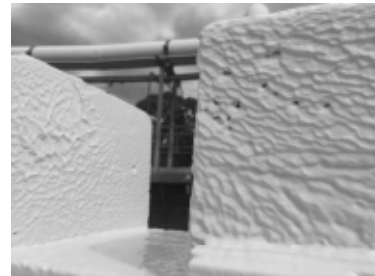
- Coatings applied on a rising concrete surface temperature will pin hole due to out-gassing.
- Coatings must be applied to ensure weather conditions are acceptable throughout the curing time. This may require a period of 16hrs to remain below 85% RH and ST 3°C above dew point.
- Dehumidification and cladding may be required to stabilise ambient conditions and ensure continuity of work without weather delays.



**Figure 8:** *Marked up region of pin-holes*



**Figure 9:** *Dry Film Thickness (DFT)*



**Figure 10:** *Example of pin-holing*

*No primer coatings* – Thick film coatings above approx. 750µm DFT should have a primer applied for the following reasons;

- Poly urea, Elastomeric polyurethane and other quick cure coatings don't have enough time to provide surface wetness therefore a low viscosity primer will wet and penetrate the concrete surface.
- Ultra-high build epoxies are often highly viscous and rather 'thick' like honey. These will benefit from the application of a low viscosity primer to provide concrete penetration and an added benefit is less pin holing caused by outgassing.

*Coating thickness* – If you want to enter an argument, ask the team how to measure coating thickness. The only true way is to measure Dry Film Thickness (DFT) is using an ultrasonic gauge. These are expensive and require experienced persons to properly evaluate the data.

Often Applicators want to use the Wet Film Measurement (WFT) to justify coating thickness but then quick cure coatings cannot be tested using the WFT method therefore they want to use a 'paint usage calculation' to justify coating thickness.

These two methods should be used to ensure Applicators are achieving reasonable coating thickness but final coating thickness testing should be performed by Ultrasonic DFT gauge.

## **4.0 COATING APPLICATION**

Why is painting so difficult? This is the question I hear over again.

The answer is because everyone associates painting with their own experience at home and underestimates' the difficulties in an industrial situation.

### **4.1 Why is Painting so Difficult?**

Let's assess the task of coating application afresh, as follows;

- Asset Owners don't often provide long term planning for coating works thus the application industry operates on a project by project basis at short notice thus resources and personnel move through cycles of boom and bust.
- The Application personnel don't have a widely accepted accreditation and training scheme nor are there career pathways thus experienced team members are often supplemented with unskilled labour to fill shortages.
- The task is to protect a structure from the effects of corrosion using highly refined chemistries that have been developed in a laboratory.
- The pre-cleaning, surface preparation and coating application is Specified using dozens of separate mandatory Standards that requires skilled workers and trained inspectors.
- The works often occur in difficult locations with poor access and worker ergonomics.
- The stage of coating application occurs at the latter project stages so all the time constraints and cost pressures that have built throughout the project are now placed on these works.
- Applicators want to ensure the coating lasts throughout the warranty (usually 2-5 years) however protective coatings are often designed to last 20, 30 or even 50 years.

Does this all sound familiar to some of your projects out there?

Why is painting so difficult?

Because we don't spend the time at the planning stages to coach the Applicator. Great project management requires you to foresee impending problems and build systems to navigate through them.

### **4.2 Use a Coatings Professional**

Did you know the pipeline industry in the USA, in the 1980's was going through the exact same problem?

They were tired of coating failures on pipeline and the ongoing repair and monitoring required managing their corrosion problems.



**Figure 11:** *Scaffold not providing adequate access to surfaces preparation*



**Figure 12:** *Use a coatings professional to ensure quality outcomes*



**Figure 13:** *Coatings inspection requires a professional skill set and additional safety training*

So they invented the Coatings Inspector Program which spawned a whole new industry in quality control that is used the world over.

Both the NACE CIP and SSPC CCI classes are available in Australia through the Australasian Corrosion Association (ACA).

Use a NACE Level 3 inspector or a SSPC CCI Level 2 inspector and interview them for their industry experience. Your coatings inspector should be a professional in protective coatings projects. Use them to assess your project.

## 5.0 CONCLUSION

The aim of this discussion is to bring people together to enhance relationships, minimise cost and increase asset durability.

After all a great coatings project will protect your structure for 20, 30 even 40 years but to be successful a coatings project requires;

- an independent assessment of your structure, and;
- A Specification of suitable repair strategies to ensure the coatings will provide the desired properties.

Additionally coating application is a difficult task often placed upon a few skilled trades-people supplemented with additional labour.

In order to obtain the best project outcomes you need to actively manage your Suppliers and Contractors by questioning and coaching from the early stages of the project and throughout the process.

My hope is this paper has reminded you of past coating problems you have encountered and helped you understand what was missing on that project.

For those commencing a coatings project my hope is you have enough information to identify the major issues and are already thinking of how to manage them.

# AQUANTIFY – TWO YEARS ON, A CELEBRATION OF SUCCESS



*Paper Presented by:*

**Mark Banting**

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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# AQUANTIFY – TWO YEARS ON, A CELEBRATION OF SUCCESS

**Mark Banting**, *Coordinator Operations Performance*, Goulburn Valley Water

## ABSTRACT

In 2015 Goulburn Valley Water replaced an aging database with Aquantify, a database developed collaboratively with Wannon Water and Thinking Windows. From the initial focus of water quality Aquantify now performs an integral role across the business.

Use of Aquantify has expanded dramatically to include operational data, inspections (dam safety, security, occupational health and safety) and water quantities (raw water, consumption and wastewater reuse). Aquantify is used throughout the organisation from the Managing Director through to front line operators.

Aquantify has enabled significant efficiency gains in the collection, visualisation and analysis of data complemented with limit and issue management functionality. Aquantify has enabled the consolidation of several hundred spreadsheets that supported the collection of data and containing historic data into a single database, a single source of the truth.

Some 100,000 tasks per month are managed across all business functions, headworks to wastewater reuse. Aquantify enables staff to visualise the data in more comprehensive ways. It is also enabling the standardisation of reporting and is empowering stakeholders to access near real time information. It is also supporting more powerful tools to analyse performance.

The deployment of Aquantify within Goulburn Valley Water has added significant business value; value worth celebrating.

## 1.0 INTRODUCTION

Goulburn Valley Water (GVW) is a Victorian regional water provider whose region extends from the outskirts of Melbourne in the south, to the Murray River in the north, covering approximately 20,000km<sup>2</sup>. GVW's water services comprise headworks, water treatment, reticulation, sewerage collection, wastewater treatment and wastewater reuse. GVW provides these services to over 60,000 customers in 54 towns who are connected to 37 water supply systems via 1,800 km of reticulation mains and 26 wastewater management facilities.

Delivering water services that achieve the aspirations of a diverse range of stakeholders from our customers, National and State government regulators and agencies through to internal management involves significant complexity. Achieving these aspirations with trust requires strong systems to provide evidence; in this light data has become a necessary good.

Ready access to data in near real time, in a standardised, repeatable manner, that has improved data integrity, ideally from a single source is now more than ever an integral business need.

Rarely do we stop to reflect on the complexity and the significant quantity of data that water businesses collect to provide their services. Data tends to be hidden, buried within a collection of databases and a multitude of spreadsheets.

This is where the Aquantify suite, Aquantify and Aquantify Mobile (a native iOS app) come in.

Aquantify went live in GVW in July 2015 as a replacement of the BridgeSoft database. Initial focus was on water quality and major customer data, but was expanded to include water and wastewater treatment operational data, a modest but significant improvement.

In the time since, efforts have been focussed on several fronts; integration of further operational data and the consolidation/abandonment of historic spreadsheets. More recently use of Aquantify has expanded to underpin facility security, dam safety, fleet safety management and an expanding range of asset inspections. Many of these are associated with regulatory compliance.

Currently within GVW the Aquantify configuration comprises some 4,000 sample points, individual assets/locations, and 1,000 parameters comprising analysis parameters and inspection questions.

From a relatively modest start the number of data collection tasks managed by Aquantify quickly moved to some 40,000 tasks per month. More recently with the expansion into fleet safety inspections this number is now exceeding 100,000 tasks per month. The task breakdown highlights the functionality of Aquantify; 25,000 tasks are associated with the drinking water and wastewater compliance data from an external laboratory, ~4,000 are auto calculations resulting from entered data and the balance, 71,000, are completed by GVW users. At this point it is worth noting that users, 170 of them, come from throughout the organisation from the Managing Director through to front line operators and contractors.

## **2.0 DISCUSSION**

Noting the complexity and the footprint of Aquantify in GVW's business it is not possible to discuss all the detail within this paper. Hopefully focussing on a couple of the significant initiatives will give readers an insight to the efficiency gains achievable. These initiatives are drinking water sampling, collection of reservoir volume data and fleet safety inspections.

It is also worth noting whilst some data is also available within SCADA, GVW still values front line staff contact with the assets and the data and as such will continue with key data gathering by staff.

### **2.1 Drinking Water Sampling**

The complexity and detail associated with the management of a compliant drinking water systems across 54 towns connected to 37 water supply systems via some 1,800 km of water mains needs to be experienced to be truly appreciated.

Historically the management of a compliant drinking water system within GVW was achieved via a complex collection of paper and electronic systems comprising Word documents, Excel spreadsheets and the Bridgesoft database. This required considerable administrative support, placed pressures on all staff in particular front line staff and exposed GVW to the high risk of noncompliance.

Aquantify is now the primary tool used by GVW to ensure the supply of safe drinking water and integral to both achieving and maintaining regulatory compliance. Aquantify configuration includes:

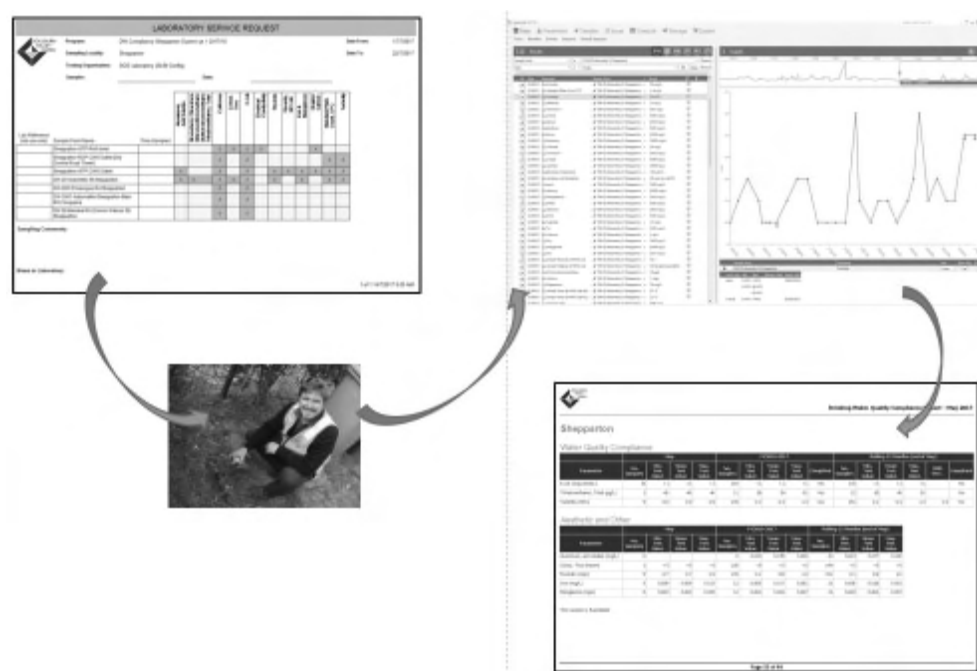
- Individual sampling localities across all GVW's drinking water processes including critical control points;
- Analysis parameters and associated critical limits;
- Sampling programs complete with rolling randomisation of sampling localities and sampling frequencies; and
- Limit breaches and associated notifications.

In support several key documents, in the form of reporting services reports, have been implemented, these being:

- The chain of custody which converts the Aquantify sampling program to a laboratory service request;
- The monthly Drinking Water Quality Report published to GVW's website.

Now front line staff collect field observations and measurements in the field using Aquantify Mobile on an iPhone. On syncing, the results are pushed to the Aquantify database for storage and processing as needed.

In addition, SGS Australia, GVW's laboratory service provider, has direct access to the chain of custody and self manages their workload and the relationship with GVW's samplers. Aquantify has also enabled SGS emailed results to be automatically imported into the database where the results are processed in real time with limit breach notifications emailed if triggered.



**Figure 1:** Chain of custody to Sampler & Aquantify visualisations and reports

Consolidation of tasks and processes into Aquantify whilst still requiring administrative support has resulted in significant efficiency gains across all stakeholders and noticeably reduced water quality and compliance risks. Aquantify is now integral to GVW ongoing compliant supply of safe drinking water.

## 2.2 Water Resources

Data associated with water resources is used to show evidence of compliance with bulk entitlements, reservoir operation in the context of drought management plans and dam safety monitoring.

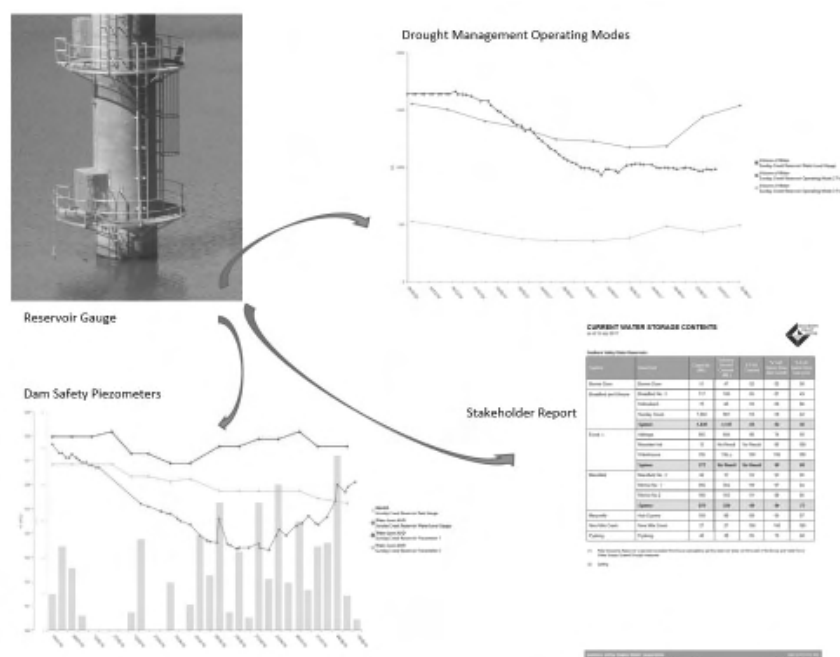
Historically front line staff would read a level gauge, convert this via a rating table into a volume (typically via a spreadsheet) then record both the level and volume in a spreadsheet. From here multiple stakeholders would establish their 'own' Excel or word documents in support of the business matter they were responsible for. There were multiple versions of the same data, all similar but different, each crafted to a specific end stakeholder; operational managers, the Board, the Minister. Overall a time consuming task with a high risk to multiple versions of the truth, delays and errors.

Now with Aquantify the front line user gathers the water level in the field using Aquantify Mobile. On syncing the result is pushed to the Aquantify database, this is the last 'human' contact with the data. Aquantify is used to convert the level into Australian Height Datum (mAHD) and reservoir and system volumes.

Aquantify then readily supports access to the data including the comparative graphing of results such as:

- Drought management plans - where trigger points are imported into Aquantify and given future results can be added these are readily available for a comparison of the current volume and timely operational decisions; and
- Dam Safety - coaxial plotting of dam piezometer levels with the reservoir level, complete with rainfall, also recorded in Aquantify, and front line users and analysts now have a complete picture for timely dam safety decisions.

In addition, a standardised reporting services report using Aquantify data is used to communicate the complete water resource position to operational managers, the Board and the Minister.



**Figure 2:** From gauge reading to Aquantify visualisations and reports

In the summary, from the single water level recorded in the field on an iPhone numerous conversations with multiple stakeholders are supported. This single initiative has allowed the abandonment of 14 spreadsheets per annum and consolidated the data into a single source of the truth that supports near real time reporting.

## 2.3 Fleet Safety Management

Safety inspections of light vehicles have now been established in Aquantify since November 2016. More recently this approach was expanded across the majority of GVW's fleet classes; trucks, trailers, forklifts, mobile plant, trailers and side by sides (ATVs) in the form of plant pre-start checklists.

Efforts have been made to standardise the inspection tasks where practical, however the tasks are tailored to the fleet class to limit the collection of non-value adding data. Task frequencies have been determined in light of the perceived risks associated with class usage environments and compliance obligations.

Selection of the tasks are controlled by using QR codes unique for each fleet asset which is attached to the asset with the intent of better ensuring that the user is present at the asset when undertaking the inspection. This approach seeks to ensure that the task list is always available at the individual asset and also supports the auditing of where the tasks have been completed.



**Figure 3:** *Fleet Safety - QR Code, Task Listing, Task Screens and Limit Breaches*

Responses to the tasks that would typically have been 'yes/no' are user defined in the Aquantify. In the case of the fleet inspections GVW has recognised that there is inferred criticality associated with task responses and has sort to guide user behaviour on completion of the inspection by including directions in the user defined response.

Critical fleet tasks have the choice of *Yes or No (Do not Operate)*; whereas alert tasks have *Yes or No (Need Approval to Operate)*. Aquantify is now an integral contributor to the change in safety behaviour needed to improve GVW's safety performance.

## **2.4 The Challenges**

Transitioning from the historic ‘way’, in particular the pure volume of historic data buried in spreadsheets and the culture change, perceived as a loss of ownership, coupled with the need to embrace new technology should not be underestimated. Resourcing the change concurrently with administering the system in an environment with the users enthusiastic about expanding and improving the application of Aquantify can place a strain on key resources.

Optimal configuration of the database to support the aspirations of stakeholders; administrators, users, report writers, data analysts and report readers; should not be underestimated. A rapid start-up doesn’t necessarily lead to a great user experience in the future.

Importantly, the benefits of Aquantify have far outweighed the challenges.

## **3.0 CONCLUSION**

Aquantify has enabled staff to collect and visualise the data in more comprehensive ways and is empowering stakeholders to access near real time information. It is also enabling the standardisation of reporting and supporting more powerful tools to analyse performance. The ease of use has resulted in users enthused about the system as evidenced by its dramatic expansion across a diverse range of tasks.

Data integrity has improved and significant efficiency gains have been made. From a relatively modest start Aquantify now performs an integral role across Goulburn Valley Water’s business.

The deployment of Aquantify within Goulburn Valley Water has added significant business value; value worth celebrating.

## **4.0 ACKNOWLEDGEMENTS**

The success of Aquantify within Goulburn Valley Water is a credit to all involved; from front line users who have embraced the Aquantify suite, to the new stakeholders like the safety team, the leadership and encouragement afforded by management and the system administrators who not only maintain the system but facilitate the expansion. The support provided by the Thinking Windows team continues to be a key element of the success being experienced.

## **5.0 REFERENCES**

Goulburn Valley Water <http://www.gvwater.vic.gov.au/>

Thinking Windows – Aquantify Suite  
<http://www.thinkwin.com.au/index.php/products/Aquantify>

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42nd Annual WIOA Queensland Water Industry Operations Conference,  
Logan, 2017*

## **WETALLA BIOREACTOR MIXER BASE PLATE REMOVAL TOOL**



***Paper Presented by:***

**Marcus Boyd**

***Author:***

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**Toowoomba Regional Council**



***80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
Conference and Exhibition  
Bendigo Exhibition Centre  
6 September to 7 September, 2017***

# WETALLA BIOREACTOR MIXER BASE PLATE REMOVAL TOOL

**Marcus Boyd**, *Senior Treatment Officer*, Toowoomba Regional Council

## 1.0 INTRODUCTION

The Wetalla Waste Water Reclamation Facility is owned and operated by the Toowoomba Regional Council. The facility is a Biological Nutrient Removal (BNR) process treating an Average Dry Weather Flow (ADWF) of 36 ML/d. The plant consists of two identical bioreactors operating in parallel. Bioreactor 1 was commissioned in 1995 while Bioreactor 2 was commissioned in 2006.

During the biannual maintenance program, maintenance staff noticed significant wear on the mixer mast locating pin (Figures 1 & 2).

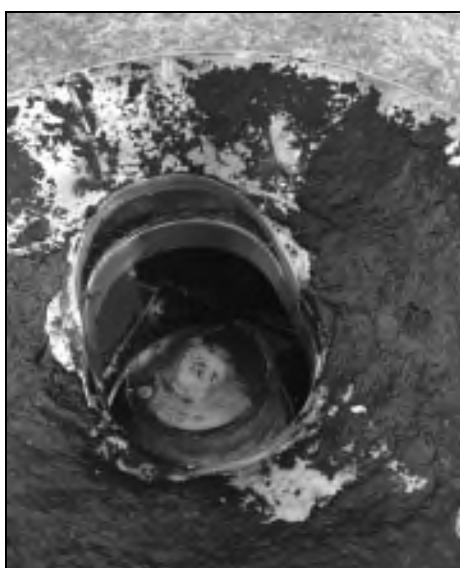


**Figure 1:**     *Mixer mast*



**Figure 2:**     *Repaired locating pin*

Each mast locates into a base plate fixed to the bioreactor floor (Figure 3 & 4).



**Figure 3:**     *Worn baseplate*



**Figure 4:**     *Worn baseplate missing locating cone*



There are 14 mixers in the bioreactor and all locating pins had evidence of similar wear. Each pin was repaired to original specifications in the workshop. However, given the extent of the wear observed on these pins, there were serious concerns expressed regarding the integrity of the base plates themselves.

An in-situ inspection was not possible as the bioreactor could not be taken offline without causing problems to the process. To work around this restriction, a commercial diving contractor was engaged to remove a single base plate for inspection. The first attempt to remove a base plate failed as it had locked onto the anchor bolts, making removal impossible without any specialised tooling.

## **2.0 BACKGROUND**

Biannually the mixer masts are removed for inspection, fitting of sacrificial anodes, and an application of a protective coating for corrosion control. During their operational life, the base plates had worn to a point where the masts were required to be rotated 90° to allow removal. This 90° rotation was necessary to free the mast from the groove that had worn into the base plate. Unable to inspect the base plates, concerns were raised as to how long the base plate could remain in service before a critical failure occurred.

Given the requirement for effective mixing in the bioreactor, a critical failure was not an option. Initial investigations took place into taking the bioreactor offline and replacing the base plates. This process proved to be expensive (\$130,000+), while potentially compromising final effluent discharge, licence compliance requirements as well as the unnecessary disruption involved with taking a bioreactor offline.

The wear on the base plates and locating pins was a result of constant rubbing caused by the normal operation of the mixers, combined with the abrasive nature of the fine grit within the wastewater. This rubbing had been continuous for the past 22 years. The mast locating pins were repaired when required, while the base plates continued to wear. Approximately 18 months ago, it became apparent the base plates would need to be replaced.

## **3.0 THE SOLUTION**

While the investigation was underway to take the bioreactor offline, the 14 replacement baseplates were procured from the original supplier. The time to order and fabricate the new baseplates was 16 weeks.



**Figure 5:**     *New baseplates*

Upon arrival of the new baseplates, it became clear the proposed option of taking the bioreactor offline would not be possible. At this point I was looking at the new baseplates and thought “I could make a tool to lift them within the bioreactor”. Having the new baseplates on site made it easy to come up with a solution as there was something to “touch and feel”. Prior to the arrival of the new baseplates, only engineering drawings were available.

A meeting with the on-site fitters was held and we started designing the lifting tool using a new baseplate as a reference point. After the lifting tool was constructed, a baseplate was bolted and glued (using Sika Flex), to the concrete in the car park. We did this to operate and test the tool as close as possible to the real application. The testing scenario was successful and became useful when divers were engaged. The dive crew could see the tool in operation prior to the actual replacement task commencing, which was extremely beneficial as there is zero visibility at the bottom of the bioreactor.

The final result was a lifting device which was lowered to the base plate using the onsite jib crane. A diver secured the lifting tool to the worn base plate using a locking pin. The height of the lifting tool could be adjusted with wing nuts and a hydraulic ram was fitted to each end of the lifting tool connected to two hydraulic pumps. Each pump had a visual gauge so the operator could watch the hydraulic pressure and maintain even pressure on each ram (see Figure 6).



**Figure 6:**     *Lifting tool*



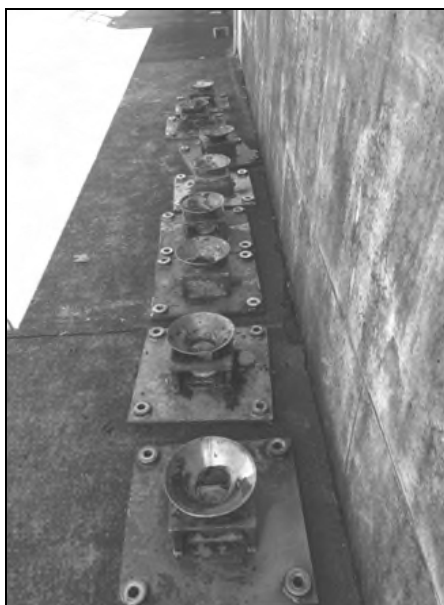
**Figure 7:**     *Lifting tool test*

The idea was to make the tool as easy as possible for the diver to operate. When the lifting tool was fitted, the diver moved away while jacking took place. The diver had full audio communication with the fitters above, which was essential for the safety and accuracy of the project. The hydraulic rams on the lifting tool had 25mm travel so a few ram height adjustments were required to clear the baseplate of the anchor bolts. The diver could feel if the baseplate was lifting off square and re adjust the wing nuts after each lift. When the plate was jacked off the anchor bolts, the lifting tool and base plate could be raised to the surface using the jib crane. This was possible as the lifting tool was still attached to the base plate with the locking pin (see Figure 8).



**Figure 8:**      *Removal of first baseplate attached to jib crane*

The day came to put the lifting tool to work. We had planned the project to take 5 days. The first base plate was removed before morning tea, and there was relief to see the base plate was as worn as expected and was in need of replacement.



**Figure 9:**      *Worn baseplates removed from service*

All 14 baseplates were completed in 3.5 days, with varying levels of wear depending on the load they were subject to.

#### **4.0 CONCLUSION**

Without the lifting tool, the baseplates could not have been removed without taking the bioreactor offline. All 14 baseplates have now been replaced and will be in service for the next 2 decades. The replacement project was estimated to cost in excess of \$160,000 if the bioreactor was taken offline. By using the baseplate removal tool, the project was completed for less than \$40,000.

# **SCHOOL BASED APPRENTICESHIPS FOR WATER AND WASTEWATER OPERATIONS**



***Paper Presented by:***

**John Day**

***Author:***

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**North East Water**



***80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
Conference and Exhibition  
Bendigo Exhibition Centre  
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# SCHOOL BASED APPRENTICESHIPS FOR WATER AND WASTEWATER OPERATIONS

**John Day**, *Executive Manager Operations*, North East Water

## ABSTRACT

North East Water have always faced difficulties attracting female applicants to apply for its outdoor positions. While promoting diversity, delivering on our promise of this goal has always met the same outcome that no female applicants applied for the advertised positions. Changing the titles and the sound of the advertisement still meet with a poor result.

For this challenge North East Water needed to rethink the problem. Conversations with local secondary colleges found an opportunity through the Victorian Certificate of Applied Learning program or VCAL as it is more commonly known. The college's found that by connecting to a water corporation under our NWP07 training modules, they could offer more to their female students in a science and trade based outcome than it currently could.

A pilot program kicked off with North East Water, Wodonga Catholic College (WCC) and Riverina TAFE at the start of 2017 school year, with two female students being selected to participate. This program is hoping to be rolled out to all 17 Victorian Water Corporations by 2018 if the current funding opportunities are realised.

This paper will explain how the program is working and how other Water Corporations could join up next year.

## 1.0 INTRODUCTION

North East Water's operations delivery has always delivered a high level of performance seeing it in the top 5 of the majority of the Essential Service Commissions benchmarks against the other 17 Victorian water corporations. It has achieved this while delivering the most affordable water bill in Australia and last year taking out Victoria's best tasting water. To top this off North East Water delivered a 92% customer satisfaction result in 2017.

While all of these outcomes are a credit to all its employees any organisation cannot just continue to do the same thing and expect to deliver the same results.

A water corporation must look to how it is resourced and trained and its mix of high quality staff which includes the diversity of its people to ensure new thinking and solid knowledge is retained. It should also look to support the community it serves by supporting the next generation of operators coming through its local schools.

North East Water have communicated through its People Strategy that we are committed to creating a more diverse and inclusive organisation that better reflects the diverse communities that we serve. Workplace diversity relates to many areas, such as race, gender, age, religious belief, disability, sexual orientation and many more. This strategy is focusing on the areas that are a current priority and that align with the Victorian Industry Diversity Strategy.

A number of key strategic priorities underpin this *People Strategy*:-

1. Women in the Workforce.
2. Opportunities for Aboriginal and Torres Strait Islander People.
3. Understanding the needs of an intergenerational organisation.
4. Supporting a flexible and empowering workplace.
5. Inclusive and respectful organisation.

To achieve these goals North East Water have set a target of increasing our female outdoor staff numbers by 10% by 2019.

To deliver on this target we have partnered with Wodonga Catholic College and their VCAL program to encourage female school leavers to work in the water industry and more specifically operations.

## **2.0 THE VCAL PROGRAM**

To meet North East Waters People Strategy in relation to diversity and the operations goal of 10% increase in female operators, we set about changing the way we advertised for operational roles. The advice we were given by other water corporations was that by changing the titles and making the roles sound less specific i.e. must have Certificate 3 in NWP07, we would attract more female applicants. Sadly whatever we did in this space it didn't work as planned with no females applying.

This left us to rethink the problem of why is the water industry not attractive to female school leavers. An approach to a local college was sort for advice and what we discovered was that they had a different problem. They had trouble attracting females to their VCAL program because of limited options for them other than hairdressing or hospitality.

The VCAL program is open to year 11 and 12 students who are looking for two days a week work experience in their chosen field and three days a week traditional classroom activities.

What was attractive to North East Water was the school would choose 4 female suitable applicants to be interviewed for the newly created apprenticeship role. This meant that they knew the students well and understood their abilities as well as their suitability to the role. WCC also wanted the program to succeed to show an alternative to the current work placements on offer, which would then attract more students to stay at school and complete their year twelve education.

While at North East Water the student would complete their Certificate 3 NWP07 in either water or waste water treatment operations.

## **2.1 How It Works**

After an extensive interview process with the selected candidates who included tours of the water and waste water treatment plants with their parents, and an informal conversation about the role. North East Water selected two candidates, one for our water treatment plant and the other for our waste water treatment in Wodonga.

The two students are in year twelve and work two days a week in their first year then fulltime in their second year.

They complete all of their learning by correspondence work in their first year through Riverina TAFE and the Water Training Centre (WTC). In their second year they will complete their in-house training in Geelong at the WTC.

While in their first year we have monthly check-ins with the college to ensure that the students have what they need and that they are successfully completing their year 12 studies.

## **2.2 Future Opportunities**

Currently we are working with Riverina TAFE to secure government funding to lower the cost of the training which is around \$10,000 per student to complete the certificate, plus accommodation and expenses.

North East Water are now currently working with other Victorian Water Corporations who are trying to achieve the same goals as us, while facing the same issues in attracting female operators.

If we can get around ten students across the state we could run a similar training arrangement that WIOA and IWN have for the Network Development course where the group of students could come together once a month at sites across the state, to share learnings while participating in the training course.

If we could get each Victorian Water Corporation to employ one VCAL student per year there would be a pool of over 50 female trained operators across the state within 5 years. What makes these employees even more attractive is that they are a mobile group that generally have no real ties to family or towns and are in most cases willing to work at other corporations as positions become available.

## **3.0 WHAT WE LEARNT**

This project has now been running at North East Water for 6 months and there have been several learnings.

1. To work with teenagers you need new skills in how to coach a school leaver. WCC have been fantastic in this space running a half day course for our operators on dealing with teenagers, something they have found helps at home
2. It doesn't suit everyone. We have had one of the students pull out as she just didn't see herself working in our industry but she did enjoy the time with us
3. There are plenty more to follow. Even though one didn't work out there were others very keen at WCC to take her place
4. It has raised interest at the school by other school leavers now looking to do work experience with us
5. With the apprentice only working two days a week it is better to combine the two days together at the start of the week for a better flow of work.

## **4.0 CONCLUSION**

So far the pilot program has been very rewarding for North East Water by opening an avenue into a stream of female employees for our outdoor operations. It has however, been a drain initially to get the program up and to set weekly routines for the girls.

Now that this has been defined next year's applicants will find it more settled and our operators know what to expect.

The program has raised a lot of interest within the college about North East Water and working in the water industry in general. It has opened up an opportunity for female school leavers into another stream other than the traditional offerings, which has in turn raised the profile of the VCAL program. This has now attracted other large manufacturing businesses in Wodonga to be a part of the program.

The next phase is to try and build a larger pool across the other 16 Victorian water corporations to attract more students into a larger training group and garner funding for the program.



*Winner of the Best Operator Paper at the annual Water Industry Operations Group Conference, Queenstown, New Zealand 2017*

## **INSTALLATION OF A 900MM FLEXTEND SEISMIC COUPLING ON A BULK WATER MAIN**



***Paper Presented by:***

**Steve Watt**

***Author:***

**Steve Watt, Works Operations Manager,**

**Wellington Water Ltd – New Zealand**



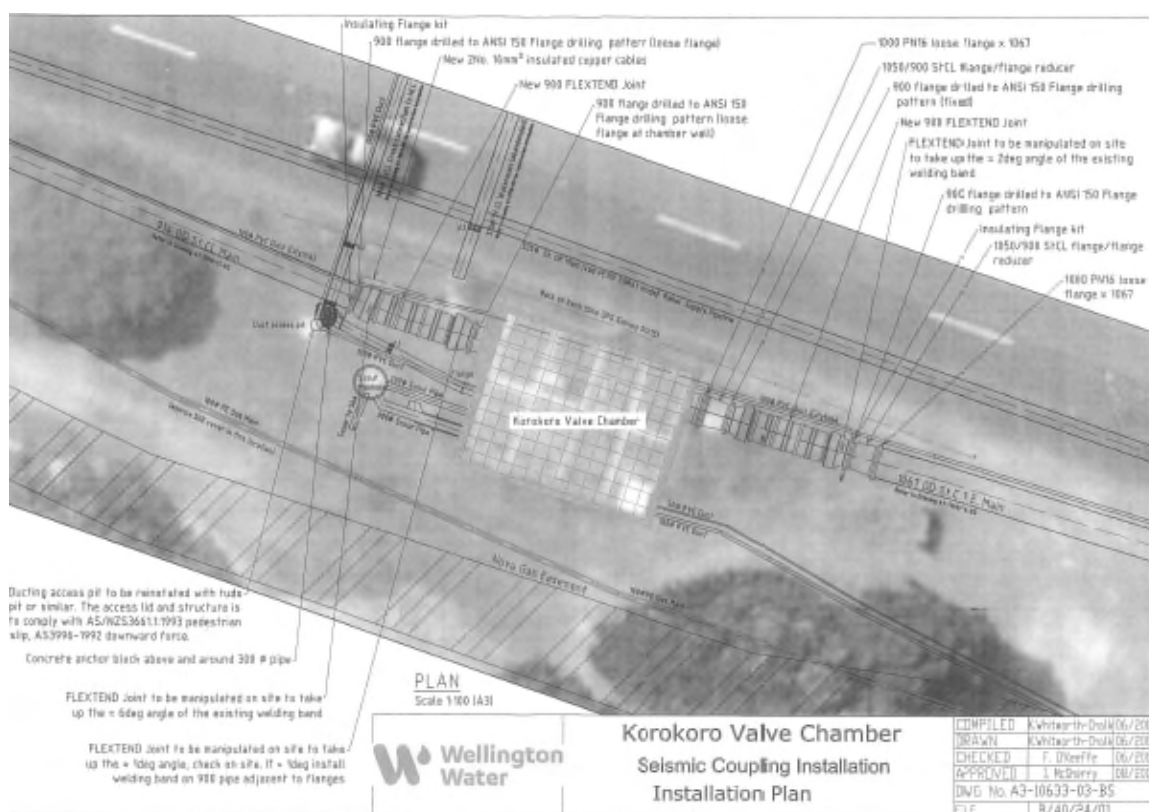
***80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# INSTALLATION OF A 900MM FLEXTEND SEISMIC COUPLING ON A BULK WATER MAIN

**Steve Watt**, Works Operations Manager, Wellington Water Ltd – New Zealand

## ABSTRACT

An area determined to have high liquefaction in a seismic event is in the location of a 900mm-1050mm diameter bulk water main that supplies Wellington City with water. A critical network valve chamber along this main was assessed by engineers that it would elevate upwards in an event of an earthquake, causing the bulk main to lift with it causing the main to rupture and cutting off the water supply to the city.



Engineers calculated that by installing Flextend flexible couplings into the inlet and outlet of the valve chamber this would allow the pipe to move with the chamber and reduce the risk of the main breaking.

## 1.0 INTRODUCTION

The Wellington Water Work Operations Pipeline Departments were given the Capex project to install the flexible couplings. The physical works took place from April 2016 through to the end of May 2016.

The project involved extensive sheet piling to ensure the excavations were safe and traffic management next to a main roadway into Wellington.

The cost of the Flextend couplings were \$200K each and the total cost of the project was \$1.8 million.

The Flextends weighed 4T each and were supplied by Hynds.

All fabrication was carried out by the Pipelines team at their Depot in Lower Hutt and onsite.

Two shutdowns were required to install the couplings. Each shut down was for a period of 15 hours. An alternative main from a different route was used to supply water and all reservoirs were topped up prior to the shuts. The Pipelines team worked closely with the Treatment Plant operators to co-ordinate these shuts.



## **2.0 CONCLUSION**

The Flextend couplings are the biggest couplings fitted to date in New Zealand.

The project was complex and approximately a year in planning and preparation.

Wellington City did not run out of water or lose pressure on the day of the shuts.

The couplings and valve chamber were intact after the Wellington earthquake in November 2016. A good sign!

There are already plans for another vulnerable valve chamber to have 1200mm diameter couplings fitted in 2018.

## **3.0 ACKNOWLEDGEMENTS**

Wellington Water Pipelines Team (my staff)  
Hynds – Flextend Suppliers

# THE NETWORK OPERATOR DEVELOPMENT PROGRAM



*Paper Presented by:*

**Andrew Povey & Jason Cass**

*Authors:*

**Andrew Povey**, *Civil Maintenance Team Leader,*  
Wannon Water

**Jason Cass**, *Water Services Operator,*  
GWMWater



*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# THE NETWORK OPERATOR DEVELOPMENT PROGRAM

**Andrew Povey**, *Civil Maintenance Team Leader, Wannon Water*

**Jason Cass**, *Water Services Operator, GWMWater*

## ABSTRACT

After gaining endorsement for the concept at a meeting of Victorian Water Corporation Managing Directors in 2016, planning for the inaugural Network Operator Development Program (NODP) was commenced. An Advisory Committee was established and tasked with developing the principles and overseeing the content of the Program.

The NODP has been established to identify, mentor and develop future leaders in the Network Operations field across the Victorian Water Industry. The program commenced in February 2017 with the first cohort of 13 participants from 11 Victorian Water Corporations participating. The aim of the NODP is to expand the knowledge, skillset, network of colleagues and practical experience of Network Operators by exposing them to strategic thinking and best practice initiatives across the technology, business management and leadership fields.

The program involves one day each month over an eight month period, with sessions held at venues across the state depending on the content of the particular day. Feedback from participants is that they have thoroughly enjoyed being involved and that the development goals set when the program was established have certainly been met. This is a great example of WIOA members identifying and then providing development opportunities and working on behalf of the industry.

By being fully engaged during the program, graduates will be provided tools enabling them to learn how to identify and implement best practice approaches, increase productivity and enhance a professional culture within their respective organisations, in order to deliver an improved customer focus in their O&M related activities

## 1.0 BACKGROUND

The field of Network Operations and Maintenance (O&M) is often viewed as the ‘little brother’ to the water and wastewater treatment functions. This notion possibly emerges as a result of less recent investment in network improvements; perceptions of lower complexity than operating treatment plant processes; and less direct interest from regulators. The current interest in certification for treatment operators, but not necessarily for networks operators, is a good example. As a result, there appears to be a lower emphasis placed on professional development opportunities for network operators.

However, the overall value of the network assets is significantly larger than the treatment assets; opportunities for improved network operations are significant; and through the field work undertaken, there is a direct link to the experience of customers. The importance of network O&M through the efficient delivery of safe drinking water and the provision of reliable sewerage services are critical and fundamental aspects of the water industry.

In an effort to deliver improvement in the industry, a group of committed water industry O&M representatives, with the full support of the Water Industry Operators Association of Australia (WIOA), have come together to create the Networks Operator Development Program (NODP).

## 2.0 PURPOSE AND AIM

The **purpose of the NODP** is to identify, mentor and develop future leaders in the network operations field across the Victorian Water Industry.

The **NODP aim** is to expand the knowledge, skillset, network of colleagues and practical experience of network operators by exposing them to strategic thinking and best practice initiatives across the technology, business management and leadership fields.

Applicants for this program must primarily work within the potable water reticulation network and/or wastewater collection systems. Network reticulation is defined as the pipelines and associated infrastructure from the Water Corporation's water treatment plant to the point where the customer's responsibilities begin. Works normally undertaken can include connection, isolation, repairs, maintenance and cleaning of potable water systems.

Wastewater collection is defined as the pipelines and associated infrastructure from the point where customer's responsibilities cease to the point where the wastewater treatment plant responsibilities begin. Works normally undertaken can include sewer system repairs, clearing blockages, pump or station operations, CCTV review of assets and odour control.

By being fully engaged during the program, graduates will be provided tools enabling them to learn how to identify and implement best practice approaches, increase productivity and enhance a professional culture within their respective organisations, in order to deliver an improved customer focus in their O&M related activities.

## 3.0 ABOUT THE NETWORK OPERATOR DEVELOPMENT PROGRAM

The NODP seeks to develop the skills of the participants by exposing them to a range of training delivery techniques including structured workshops, field days, technical sessions, comparative analysis of practices and technology utilised within the industry, conference attendance, along with assignments and projects, over the course of the program period.

The nomination process is open to all Victorian Water Corporations with any employee who meets the selection criteria and is predominantly involved in Network Operations/ Service Delivery eligible to enrol.

Participating Water Corporations are encouraged to nominate participants who:

- have the potential to develop as industry leaders,
- can contribute to innovation,
- can promote and implement best practice,
- can drive and demonstrate business values.

The preferred number of program participants annually is 12-20, preferably one per Water Corporation with an even spread across the water industry. If there are insufficient nominations received, additional participants may be selected from a single Corporation.

Participating in the program involves one contact day each month over an eight month period, with venues rotating around the state depending on the content of the particular day. Successful completion of the program requires participants to undertake some workplace projects and assignments in the time between the contact sessions. Each participant is also required to research, develop and deliver a presentation to the group on a focus area.

Each year, the NODP Advisory Committee will select one participant to be awarded the WIOA Network Operator of the Year. The winner will be announced at the WIOA Conference Awards Dinner annually and receives sponsorship to the value of \$3,000 provided by Water Training Australia. This must be used on an appropriate professional development opportunity for the winner. Participants will be encouraged to, and given the opportunity to attend the annual WIOA conference and be actively involved in the conference.

#### **4.0 NODP PROGRAM**

The program and the key dates for activities along with the topic for each of the workshop days are listed below. Due to the evolving nature of the program, the full details of each of the Workshop days including the dates, locations, times, presenter details and specific content is located on the WIOA website at [www.wioa.org.au/](http://www.wioa.org.au/)

<b>November:</b>	Applications received from Water Corporations
<b>December:</b>	NODP Advisory Committee meets and confirms program participants. Nominating Water Corporations and nominees advised.
<b>February:</b>	Workshop 1 – Leadership & Industry Focus via Water Corporation MD's and Regulators (DHHS & EPA)
<b>March:</b>	Workshop 2 – Water Quality Awareness and Water Main Repairs for Safe Drinking Water
<b>April:</b>	Workshop 3 – Network System Management Issues
<b>May:</b>	Workshop 4 – Wastewater Collection System Management Issues
<b>June:</b>	Workshop 5 – Pumps and Pumping Systems Management Issues
<b>July:</b>	Workshop 6 – Asset Management
<b>August:</b>	Workshop 7 – Program Wrap up, Field Trip and Program Evaluation by Participants
<b>September:</b>	WIOA Victorian Conference
<b>October:</b>	Program evaluation and review of participant feedback by Advisory Committee. Planning of content for the next year to be undertaken.

#### **4.1 Successful Completion of the NODP**

To successfully complete the Program, participants should meet the following criteria:

- Program participants must attend all of the Workshop days as well as the WIOA conference as a delegate. The Advisory Committee may approve an absence from a Workshop day, but only in exceptional circumstances.
- Completion of the projects and activities as assigned after each Workshop session.
- Completion of at least one presentation during the program. This can be a report back to the Advisory Committee on the previous month's topics or in another agreed format.
- Participants are expected to proactively participate in all aspects of the Program and contribute to the discussions during the Workshops
- Participants are expected to build a network so that they can engage with one another, the presenters and their workplace coach. A diary or log recording all such engagement is to be maintained by the participants and made available to the Advisory Committee if requested.
- Participants must produce evidence that they have conducted at least two presentations to their workplace team about the Program and their progress in it.
- Assessment and review by the Advisory Committee of feedback from employers outlining the progress of their participants whilst they undertake the Program.

## 4.2 NODP Advisory Committee

The role of Network Operator Development Program Advisory Committee is to develop the principles and oversee the introduction of the Program. On an ongoing basis, the Advisory Committee is responsible for:

- Confirming the selection of each year's participants in the program.
- Developing the course content and assessment criteria used to determine successful completion of the program by participants.
- Facilitating the monthly development sessions for participants along with managing and running the program for each session.
- Annual assessment of participants.
- Overview of the program, accepting feedback from participants and Water Corporations.
- Reviewing the content of the program and ensuring the activities and topics remain relevant to the intent of the program.

The Advisory Committee members should be either directly employed in the O&M field, be responsible for the management of O&M activities, or be recognised as having intimate knowledge of the O&M activities. The Program Advisory Committee shall ideally be comprised of eight individual WIOA members, including at least one WIOA nominated representative.

The 2017 Program Advisory Committee comprises the following people and organisations:

Mick Mahoney	Wannon Water
Neville Whittaker	Goulburn Valley Water
Dean Barnett	Western Water
Russell Bates	East Gippsland Water
Stephen Parish	GWM Water
Mike Rankin	Water Training Australia
George Wall	WIOA.

The ideal term for Advisory Committee members is no more than four consecutive years.

### **ANDREW POVEY, WANNON WATER - NODP PARTICIPANT FEEDBACK**

I was given the opportunity to participate in the Inaugural NODP program after being selected from the applicants within Wannon Water. This selection process also took place at many of the other water Corporations around Victoria with a total of 13 participants coming together to form the first NODP group.

Over the last nine months the group has met at various locations across Victoria, attended a total of eight workshop and development sessions on a variety of topics including but not limited to: Leadership and The Water Industry, Water Quality, Water Reticulation Systems, Wastewater Collection Systems, Pumps and Pumping Systems and Asset Management.

When we came together at the February meeting in Melbourne, I'm sure everyone was as excited and as nervous as I was, not quite knowing what to expect from the program. It took a while for all the participants to open up and get to know each other better, but the longer the program went, the more comfortable everyone felt and they freely shared their knowledge, skills and experiences.



## **What have you gained from the NODP?**

I would like to quickly give you an insight to what I have gained over the duration of the NODP. The first session involved Leadership. This session was possibly one of the most beneficial parts of the program for me, as it has helped me in my current role as a Team Leader. It has also benefited me away from the work environment where I have since taken on a role as a Community Bank Director where I can use some of these skills gained to help within my local community.

All participants were required to deliver a presentation to the group on one of the sessions at some stage throughout the program. This did bring some members of the group out of their comfort zone, including myself, but the result is that everyone has gained some extra self confidence in public speaking from the experience.

One of the biggest benefits of the program is that it has created some great working and social relationships with other NODP participants or committee members. This definitely allows networking and problem solving to be undertaken much easier than previously was the case.

The program has shown me that we are all dealing with similar issues on a day to day basis, and we are not out there on our own. We can all help one another to solve problems, share knowledge and ideas, and also share the experiences (good or bad) of the multitude of new technologies and systems that are being introduced more frequently than ever. This networking can be used as a cost saving exercise across all the participating Corporations. What we have been able to save our respective Corporations through our increased knowledge, would easily offset the cost of the program, hopefully allowing the attendance of future participants.

The program also allows recognition for the specialised skill of "Civil Maintenance" which often goes unnoticed. For example when a kitchen tap is turned on nobody ever thinks this water is at my tap thanks to the Maintenance team. We all know that without this team, nobody would be getting water out of that tap regardless of its taste or quality. Or when the toilet is flushed nobody says thanks for the great job of ensuring that the waste is removed from my property and treated to a standard that does not impact the environment.

The NODP has highlighted that Maintenance and Treatment go hand in hand, and are of equal importance, deserving equal recognition. I hope for future participants this program will only get bigger and stronger, and benefit all involved either directly or indirectly through the sharing of knowledge and experience.

## **JASON CASS, GWMWATER - NODP PARTICIPANT FEEDBACK**

I am a Network operator from GWMWater based in the Mallee. I was excited to be chosen to participate in the program on behalf of GWMWater. Like all the other attendees, I was a little uncertain, almost overawed, going into the program. The Advisory Committee members and the other participants were really friendly and supportive and it didn't take long to feel at ease.

The first session at Melbourne Water in February really set the scene for the rest of the program. Hearing Suzie Sarkis from DHHS and Chris Webb from the EPA speak about our responsibilities as operators and how and why we report to them put things into perspective for all of us. Talking with these people helped me to get a better understanding that we are 'partners' in producing a product for consumers. I say partners because that is how it was explained to me, we work together to produce a safe product for our customers and both DHHS and EPA are here to help us with that.

To have two well respected Water Corporation Managing Directors speak to the group (under Chatham Rules) was a very rare experience. Apart from speaking to us about the water minister and Water Act, the ramifications of noncompliance, and the letter of expectations, they also spoke very candidly about how they believed their people are their biggest assets. They provided their views on what good management is all about. A couple of pearls of wisdom included “we must always consider that if customers had a choice, would they choose us?” and also “value isn’t just about the cost in dollars, it is all about the services we provide”.

### **Tell Us about Some Specific Outcomes from the NODP**

By far the biggest benefit of being involved in the NODP was the exposure to new technology, latest thinking about processes and systems, and the opportunity to interact and share with the presenters, other participants and Committee members.

Given how isolated we are compared to the rest of the State, we don’t often hear about or see new technologies. I was amazed by the scope and range of technologies that are being investigated and trialled under the IWN project. One that really stood out for me was the SLRat system which could be used to identify sewer blockages and from what we were shown, could also help make scheduled cleaning of sewer mains much more efficient and effective.

Having the Toxfree team come along and present also gave me some good information on how to better operate our equipment when jetting sewer mains, something that I have been able to share with other operators in our region.

Hearing Peter Mosse talk to us about hygiene in pipe systems, in water mains replacements and when repairing a main break opened my eyes to a whole new bunch of risks we have not considered and new way of doing things. Western Water was kind enough to let us witness them replacing a section of main so that we could all see how they do it. Water main replacement procedures is currently a hot topic in our industry and it’s great to see someone else doing it and be able to take note so that we can implement their good ideas at our organisations. To see the commitment that operators at organisations like Goulburn Valley Water have placed on this task, makes me really keen to help GWMWater get to the same level.

With a session on unaccountable water issues and leak detection, including technology like satellite leak detection, it was interesting to hear how many organisations have variable levels of success managing this issue. Seeing some of the data and processes for cleaning the water reticulation network was great because I have not heard much about ice pigging. We are doing some ice pigging in another area of GWMWater soon and I hope to be able to see the process first hand. To find out about the NoDes flushing system and seeing the truck was also impressive and this technology has the potential to save heaps of water whilst keeping the water mains clean. Learning about flushing velocities in both the water network and also for sewer pumps and mains was really interesting.

The assignment work following each session really helped tie what we had discussed during the day into what we do at our individual organisations. I have a list of items as long as my arm about what I would like to help change so that I can help our organisation be more efficient and deliver better services to our customers. I plan to just keep chipping away over time.

Finally, participating in the program has provided me a really tight network of people that I can call on at any time to help me work through any issue I may have. This is by far the biggest benefit of participating in the NODP.

# RAPID CONDITION ASSESSMENT OF SEWER MAINS USING SEWERBATT™



***Paper Presented by:***

**Leon Stackpole**

***Author:***

**Leon Stackpole, *Sewer Assets and Operations Manager,***

**Coliban Region Water**



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# RAPID CONDITION ASSESSMENT OF SEWER MAINS USING SEWERBATT™

**Leon Stackpole**, *Sewer Assets and Operations Manager*, Coliban Region Water Corporation

## ABSTRACT

Coliban Water has used SewerBatt™ acoustic sensing technology to assess the condition of a range of small and medium sized sewer pipes within the Coliban Water sewer network. The results have been compared to CCTV condition assessment reports. The results demonstrate that the technology is more accurate for assessing the condition of medium sized sewer pipes (>150 to ≤450mm diameter). Therefore the tool is being used on an ongoing basis to prevent larger sewer spills from medium sized pipes. Further work is required to determine the value of the technology for smaller pipes. The project has identified key attributes of a successful SewerBatt™ program including operator capability and program design. The program was enhanced by combining it with a sewer manhole condition assessment program.

## 1.0 INTRODUCTION

A large proportion of Coliban Water's sewer network is relatively shallow and in well vegetated areas thus increasing the risk of blockages and significant environmental spills.

Around 95% of blockages occur in small diameter pipes (100-150mm). Ongoing review of performance demonstrates that around 30% of blockages experienced each year occur in sewer lines with no previous blockage history in Coliban Water's asset management information system. A capacity to proactively and cost effectively identify potential first time blockages before they result in service issues would provide a valuable tool to reduce customer impacts, when used in conjunction with other traditional programs.

Larger spills from the gravity sewer network have occurred from medium sized diameter pipes (>150 and ≤ 450mm) that are often located in rarely visited bushland areas along gullies and minor watercourses. Blockages in these pipes are rare however they can result in significant spills and environmental impacts.

Australian water utilities frequently use CCTV to assess sewer condition using the WSAA Conduit Inspection Reporting Code Appendix E categorisation system, however these assessment processes take time and require sizeable investments.

Coliban Water participated in Isle Utilities led trials to assess the value of two acoustic sensing technologies to rapidly assess the condition of sewers – SL-RAT® and SewerBatt™. Following the trials Coliban Water purchased a SewerBatt™ unit in 2015. The ability of SewerBatt™ to assess a sewer from one manhole was a key reason for selecting this technology.

Two standard versions of the SewerBatt™ acoustic sensor are currently available: one is for pipes with a diameter range of 75-225mm; and the other for pipes with a diameter range of 150-600mm. Each SewerBatt™ assessment produces a scan result and a traffic light score. With experience an operator can assess the acoustic signature generated by the scan to determine pipe length, location of blockages, lateral connections and other faults.

The Traffic Light system provides an objective means of grading pipes as 'Good', 'Fair' or 'Poor', represented by 'Green', 'Yellow', and 'Red' traffic lights respectively.

Coliban Water has initiated a program of manhole condition assessment to manage the public safety risk from failed manholes. This assessment generates data including manhole condition rating, location, levels (manhole lid and sewer pipe invert) and photographs. There is an opportunity to conduct both manhole and SewerBatt<sup>TM</sup> sewer assessment at the same time.

## 2.0 DISCUSSION

Key potential uses of SewerBatt<sup>TM</sup> that have been identified are:

- Blockage reduction especially in 150mm diameter mains;
- Reduction of large spills especially in >150 and ≤ 450mm diameter mains;
- A faster and cheaper form of condition assessment compared to CCTV; and
- Any of the above used in conjunction with a broader sewer manhole condition assessment program.

The aim of the investigation is to determine whether SewerBatt<sup>TM</sup> can be used in place of CCTV and determine the associated level of risk reduction. This would help to determine further uses of the technology. The investigation was carried out in three phases.

**Table 1:** *Investigation phases*

Phase	Investigation	No of lines	Pipe diameter (mm)	Date
1	Assess small to medium sized sewers using SewerBatt <sup>TM</sup>	349	150 – 375	Jan 2015
2	Compare phase 1 results to CCTV	139	150 – 375	2015
3	Assess medium sized sewers using SewerBatt <sup>TM</sup>	167	225 – 450	2015-16

### 2.1 Phase 1 - 100 to 375mm diameter sewers

The SewerBatt<sup>TM</sup> sensor for pipes with a diameter range of 75-225mm was used in this phase. Five areas were selected for investigation (see Table 2). Criteria for site selection included:

- Readily accessible sites;
- Sites with a variety of pipe diameters and materials; and
- Sites with CCTV data already available and preferably undertaken no greater than 12 months prior to the SewerBatt<sup>TM</sup> trial.

**Table 2:** *Phase 1 sewers*

Area	Sewer network	Pipe diameter (mm)	Length assessed (m)
Long Gully, Bendigo	Bendigo	150-300	4,474
Kennington, Bendigo	Bendigo	100-375	4,024
New estate in Huntly	Bendigo	150-225	994
Kyneton	Kyneton	150-300	4,327
Golden Square	Bendigo	100-150	3,599
Total			17,418

Phase 1 SewerBatt™ results are outlined in Table 3 using the traffic light system. This does not include sewers that were not able to be accessed which was <20% of the originally targeted lines.

**Table 3:** *Phase 1 SewerBatt™ overall grades for 349 lines 150-375mm*

SewerBatt™ overall grade	‘Good’ condition	‘Fair’ condition	‘Poor’ condition
Proportion of lines with result	21%	26%	53%

The accuracy of results for pipe diameters greater than 250mm possess an element of doubt as the SewerBatt™ acoustic sensor utilised in the testing was not recommended for use on pipe diameters greater than 250mm. Nevertheless strong signals were typically obtained for the 300mm and 375mm diameter pipes.

## 2.2 Phase 2 – Comparison to CCTV

A selection of 139 pipes from Phase 1 were compared to CCTV results with grading undertaken in accordance with WSAA Conduit Inspection Reporting Code, Appendix E. Pipe diameters were as follows: 100mm x2, 150mm x68, 225mm x34, 300mm x31 and 375mm x 4.

The traffic light results were compared to CCTV grades in the following manner - CCTV grading 1-2 equivalent to SewerBatt™ ‘Good’, CCTV grading 3 equivalent to SewerBatt™ ‘Fair’ and CCTV grading 4-5 equivalent to SewerBatt™ ‘Poor’.

The SewerBatt™ grading was then classified as either consistent or not consistent with CCTV inspection.

**Table 4:** *SewerBatt™ grade consistency with CCTV*

SewerBatt™ grade	Good condition	Fair condition	Poor condition
Overall grading	53%	15%	62%
Service grade only	87%	29%	32%
Structure grade only	67%	8%	56%

SewerBatt™ was most accurate when determining the service grade of pipes in ‘Good’ condition, with a consistency of 87% (the remaining 13% were classified as ‘Fair’ by CCTV). This was more accurate than the structural grade of pipes in ‘Good’ condition, which had a consistency of 67%.

Table 7 details the accuracy of SewerBatt™ to detect pipes in ‘Good’ or ‘Poor’ condition.

**Table 5:** *Accuracy of SewerBatt™ to detect pipes in ‘Good’ or ‘Poor’ condition*

CCTV grade used for comparison	Graded by SewerBatt™ as ‘Poor’ but actually ‘Good’	Graded by SewerBatt™ as ‘Good’ but actually ‘Poor’
Overall grading	32%	0%
Service grade only	49%	0%
Structure grade only	37%	0%

In no instances was a sewer pipe classified as ‘Good’ condition by SewerBatt™ when it had been classified as ‘Poor’ by CCTV assessment.

Some 35 of the 139 pipes investigated were 300mm or 375mm diameter pipes. Though this SewerBatt<sup>TM</sup> sensor is not recommended for pipes with a diameter greater than 250mm the traffic light results for the larger pipes were similarly consistent to CCTV as the smaller pipes.

The above analysis assumes negligible error associated with the CCTV grading however it is likely that the following factors will have affected the results:

- Accuracy of CCTV – Coliban Water uses qualified contractors to conduct CCTV surveys in accordance with the WSAA categorisation system, however such surveys are subject to operator judgement which can generate errors and inconsistencies in the results; and
- Timing of comparison - Some CCTV was taken up to 18 months prior to the SewerBatt<sup>TM</sup> survey. It is clearly preferable to conduct the surveys as close together as possible to reduce the opportunity for changes in the pipe in the meantime.

### 2.3 Phase 3 – 225 to 450mm diameter sewers

The SewerBatt<sup>TM</sup> sensor for pipes with a diameter range of 150 - 600mm was used in this phase. 167 medium sized sewers within Castlemaine were assessed. The pipes were primarily vitreous clay.

**Table 6:** *Phase 3 sewers*

Area	Pipe diameter (mm)	Length assessed (m)
Castlemaine	225 – 450	8,400

Phase 3 SewerBatt<sup>TM</sup> overall grade results are outlined in Table 9 using the traffic light system. This does not include sewers that were not able to be accessed which was <10% of the originally targeted lines.

**Table 7:** *Phase 3 SewerBatt<sup>TM</sup> overall grades for 167 lines 225-450mm*

	'Good' condition	'Fair' condition	'Poor' condition
Proportion of lines with grade	59%	28%	13%

### 2.4 Further results and discussion

The SewerBatt<sup>TM</sup> grades from Phases 1 and 3 are compared in the table below.

**Table 8:** *SewerBatt<sup>TM</sup> overall grades from Phases 1 and 3*

Phase	Pipe diameter (mm)	'Good' condition	'Fair' condition	'Poor' condition
1	100 - 375mm	21%	26%	53%
3	225 - 450mm	59%	28%	13%

These results indicate that SewerBatt<sup>TM</sup> will typically grade a higher proportion of larger mains as 'Good' condition compared to the general mains assessed in Phase 1 – the majority of which were 150mm to 225mm sewers.

This is most likely due to a combination of factors:

- Larger pipes are typically less prone to blockages than smaller pipes;
- Smaller pipes have a greater proportion of lateral connections (e.g. house connections) that provide opportunities for failure including access of tree roots to the sewer main; and/or
- The larger number of lateral connections in smaller pipes are more likely to affect the acoustic signal leading to a greater chance that the signal will be misinterpreted by the unit.

The above results have been used to estimate costs for the assessment of all medium sized sewers in Coliban Water's region using SewerBatt™, CCTV or a combination of both, as a means to reduce the risk of large spills. Refer to Table 11 below. This assumes that CCTV is conducted by a competent practitioner and that all mains are reasonably accessible and includes typical cleaning costs to enable CCTV.

Indicative numbers for the assessment of the entire Coliban Water sewer network are also provided.

**Table 9:** *Indicative comparative costs of assessment for the Coliban Water sewer network*

Cost (million \$)	Medium sized sewers	All sewers	Sewer spill/failure risk
Pipe diameter	225-450mm	100-1050mm	
Length of sewers	209 km	1,739 km	
SewerBatt™	0.21	0.82	Highest ↓ Lowest
SewerBatt™ followed by CCTV for 'Poor' graded lines	0.43	4.4	
SewerBatt™ followed by CCTV for 'Fair' and 'Poor' graded lines	0.75	6.3	
CCTV	1.2	8.8	

## 2.5 Operational issues and costs

Coliban Water engaged contractors to undertake the SewerBatt™ surveys using staff with a plumbing/trade background. Surveys were conducted with 2 staff. The Phase 3 surveys also incorporated manhole condition assessments which added around 20% more time to each survey. Costs for implementing SewerBatt™ have varied from \$0.57 to \$1 million (excluding GST). Costs increase in areas where manholes are more difficult to locate and access and when surveys were conducted in conjunction with the manhole assessment.

Other points to consider when implementing a SewerBatt™ program:

- The traffic light system generates valuable information, however in order to get the best value from the technology, it is important to develop staff expertise and experience to enable interpretation of the more subtle aspects associated with the pipe acoustic signatures and to ensure program consistency.
- Gradual wetting and accumulation of material on the SewerBatt™ head during surveys will result in incorrect signals. It's recommended to carry spare dry heads and a sensor chip in case they are wetted and avoid submerging the head; and
- Operators should be ready to field questions from the public as the noise from the SewerBatt™ microphone can attract attention and interest.



At the time of writing Coliban Water has used SewerBatt™ to assess around 200 km of sewers. Further analysis of the results obtained from the program is still to be conducted, however the results have been consistent with those in this paper.

Significant value has been obtained by incorporating a manhole condition assessment program into the assessment to identify manholes in need of repair and obtain new and more accurate manhole asset data.

### **3.0 CONCLUSION**

Coliban Water used SewerBatt™ to grade around 500 sewer pipes. 139 of those pipes were graded using CCTV.

SewerBatt™ was most accurate when determining the service grade of pipes in ‘Good’ condition, with a consistency of 87% (the remaining 13% were classified as ‘Fair’ by CCTV). This was more accurate than the structural grade of pipes in ‘Good’ condition, which had a consistency of 67%.

In no instances was a sewer pipe classified as ‘Good’ condition by SewerBatt™ when it had been classified as ‘Poor’ by CCTV assessment. This is significant because it signifies that it is highly unlikely that using SewerBatt™ assessments to prioritise CCTV inspection would overlook ‘Poor’ pipes that are most likely to require maintenance.

The high proportion of ‘Good’ SewerBatt™ gradings for mains with a diameter >150mm to ≤ 450mm indicates that SewerBatt™ can play a useful role for surveying these middle sized mains and help to reduce significant environmental spills.

Coliban Water will continue to use SewerBatt™ to proactively identify potential spills from medium sized mains and progressively apply to the blockage prevention program.

### **4.0 ACKNOWLEDGEMENTS**

Thanks to the following involved in conducting the in-field surveys including Darren Griffith & Lisa Mills (D&L Plumbing), Tom Tickner (Lendlease) and Norm James. Special thanks to Simone Ridgeway who coordinated the Phase 1 and 2 trials and completed the associated data analysis. Thanks to Coliban Water and Lendlease staff that have supported the program and assisted with this report in particular Rick Hartland, Leah Hutchins, Ryan Joyce, Angus Bowles, Nathalie Lopez and John Wright and Malcolm Anderson. Thanks to Eduardo Santos (UVS) for ongoing support.

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# WHAT OUR CUSTOMERS DON'T SEE: INCIDENT RESPONSE



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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
Conference and Exhibition  
Bendigo Exhibition Centre  
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# WHAT OUR CUSTOMERS DON'T SEE: INCIDENT RESPONSE

**David White**, *Water Optimisation Specialist*, Yarra Valley Water

## ABSTRACT

On the 9th of October 2016 Victoria was lashed with a severe wet weather and wind event which resulted in a tree crashing into a major supply reservoir for a town of 7000 people. Over the next three weeks a major incident response team across multiple businesses operating 24/7 battled multiple failures of critical assets to maintain supply to customers.

The adage, 'what can go wrong, will go wrong' is particularly pertinent in this incident response which tested the robustness of the supply and distribution systems with contingencies tested to the limit.

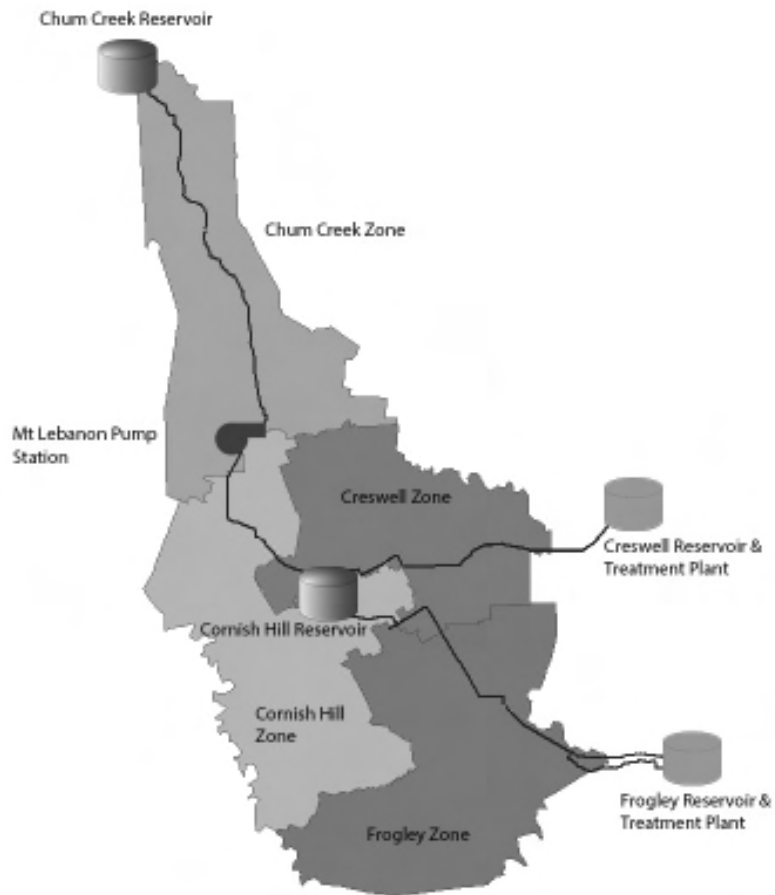
This paper will detail the incident response and then explore the concept of risk exposure within water treatment and distribution systems during an incident and how your contingencies may not be as good as you think they are.

## 1.0 INTRODUCTION

The severe storm that hit Victoria on Sunday, the 9<sup>th</sup> October 2016 with gusts up to 119 km/hr resulted in approximately 120,000 properties without power with 22,000 of these properties without power for greater than 2 days. Emergency services received more than 6000 calls for assistance, one person died when a tree collapsed on their property and another 20 people were taken to hospital with storm related injuries. Yarra Valley Water's Sewer and Water distribution systems were also impacted by the storm, one of the hardest areas hit was the town of Healesville.

Healesville receives water from a discrete water supply system consisting of two filtration and chlorination treatment plants and service reservoirs (Creswell and Frogley) operated by Melbourne Water. The distribution network, two service reservoirs (Chum Creek and Cornish Hill) and two pump stations (Mt Lebanon and Healesville Booster) are operated by Yarra Valley Water.

The towns supply is split into four distribution zones, typically supplied by each of the service reservoirs, with some interconnectivity between the Creswell and Cornish Hill zones. The Mt Lebanon and Healesville Booster pump stations take water from the Creswell and Cornish Hill reservoirs to supply the Chum Creek Reservoir.



**Figure 1:**     *Healesville Distribution System*

The storm impacted the Healesville water supply in several ways, including;

- A burst on the single feed to the Chum Creek Reservoir resulting in that reservoir completely emptying. Customers did not lose supply due to the location of the burst and the ability to continue pumping from the Mt Lebanon Pump Station.
- Prolonged loss of power to most assets including both treatment plants.
- Blocked access to both treatment plants.
- Damning of the Coranderk Aqueduct so that it no longer could supply the treatment plant
- Most dramatically the insertion of a large tree into Frogley Reservoir (Figure 2)



**Figure 2:**     *Internal & External View of Frogley Reservoir*

## **2.0 DISCUSSION**

### **2.1 Initial Response**

Due to the nature of the sewer and water networks the initial incident response was focused primarily on the sewer network and preventing spills to the environment. However, it became clear on the Monday morning that there was a major threat to the supply of drinking water to Healesville. No power was available to treat water and therefore the supply was dependant on the storages of the four reservoirs.

Additionally, early on Monday morning a Melbourne Water operator hiked into the Frogley Reservoir, (road access was restricted due to fallen trees), and observed the damage that required the tank to be taken offline immediately.

To facilitate taking this tank offline Yarra Valley Water set up a trailer mounted mobile pump at the Cornish Hill Reservoir site that could then pump directly into the Frogley Zone. This pump and associated generator was required to run 24/7. This created a noise concern for the nearby residents several of whom were relocated into temporary accommodation.

Normally the Cornish Hill Reservoir is supplied via gravity from the Frogley Reservoir. At the time of the temporary pump installation it was assumed that the Cornish Hill Reservoir could be filled from Creswell Reservoir as its top water level is 2.4m higher than Cornish Hill Reservoir. As discussed later this was found to be an inaccurate assumption.

Over the course of the Monday and Tuesday both Yarra Valley Water and Melbourne Water were occupied with the tasks required to assess the extent of the damage, source pumps, generators, crews to fix the burst main, remove fallen trees, respond to customer's noise related enquires, source quieter generators, sound proofing etc. However, by late Monday evening things were beginning to settle down with power via a generator restored to the Creswell Treatment plant and therefore the water supply to Healesville seemingly secure.

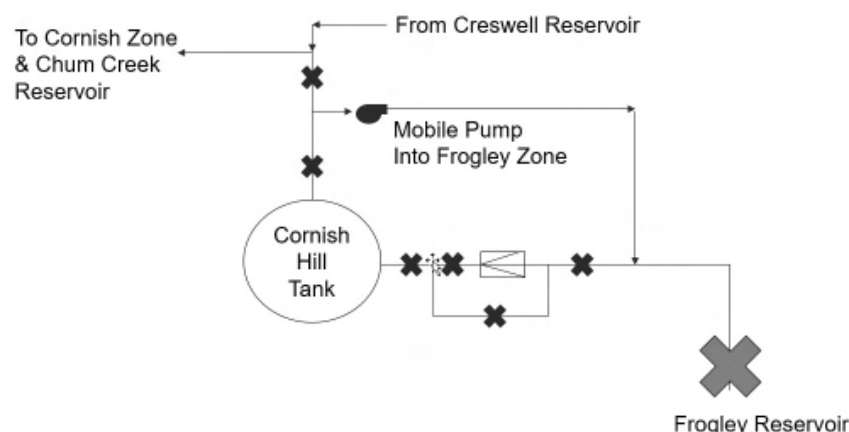
### **2.2 Extended Response**

On the Tuesday afternoon, it became apparent that Cornish Hill Reservoir was not filling from Creswell and would, without intervention, empty within 12 hours leaving much of Healesville without water. When the incident team ran the model for the distribution zone it was identified that due to head loss during peak periods, water from Creswell Reservoir was unable to supply both the mobile pump and the Cornish Hill Reservoir and that whilst the mobile pump continued to operate Cornish Hill Reservoir would continue to empty. The schematic layout is shown in Figure 3.

The incident team's immediate response was to organise a procession of water tankers to manually fill the reservoir, which would increase the time before the reservoir was empty but not by more than 6 hours. There were some additional challenges with this operation around customer and noise mitigation for tanker deliveries through the night as well as a report that indicated the access ladder was unsafe and therefore required a knuckle boom to be sourced to commence filling through the rooftop access hatch.

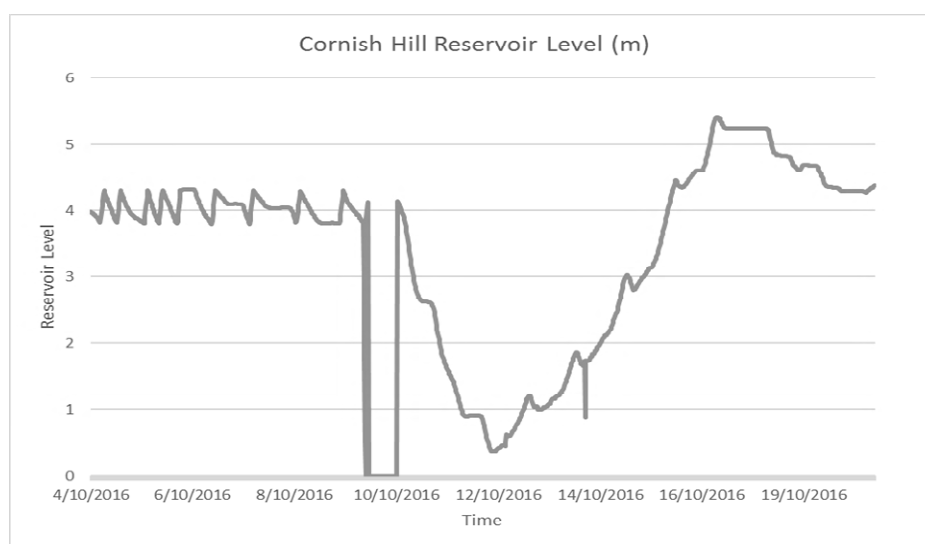
A request to the town's high water users was made to minimise their usage if possible.

The next challenge for the incident team was to figure out how to fill the Cornish Hill reservoir using a pump that was currently sourcing its water from that same reservoir.



**Figure 3:** *Cornish Hill Schematic*

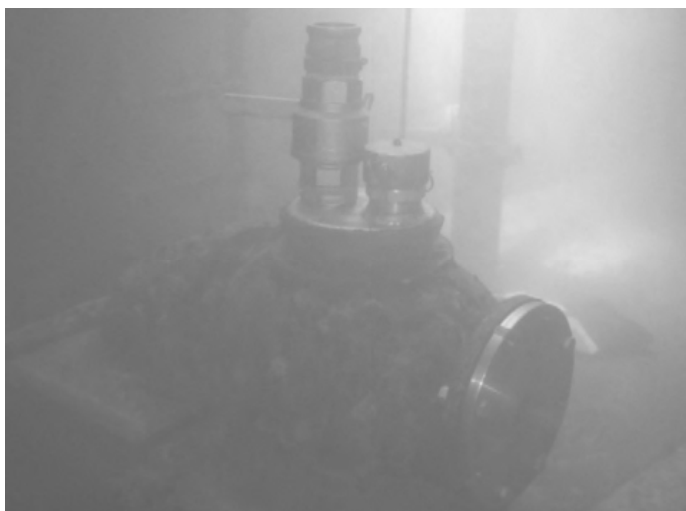
The solution was that during low demand periods the outlet valve of Cornish Hill Reservoir could be closed and the inlet valve opened so that the mobile pump was supplied with water from Creswell Reservoir, supply the Frogley zone and fill the Cornish Hill Reservoir. During high demand periods the outlet valve was opened and the inlet valve closed so that the mobile pump was supplied from Creswell reservoir and supplied the Frogley zone, whilst the Cornish Hill Reservoir depleted. Fortunately, more water could be supplied to the Cornish Hill Reservoir during low demand than was used in high demand periods. This operation required an operator on site 24/7 for 2 weeks before works were completed to make this automatic and allowed the tank level to recover to within normal operating bounds.



**Figure 4:** *Cornish Hill Reservoir Level*

This operation was reliant on both the inlet and outlet valves remaining operational, however after a few days the inlet valve to the Cornish hill reservoir failed in the shut position. With no way to fill the reservoir and no way to isolate the valve to repair, the level began to decline again and tankers were again used to buy more time.

After an inspection of the internals of the reservoir using a submersible ROV it was determined that the only way to isolate the failed valve was to have divers enter the online tank and fit what amounted to a large cork into the inlet structure.



**Figure 5:** *Inlet Structure “Cork”*

Whilst this inlet valve was the most critical of failures an additional 2 other valves including the altitude valve used to fill the reservoir also failed over the next couple of days. Adding to the complications for the incident team were a burst main in the Creswell Zone that began to deplete the storages as well as an unrelated elevated chlorine incident at the Chum Creek Reservoir.

## **2.3 Debrief Outcomes**

The incident debrief identified several issues with the incident response;

- The contingency plan for when Frogley Reservoir must be taken offline did not work due to the hydraulic deficiency within the zone.
- Modelling to identify the hydraulic deficiency could have been performed earlier in the incident response.
- Customer impact from generator noise went on longer than ideal.
- Fatigue management of incident staff could be improved with some staff working over the fatigue management policy guidelines.

## **2.4 Continual Assessment of Risk Exposure**

One of the key learning outcomes of this incident was the recognition that during an incident the ground is continually shifting under your feet and that identification of the risk exposures and developing a response ‘just in case’ should be a priority of the incident team. This will involve documenting the current situation but also numerous projected situations, looking at, what is the worst thing that could happen to us now and how will we deal with this, for example;

### **2.4.1 Hydraulic Deficiency**

On the Tuesday morning, the incident team was de-escalating as the mobile pump was in place providing an alternative supply to the Frogley zone. A significant uncontrolled risk for this method of operation was failure of the mobile pump.

This occurred due to an unidentified hydraulic deficiency within the network resulting in supply to the town almost being lost due to the length of time required to put in place contingencies. If the “what if” scenario had been run earlier and the problem identified the response could have been put in place a lot earlier. Whilst in this instance the supply to the town was not lost it was very close.

#### **2.4.2 Inlet Valve Failure**

Whilst not ideal and requiring 24/7 manual intervention the Cornish Hill Reservoir was gradually filling and had reached normal operating levels by the 17<sup>th</sup> October. The unidentified uncontrolled risk at this time was for the inlet valve to the reservoir to fail in the shut position. When this occurred, there was no way to fill the reservoir and no way to easily isolate the valve.

#### **2.4.3 Access to Access Hatch**

Tankers were used buy a small amount of extra time. When they arrived on site the ladder to the access hatch to allow filling was deemed to be unsafe. Therefore, delays were incurred trying to source a knuckle boom to access the hatch.

#### **2.4.4 Burst in the Zone**

This is one example of where a risk was identified prior to it occurring. If a burst was to occur anywhere in Healesville during the time of the incident the Cornish Hill Reservoir would be the source of water and empty very quickly. Therefore, a procedure to restrict flow from Cornish Hill Reservoir and transfer to Creswell Reservoir was developed early in the response. When a burst did occur, it had a short and minimal impact as opposed to a major impact if the contingency plan hadn't already been documented.

### **3.0 CONCLUSION**

Multiple failures happen. Being prepared is not just about having a contingency plan in your back pocket, it's an ever-evolving position during an incident. Whilst it seems like during an incident its go, go, go, a key task of the incident controller is to step back and ensure that someone is looking at the current situation and preparing best case and worst case scenarios of where you will be in the short and long term. Thinking about what is the worst thing that can happen right now and what are we going to do about it.

### **4.0 ACKNOWLEDGEMENTS**

I would like to acknowledge the efforts of the entire incident response team across Yarra Valley Water, Melbourne Water, Ventia and C-Tech.

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# YACKANDANDAH ENERGY STORAGE PROJECT



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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# YACKANDANDAH ENERGY STORAGE PROJECT

**David Bedggood**, *Area Coordinator, Beechworth, North East Water*

## ABSTRACT

North East Water (NEW) in partnership with the Intelligent Water Network (IWN) and the Totally Renewable Yackandandah (TRY) group are currently building the first solar photovoltaic and battery storage installation to run a water treatment plant off grid.

Along the journey, NEW has also partnered with SPAusnet to test energy storage through a mini grid pilot program that will see a sewerage pump station being powered by local housing that will collect solar energy for the batteries to run the station. Both these projects are helping North East Water meet its carbon pledge of a 50% reduction in carbon emissions by 2025.

This paper will map out the process of how this project came about and the learnings to help other corporations deliver renewable energy projects. Energy storage will be the game changer for the water industry over the next ten years. The introduction of battery storage can deliver water corporations control of the cost and reliability of their energy supply.

## 1.0 INTRODUCTION

In June 2015 the IWN formed a group to look at energy on behalf of the Victorian water industry. The group held two workshops with representatives from the 17 Victorian water corporations. From these workshops five key projects were selected, they were:

1. Large Scale Energy Generation
2. Energy Storage
3. Energy Procurement Models
4. WSAA/IWN Aeration Benchmarking
5. Pump Efficiency Monitoring

These projects were chosen to assist the industry to better understand the volatile and dynamic energy sector.

This paper will review the progress of the 'Energy Storage' project. The energy storage project was chosen as it represented three opportunities that could inform the water industry. Those opportunities were:

- Using energy storage instead of generator back up during power outages
- Saving utilities energy costs by being able to store renewable generated power
- Changing operating hours to suit the use of renewable energy

## 2.0 THE PROJECT

Early on in the project it was identified that a site for this trial needed to be a small water or waste water treatment plant (around 1 ML/d) for risk management purposes. By selecting a smaller plant, contingency energy or water supply could be supplied if issues with the storage unit were to arise. It was also helpful if the project could capture community support to promote the project as a positive outcome, and not an argument around climate change verses capital expenditure. After several sites were investigated, Yackandandah was selected as it had the right sized Water Treatment Plant (WTP), and a community group focused on renewable energy outcomes.

The community group known as TRY or Totally Renewable Yackandandah had set themselves a goal of being 100% renewable by 2022. The Yackandandah WTP covered the aspects associated with risk, including the ability to cart water if required.

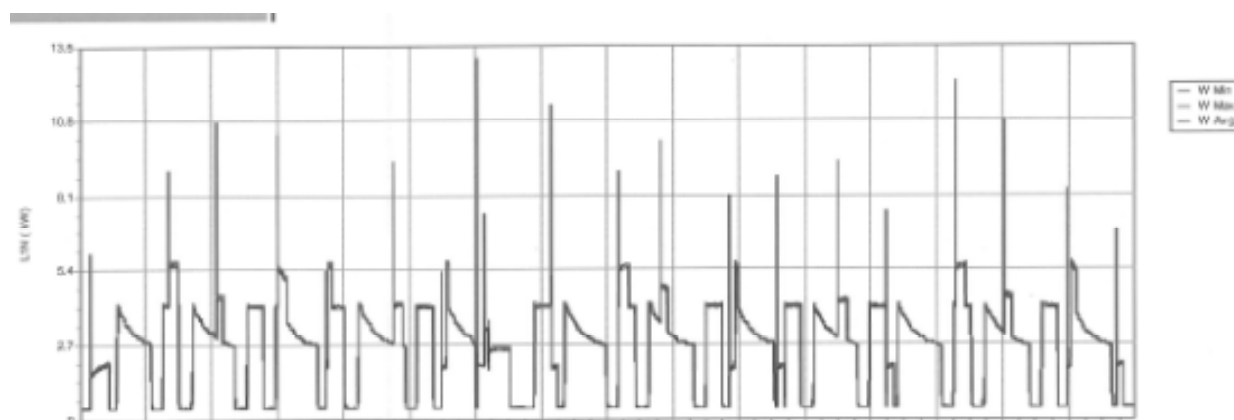
Another feature that made the Yackandandah project attractive to North East Water was that in times of bushfire and heatwave events the town's energy supply can become unreliable at a time it is needed the most. There is no energy back up at this site and energy storage could fill this gap.



**Figure 1:** *Yackandandah WTP and Storage*

## 2.1 First Step - Energy Reduction

The first step to understanding what the project might look like, North East Water first had to assess the energy profile of the plant. This allowed NEW to understand the energy requirements to have sufficient renewable energy and storage to run the WTP “off grid”. It was initially identified through profiling the energy consumption that the WTPs energy use was highly variable showing large spikes during the plants operation (*see Figure 2*).



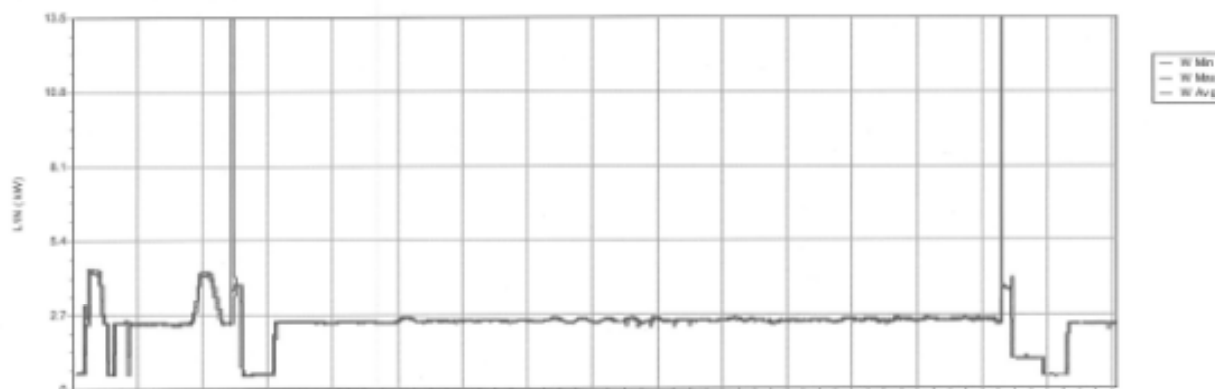
**Figure 2:** *Yackandandah WTP energy use*

What this highlighted was that the future solar and battery storage installations would need to be sized for the spikes. North East Water was advised that this could result in the project being twice the size than it need to, to allow for the energy spikes.

This then led to an in-house project team comprising of operations staff, treatment technicians and electricians to determine whether we could reduce the spiking and optimise energy consumption.

First a variable speed drive was installed to supply power to the water storage pumps that pushed water uphill to the storage tank. The second offender was the air compressor that supplied air for the control valves. The introduction of electrically actuated valves removed the need for the compressor and also improved plant operation as the new valves featured better control, due to the smoother valve movement delivering better water quality.

Both these changes resulted in a dramatic reduction in power spiking and energy use as highlighted below in Figure 3. As a result of these improvements, the design of energy storage and solar generation plant could be reduced from 100 kW solar and energy storage to 40 kW each, bringing the cost of the installation down significantly.



**Figure 3:** *Yackandandah WTP energy use after optimisation*

## 2.2 Community Engagement

The other significant connection with this project was having the community along for the journey, and given the project would require North East Water's CAPEX funding (noting supported through IWN), which is essentially the community's dollars, North East Water wanted to ensure it had community support in this project.

At the time energy costs were lower than current prices and would only see a break even life cycle cost of the 10 year project.

A connection was formed with the Yackandandah community through the 'TRY' group who saw this project as a great initiative for its goal of 100% renewable energy by 2022 for Yackandandah. The TRY group had already achieved the town's energy supplied with 33% renewable energy through their community project, which is one of the highest in Australia.

This connection then saw SPAusnet (Energy network provider), the community and North East Water's network provider coordinate to introduce a mini grid installation.

By having the key partnerships with TRY other parties have expressed interest and now wanting to get involved. Further projects are now being investigated to help reach the 2022 target.

## 2.3 The Installation

Once the two pieces of critical project initiation had been covered off, being energy optimisation and community support, North East Water went out to tender for the supply and installation of 40kW solar photovoltaic panels and 40kW battery storage unit.

Research into the type of battery identified that there was essentially two type of energy storage batteries currently available for this application, either lead acid or lithium ion.

The tender did not specify which type battery was preferred only that they needed to run the WTP in ideal generating conditions, as well as a standalone “off grid” plant for 24 hours. Remembering that this was an IWN trial to test battery storage and its advantages, and not to build an energy storage plant big enough to run continuously.

The trial is intended to assist other Victorian Water Corporations understand performance outcomes of energy storage installations.

The installation will consist of a solar photovoltaic array of 80 panels situated at the top of the WTP storage, with a DC powerline down to the plant with 12 lithium ion batteries and inverter combinations inside a weatherproof switchboard. The switchboard will be 2.4metres in length by 1.2 metres high. This is the value of the lithium Ion batteries North East Water are installing in that the footprint is small and can fit into the current footprint.

The generated solar power will feed the plant while the WTP is running, the excess energy will top up the batteries at the same time or when the plant is in idle mode. When the solar panels no longer generate the plant will switch over the battery supply. The batteries also have the opportunity to top up on cheaper off peak power then run during the day during high peak power supply. This operating mode can be very useful in overcast periods when solar power isn't generated but real saving in energy costs can be made.

### **3.0 CONCLUSION**

The successful tenderer has been selected in Renewable Energy Australia with construction of the 40kW solar and energy storage project underway, with commissioning to occur in September 2017.

The project has been a long journey of discovery for North East Water and the IWN energy group, with outcomes beyond our first set of three opportunities in:

- Using energy storage instead of generator back up during power outages
- Saving utilities energy costs by being able to store renewable generated power
- Changing operating hours to suit renewable energy

We have now added a few more opportunities to this project, including:

- Utilising energy storage and a mini-grid arrangement to power a SPS through community energy
- How to undertake an energy audit and optimise power consumption
- Energy optimisation can lead to better plant performance and water quality outcomes
- The value of connecting to an energised and focused community group that can connect you to others
- The types of batteries available and how they work

North East Water and the IWN have now engaged the services of RMIT to undertake a performance study for this project to fully understand what other opportunities of this type of technology could offer to the water industry.

# **A CASE STUDY INVESTIGATING THE IMPACTS OF ALTERNATIVE COAGULANTS ON TASTE AND ODOUR IN DRINKING WATER**



***Paper Presented by:***

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# A CASE STUDY INVESTIGATING THE IMPACTS OF ALTERNATIVE COAGULANTS ON TASTE AND ODOUR IN DRINKING WATER

**Tara Callingham**, *Senior Engineer – Water Quality Systems*, Goulburn Valley Water

## ABSTRACT

A case study was undertaken at Euroa WTP to determine the impacts of using alternative coagulants on taste and odour in drinking water. A triple bottom line assessment was used as a comparison tool looking at the financial, social and environmental impacts associated with each alternative coagulant. The WTP uses traditional technology of chemical coagulation, clarification and filtration prior to disinfection. Euroa WTP has consistent anecdotal taste and odour issues, which have been attributed to vegetation in the catchment.

Existing data was reviewed to understand the problem and a range of coagulants was evaluated in terms of the impact on taste and odour of the treated water. Taste and odour panels were used throughout the case study to understand any changes. This data was used as the basis of the triple bottom line assessment. The financial assessment incorporated any variations in operational costs and any potential infrastructure requirements. The social assessment discussed the link between staff as part of the community and the impact a service level improvement would have on them as staff and community members. Environmental impacts were assessed looking at the impact on downstream infrastructure associated with changes in sludge volumes and wastewater quality.

## 1.0 INTRODUCTION

Goulburn Valley Water (GVW) is a regional water business that provides water and waste water services to 54 towns across 20,000 km<sup>2</sup> in Northern Victoria. Every five years a plan is submitted to the Essential Services Commission (ESC) detailing all activities and customer pricing for the five year period. In 2013 GVW submitted their five year water plan to the ESC for 2013- 2018. The subsequent review of the submitted plan resulted in a customer bill reduction over the five year period. Despite this, GVW retained the same capital expenditure (CAPEX) and operational expenditure (OPEX) which led to a forecast increase in debt. In order to curtail this debt, GVW aimed to find business efficiencies through innovation, mainly focussing on the reduction in OPEX. The annual OPEX for operations and maintenance is around \$26 million p.a. with \$1 million p.a. being used for water treatment chemicals only. Approximately 50% of all water treatment plant chemical use is in the coagulation process.

Following on from this, planning commenced for the next five year period (2018 – 2023) with the ESC requiring a more customer centric model for water utilities. A series of customer engagement activities by GVW showed that taste and odour is one of the areas considered to be important by the customers. Taking this into account, and previous work completed around innovation and reduction in OPEX, GVW undertook a case study to understand improvement of taste and odour through optimisation. This case study aimed to gain an understanding the economic, social and environmental aspects of improving odour through optimisation and alternative coagulation chemicals.

The case study was based in the town of Euroa (population 3,500), which is situated in the Strathbogie Ranges in North Central Victoria.

The WTP is gravity fed from Mountain Hut Reservoir and coagulated using aluminium sulphate (AS), caustic soda (CS) and a flocculation aid prior to entering a single sludge reactor clarifier.

Following the clarifier, the settled water is filtered through two dual media filters and disinfected using chlorine gas then pH corrected using CS. Water is stored in a 2.2 ML clear water storage (CWS) before entering into the reticulation network.

Historically, Euroa has had issues with taste and odour. However, there are limited numbers of formal complaints around these issues. The formal complaints show a variety of descriptors associated with the taste and odour with the complaints coming from widespread locations across the town.

## **2.0 DISCUSSION**

An investigation into the unknown taste and odours within the Euroa reticulation system was completed using a Taste and Odour Panel which, was made up of 20 GVW staff. The key odours were determined as earthy/ musty and chlorine. However the panel were unable to determine any specific tastes. The panel detected that the odours changed through the reticulation system with chlorine odours dissipating through the reticulation system, whereas the number of earthy musty odours detected was consistent through the system. As chlorine can be used to mask earthy musty odours, the greater perceptions of chlorine odours seen at the WTP are likely attributed to this.

Geosmin and 2-methylisoborneol (MIB) are well known as causing earthy/ musty odours, and were therefore investigated over a 12 month period as a potential source. These data showed there were no detections above the odour detection threshold and therefore these could not be considered as the underlying cause. The free chlorine residual at the point of entry to the reticulation system is consistently above the Australian Drinking Water Guidelines (ADWG) aesthetic limit for chlorine and this therefore was considered an obvious cause for the chlorine odours detected.

Odours detected by the panel from reticulated water samples were correlated to water quality parameters. These correlations suggested that there were some relationships between the identified odours and indicators of natural organic matter. The key raw water parameter, which had a significant correlation, was specific UV absorbance (SUVA), which is determined using UV absorbance at 254 nm and dissolved organic carbon (DOC). The level of free chlorine residual at the point of disinfection directly correlated to the number of chlorine odours detected by the panel. However, the chlorine residual at outlet of the CWS had no correlation to the chlorine odours, despite the free chlorine residual consistently being above the aesthetic limit. Interestingly, it did relate to the count of earthy musty odours seen in the reticulation system.

An investigation by the Water Research Foundation (2014) stated that chlorine can be used as a method of controlling earthy/ musty odours. This can be problematic because if the free chlorine is not controlled effectively, the earthy musty odours can reoccur after a time. In the case of Euroa WTP the disinfection chlorine dose rate is high (~3 mg/L) to allow for sufficient disinfection whilst maintaining a suitable chlorine residual within the reticulation. This reasoning relates to the findings where the free chlorine residual at the outlet of the CWS relates to the earthy musty odours seen.



This indicates that the free chlorine is initially masking the earthy musty odours then dissipating through the system re-releasing these odours. With the correlations between the count of the perceived odours relating back to indicators of natural organic matter, optimisation of the existing process and the use of alternative chemicals focussed on organics removal.

## 2.1 Coagulation Modification for Odour Improvement

The existing WTP operation was reviewed for organic removal and the coagulation dose optimised. Ferric sulphate (FS) and aluminium chlorohydrate (ACH) were trialled as alternative coagulants as these traditionally have a higher affinity for DOC removal than AS.

### Raw Water Quality

The raw water is high in colour with low turbidity which can lead to a light and fluffy floc which in turn can lead to an unstable sludge blanket. The raw water is quite variable and has a high organic loading. In order to overcome the variability, it is common practise to slightly overdose with AS. This practice helps to keep ahead of the variability whilst assisting with the light floc blanket during periods of low turbidity. The data in Table 1 shows the raw water quality and the associated variability.

**Table 1:** *Raw Water Quality Associated with Euroa WTP*

	Average	Standard Deviation	Sample Number
<b>True Colour (Hazen)</b>	153.92	84.11	170
<b>DOC (mg/L)</b>	9.15	3.94	57
<b>UVT (%)</b>	27.47	10.792	57
<b>SUVA (L/mg.min)</b>	7.40	4.30	56
<b>pH</b>	7.18	0.37	244
<b>Turbidity</b>	15.02	11.56	212

The SUVA values seen in Table 1 indicate that the removal pathway for organic matter is predominantly through coagulation. Jar tests were completed using the guidance given in (Murray & Mosse, 2015). Table 2 shows the DOC removal rates from the jar tests.

**Table 2:** *DOC Removal Rates between the WTP and the Jar Tested Samples*

	WTP	AS	FS	ACH
<b>Average</b>	56.85 %	54.84 %	71.70 %	58.65 %
<b>Standard Deviation</b>	9.61 %	8.73 %	6.87 %	13.11 %
<b>Minimum</b>	23.10 %	26.80 %	57.34 %	32.45 %
<b>Maximum</b>	72.35 %	64.50 %	79.90 %	71.82 %
<b>Sample Number</b>	33	15	9	12

The following key points were determined from the jar tests and the findings in Table 2;

- The FS jar test results were as expected showing a greater average DOC removal than the other samples;
- The average DOC removal rates provided by ACH were lower than expected. The reason for this is unknown and could be further investigated as a subsequent step to this case study;

- The DOC removal rates seen by the AS and WTP are consistent with each other, which is expected;
- The WTP showed a greater range of results than the AS despite the similar average. This is likely due to the clarifier being exposed to the elements where outside factors such as the weather can potentially impact on the operation; and,

## **Odour Results**

Jar test odour testing was completed using the original taste and odour panel. The chi squared statistic was used to calculate the expected values based on the observed odours. The following key points were determined from the odour testing results;

- The number of earthy/ musty odours detected decreased against the expected value when using ACH;
- The number of no odour detections were greater than the expected value when using ACH;
- The FS samples had a greater number of other odour detects than the expected value, however there were less earthy musty odours detected than the expected value;
- The earthy musty odours of the WTP samples were greater than the expected values;
- The earthy musty odours for the AS sample were equal to the expected value.

These results indicate that the use of chemical coagulants specific for organics removal will improve the odour of the final water at Euroa WTP. Optimisation of the aluminium sulphate for organics removal did not appear to have any benefit with respect to a reduction in earthy musty odours.

## **2.2 Triple Bottom Line Assessment**

A triple bottom line (TBL) assessment was completed using GVWs TBL tool to assess the benefits of each of the coagulants in comparison to the WTP. The economic, social and environmental impacts of each of the coagulants were assessed and compared.

### ***Economic Assessment***

The cost of treatment was assessed with consideration to the chemical costs and determined on an annual basis using an average production rate of 710 ML. The chemical prices were sourced from the GVW chemical contract. In addition to this the existing infrastructure projects associated with Euroa identified and the impact of each of the coagulants on these projects was assessed.

The key findings associated with the economic assessment with respect to the chemical costs are as follows;

- The overall operational costs would decrease annually by approx. \$6,350 per annum when using ACH;
- The use of FS would increase the site chemical costs by approx. \$6,640 pa;
- The optimisation of the aluminium sulphate would produce \$3,380 savings pa against the current site operation.

With respect the existing infrastructure program, the only project that would be impacted by any of the proposed situations is a planned upgrade to the sludge handling system.

The use of FS would increase the amount of sludge produced and the planned upgrade might not be sufficient. Conversely the use of ACH would not produce as much sludge and therefore this project could potentially be deferred.

### ***Environmental Assessment***

The environmental impacts of each chemical were assessed based on their potential offsite impacts. The potential for sending waste sludge to landfill was assessed as well as the potential upstream aspects based on the carbon emissions associated with the delivery of the chemicals.

The key findings from the environmental assessment are as follows;

- The use of FS produces more sludge than either AS or ACH, therefore creating a greater volume of waste to be sent to landfill;
- ACH creates minimal sludge and therefore has a lower landfill potential;
- Volume of sludge sent to land fill would be less than the current WTP operation;
- The difference between the AS and the current operation is considered to be minimal;
- FS and ACH dose rates were lower than the AS and WTP dose rates therefore requiring fewer deliveries (5, 2 and 7 deliveries respectively based on 10,000L deliveries) across the year.
- The AS and WTP chemical delivery requirements were considered to be the same;
- With respect to the pH correction there was no difference in the requirements for FS and the current operation (2 deliveries each per year based on a 10000L delivery);
- The ACH requires no pre pH correction therefore the post pH dosing only is required. This equated to a single chemical delivery per year.

### ***Social Assessment***

The impacts on the community and GVW staff were assessed based on the changes in odours. Poor taste and odour in drinking water is regularly cited as the key reasons consumers choose alternative sources of drinking water (Puget, et al., 2010). Informal discussions with Euroa residents indicated that some of the customers within the community connected to town water still maintain a rainwater tank for drinking purposes. The key reason for this is in line with the literature being around the taste and odour of the drinking water (Doria, 2010). Therefore it is assumed that with improved odour, in time the community members would begin to use town water for drinking in preference to the rainwater. This would reduce the health risks posed to the customers through the use of rain water tanks (Sinclair, Leder, & Chapman, 2005).

Similarly as GVW staff are integrated into the community there is a culture of word of mouth or informal feedback from the community to staff members. It is well accepted that recognition and praise is an effective tool at motivating staff. Therefore it is expected that with improved odours there would be potential for this informal feedback to be more positive, thus improving the motivation and pride of the staff in GVW.

### **Outcomes of the Triple Bottom Line Assessment**

The outcomes of the TBL were assessed and the key findings are as follows;

- ACH is the most attractive option across all criteria, providing financial, environmental and social benefits;

- Optimisation of the AS has minimal financial benefits in comparison to the current WTP operation;
- The use of FS has social benefits with respect to the improvement in odours. However the financial and environmental assessment demonstrate the use of FS is not as attractive as the ACH despite having a slightly lower requirement for chemical deliveries.

### 3.0 CONCLUSION

The following conclusions were made from this study

- The predominant odours determined from the Euroa system resulted from the natural organic matter within the raw water;
- Targeting coagulation for organics removal can improve the odour of the water;
- For the Euroa system ACH provided the best outcome when looking at a social, economic and environmental benefits;
- Although FS provides a good solution to the natural organic matter in the system, the financial and environmental aspects make it less attractive than ACH;
- Within the Euroa system, optimisation for organic removal provides minimal benefit with respect to the current operation.

### 4.0 ACKNOWLEDGEMENTS

I would like to thank RMIT University and GVW for supporting me to complete this study. In particular I would like to acknowledge Felicity Roddick and Linhua Fan of RMIT and Mark Putman and Steven Nash of GVW for their ongoing support and patience throughout the process.

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# BLACKWATER 3.0 – THE RETURN OF THE ORGANICS



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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# BLACKWATER 3.0 – THE RETURN OF THE ORGANICS

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## ABSTRACT

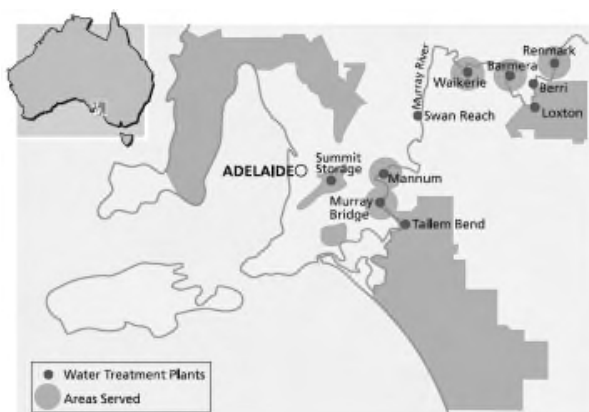
The ten Riverland Water Treatment Plants (WTPs) have been operational in the Riverland region of South Australia since early 2000. Following a decade of drought conditions and good river water quality, the region was hit with a ‘blackwater’ event in late 2010 that saw a large amount of organic material washed into the river causing subsequent issues with critical treatment parameters such as true colour, Dissolved Organic Carbon (DOC) and turbidity.

Following a second similar event in 2012, water quality challenges subsided and the river was thought to be in recovery mode, with the combination of the two events being considered a ‘1 in 100 year’ occurrence. This was not to be however, with the region being subjected to comparatively its worst blackwater event in recorded history in late 2016 that resulted in significant operational challenges to the treatment plants.

Utilising a systematic process approach and lessons learnt from the previous events, the Riverland WTPs emerged from the challenge largely unscathed, even in the face of tighter regulatory performance guidelines.

## 1.0 INTRODUCTION

TRILITY operates ten conventional WTPs within the Riverland region from Balhannah up to Renmark under a BOOT contract with the local authority. Aside from locational anomalies the design of each of the facilities is more or less the same.



**Figure 1:** *Riverland WTP Location and Area Served*

As part of conventional operation, the WTP process consists of the following unit processes in order:

- Powdered Activated Carbon (PAC) dosing (optional)
- Rapid mixing with coagulant and pH adjustment
- Flocculation with optional flocculant aid
- Sedimentation through lamella tube settlers
- Gravity filtration through dual media (coal and sand) filters
- Ultraviolet (UV) disinfection
- Disinfection with chlorine or chloramine

The WTPs range in size from 4 ML/d (Waikerie) up to 90 ML/d (Swan Reach) and generally supply potable water to their local areas and adjacent communities connected to the networks. The exception to this is Swan Reach WTP, which primarily supplies areas within and surrounding the Yorke Peninsula.

When the WTPs were first constructed from 1997 – 2000, process performance was based around being able to treat incoming raw water from the River Murray at variable quality up to the worst that had been recorded to date. Under ‘business as usual’ circumstances this would have been a fair assessment, however Murphy’s Law dictates that this will never be the case.

## **2.0 BACKGROUND**

### **2.1 Millennium Drought**

The Millennium Drought occurred across a large area of Australia from 1996 through to 2010 due to successive El Niño events that culminated in extended periods of lower-than-average rainfall and warmer-than-average temperatures.

Though the drought had devastating impacts on agricultural production and the urban water supply in many areas, the impacts to WTP performance were in fact largely beneficial as the quality of water from the River Murray was low in key process parameters such as true colour, turbidity and DOC, that can cause subsequent challenges at higher concentrations.

### **2.2 2010 Blackwater Event**

All this changed in 2010 as a La Niña event arose and resulted in lower overall temperatures and flooding across many areas of Australia. These floods washed dried organic matter into the larger river systems that had been accumulating for the better part of 15 years. The result of this sudden influx in organic matter was a significant spike in measured true colour, turbidity and DOC within raw water being drawn for the Riverland WTPs, as well as a decline in dissolved oxygen (DO).

These ‘1 in 100 year’ conditions proved challenging to the Riverland WTPs, with both true colour and DOC exceeding expected design maximum limits at various times. To ensure that the impact to treated water quality and production was minimised, the main strategies involved configuring primary coagulant dosing of aluminium sulphate (alum) at rates higher than designed, and the implementation of PAC dosing for the primary purpose of aiding coagulation as opposed to its usual purpose of taste and odour compound removal. These changes in dosing configuration were supported by numerous jar testing results undertaken throughout the period.

An open level of communication between all water authorities and operators from along the source water area ensured that all WTPs could reasonably stay as far ahead of the game as possible and have adequate time to prepare for the challenges incoming.

### **2.3 2012 Blackwater Event – The Encore**

The second blackwater event, also spurred on by La Niña-induced flooding, saw the previously troublesome true colour and DOC remain relatively steady this time around (albeit with some noted increases), this time replaced by more significant spikes in turbidity and alkalinity causing process challenges.

Process adjustments made this time around included the elevated dosing of alum for the primary control of pH rather than coagulation (in the absence of acid dosing) as well as the reduction in treated water pH targets to prevent calcium precipitation.

Following the end of this event around mid to late 2012, water quality in the River Murray went back to reflect average historical values, even beginning to lean towards Millennium Drought conditions following an El Niño event from 2014 to 2016.

### **3.0 THE RETURN**

#### **3.1 Blackwater 3.0**

As should have been expected by now, the hot and dry conditions broke once more in mid-2016 to make way for higher rainfall and more flooding around the river catchment areas. This once again caused a '1 in 100' event to occur in the River Murray within South Australia, with both true colour and DOC spiking to elevated and prolonged levels never before recorded in recent history. Raw water true colour hit levels of up to 30% greater than the WTP design limits, and DOC nearly 70% greater. A comparison of raw water quality results across the Riverland is shown in the table below. Figure 1 shows a graphical representation of the true colour changes throughout 2016-17 for the Mannum WTP.

**Table 1:** *Raw water quality comparison*

<b>Unit</b>	<b>Design Maximum</b>	<b>Average</b>	<b>2010 Blackwater Maximum</b>	<b>2016 Blackwater Return</b>
True Colour (HU)	130	15	133	182
DOC (mg/L)	15	7.5	18.4	25.7

The impacts to plant performance were almost immediate; filter ripening periods extended, chlorine demand increased, UV transmissivity and dose rate reduced, and coagulation effectiveness got to the point where jar tests showed that the optimum alum dose was more than 200% of what the dosing system was capable of achieving.

The process challenges experienced during this particular event were unlike any seen in the history of the WTP operation. However, it was important to remember that these systems are physical and chemical processes, and when it comes to scientific and engineering challenges, there is always an answer to be found!

#### **3.2 Filter Ripening**

The first area of focus was the filter ripening; without control of this the filter performance would result in multiple breaches of Department for Health and Ageing (DHA) reportable limits, not to mention result in increased difficulty in applying both UV and chlorine disinfection due to turbidity interference.

Interestingly, it was discovered that once ripened, filter performance was extremely stable to the point where filters at certain WTPs were able to run up to 150 hours, compared to a historical average of 20 – 90 hours, whilst producing turbidity of less than 0.2 NTU and without triggering other pre-programmed backwash trigger levels. It was also found that extending filter run hours appeared to have a positive impact on ripening levels, albeit not to the desired extent.



Extensive research into optimising the filter ripening process had been undertaken over the prior few years, based around differing configurations and programming changes, and this was sufficient to enable an appropriate strategy to be put in place.

The biggest changes implemented to the filters were a minimum one hour delay in returning to service following a backwash, as well as a slightly modified enhanced terminal sub fluidised wash (ETSW), which saw the filters refilling with treated water through the bottom of the media. However, in this case very little of this water was washed out due to volume limitations in on-site lagoons and the inability to filter to waste.

### **3.3 Chemical Dosing**

Jar tests were the theme of the day; with the water quality well outside WTP design limits and constantly changing, it was important to ensure that we were able to not only theoretically support current dosing configurations, but also pre-empt incoming water quality changes as they arrived.

Indications from the jar tests placed a heavy emphasis on alum dosing, expected due to its propensity to remove true colour, however at dose rates well above original design limits. A polyacrylamide flocculant aid was also introduced to help add weight and assist the process. Alum dosing systems at the Riverland WTPs are duty/standby pump arrangements with a design maximum dose rate of 100 mg/L. Jar test results called for alum dose rates of 150 – 180 mg/L, with some even showing the most ideal dose at over 220 mg/L! Even though WTP throughputs were lower than average due to the cool, wet conditions, the physical limitations of the dosing systems came into play when considering dose rates of this magnitude. This also had an effect on supplementary sodium hydroxide dosing systems for optimised flocculation pH adjustment.

To offset this challenge, PAC dosing was implemented prior to the coagulation stage to help remove DOC and other organics as well as add extra weight to the formed floc to aid in settling within the clarifiers. Dosing of PAC is typically used for the removal of taste and odour compounds and so to turn it into effectively another coagulant aid was considered to be an interesting strategy. PAC had been used to some success in the 2010 blackwater event but carried a heavier reliance to the optimisation of WTP performance this time around.

### **3.4 UV Disinfection**

Due to the elevated levels of organics passing through the system, the UV transmissivity took a big hit, which greatly affected applied dose rates. Design transmissivity levels are 70 – 100%, with typical levels within the Riverland being greater than 95%. During the blackwater period this fell significantly down to the low 70's and at many times threatened to go below design limits.

The implementation of PAC dosing mentioned above had a significant impact on the improvement of UV transmissivity. After coagulation challenges began to improve and the reliance on PAC at the front end diminished, the UV transmissivity became a manual feedback control point for the PAC dose rate to ensure that the minimum design limitation was not breached.

Whilst not strictly a water quality performance issue, the increased level of organics appeared to introduce a mild surfactant that caused foaming to occur in some of the UV channel systems. This led to rather frustrating issues in UV system monitoring as the foam caused false readings with a number of online measurements.

To overcome this, operators needed to rig up a makeshift foam suppression system within the UV channels by configuring irrigation pipework connected to treated service water.

## **4.0 RESULTS**

Compared to the first blackwater event experienced in 2010, the Riverland WTPs improved design treatment water quality performance incidents by over 30%. Type 1 reportable DHA incidents also reduced from 17 to 1. Whilst any reportable or performance incident is in theory too many, the improvement over the previous event under more trying water quality conditions is important to note.

WTP performance overall remained high in spite of the challenges, with an average turbidity and true colour removal throughout the process of over 95%.

To summarise further outcomes of the actions listed above:

- Filter ripening changes resulted in significant decreases in both filter ripening turbidity and duration.
- Implementation of PAC dosing helped maintain UV transmissivity and supported coagulation by allowing reduced alum dose rates to be applied.
- The reduction in applied alum dose rates aided in maintaining the standby/duty method of operation and allowed the WTPs to maintain a similar risk profile throughout the challenge.
- The foam suppression system configured for the UV channels produced an immediate improvement in operational performance.

In addition to the above, it should be mentioned that the level of communication between surrounding water authorities and treatment groups throughout the event, both downstream and upstream, was paramount to enabling the Riverland WTPs to better prepare for what was coming their way.

## **5.0 CONCLUSION**

The water treatment process under everyday operating conditions can seem straightforward; dirty water in and clean water out, but it's important to be prepared for the circumstances that arise that will challenge this assessment. The Riverland WTPs have now been through three '1 in 100 year' blackwater events, with the 2016 event being arguably more challenging to WTP performance than any condition seen in recent history.

Whilst this places a challenge to the original design intent, the treatment plants are still bound by the laws of science and engineering and are open to pushing design boundaries if the right approach is made. In the instance of the Riverland WTPs, this was done by a reimagining of key unit process applications and of course a bit of trial and error. Approaches to process issues consisted of those steeped in chemistry theory, such as the implementation of PAC dosing for enhanced coagulation through prior organic removal, to more basic agricultural solutions such as the temporary irrigation set up to suppress foam in the UV channels; and all worked well.

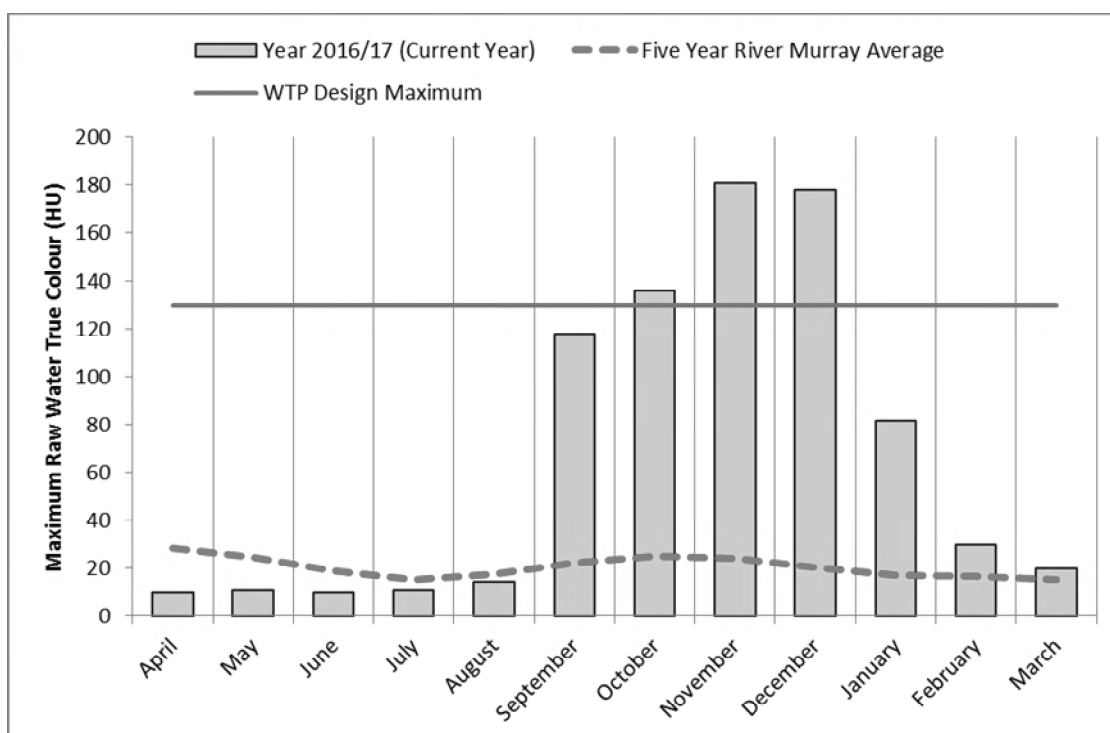
External and internal communication was no different than what was put in place during the previous two blackwater events, but it is important to note nonetheless. Without this, it is likely that the same process changes and improvements would have been made, but potentially only after further water quality incidents or WTP challenges had been experienced.

Predicting the weather or what the water quality is going to do is a challenge that we have not quite yet mastered to an expert degree to the point where we can ‘set and forget’ our treatment plants, and so having open communication lines between treatment groups and extending knowledge sharing goes a long way to helping ensure we are all across best practice and innovation for the benefit of the public.

During such extreme challenge events, the theoretical ‘right’ way to run a WTP goes out the window along with the manual. However, a thorough understanding of how the process works and what the challenges actually are enables each event to be broken down and tackled at more manageable levels. In short – there is always an answer!

## NOMENCLATURE

Alum	Aluminium Sulphate
BOOT	Build, Own, Operate, Transfer
DHA	Department for Health and Ageing
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
HU	Hazen Units
mg/L	milligrams per Litre
ML/d	Megalitres per day
SA	State of South Australia
UV	Ultraviolet



**Figure 2:** *Maximum Monthly True Colour Readings from Mannum WTP*

# EVALUATING 10 YEARS OF GAC FILTER PERFORMANCE FOR TASTE AND ODOURS



*Paper Presented by:*

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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations*  
*Conference and Exhibition*  
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*6 September to 7 September, 2017*

# EVALUATING 10 YEARS OF GAC FILTER PERFORMANCE FOR TASTE AND ODOURS

**Emma Sawade**, *Scientist, SA Water*

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## ABSTRACT

Cyanobacteria can produce metabolites which impart tastes and odours which are a problem for the water industry as they can damage customer perception of water quality. Granular activated carbon (GAC) filters can be an effective barrier for the removal of these metabolites; however, like all adsorption processes there is a limited capacity. GAC filters can also be effective biological filters as the surface of the particles offers excellent substrate for biomass attachment. If these microorganisms can degrade the metabolites, the GAC filters have the potential to function indefinitely, despite reduced adsorption capacity over time. At full scale it is difficult to determine the adsorptive/biological removal potential of the GAC. Such knowledge will allow for planning of GAC replacement or that current GAC condition is such that during the next cyanobacterial bloom a taste and odour breakthrough is unlikely. Consequently, tools that can be applied to measure the effectiveness of GAC filters over operational life time are of value for water authorities.

This study used laboratory GAC column experiments to evaluate the performance of full-scale GAC filters at selected SA treatment plants at various times since commissioning (10 years). The GAC from the filters was tested for the removal of two taste and odour compounds; MIB and Geosmin.

## 1.0 INTRODUCTION

The prevalence of cyanobacteria in water supplies is problematic for water authorities as they can impair water treatment processes and subsequently the quality of drinking water. Of major concern are the metabolites that these organisms produce, some of which impart taste and odours (T&Os) which can result in consumer complaints and the general perception that there is a problem with the safety of the drinking water.

Granular activated carbon (GAC) has long been considered a viable treatment option for the removal of organic compounds from water, including cyanobacterial metabolites MIB and Geosmin (Pirbazari *et al.*, 1993; Newcombe *et al.*, 1996; Elhadi *et al.*, 2006). This is because GAC can remove compounds via two mechanisms, adsorption and biological degradation.

The commissioning of the Country Water Quality Improvement Project – Phase 3 (CWQIP3) water treatment plants by SA Water and United Group Limited (2007) sought to improve the quality of the drinking water for the Adelaide Hills and Riverland regions. The plants source water from the River Murray and utilise advanced treatment technologies which were not previously employed in the Adelaide metropolitan region or other plants located in the Riverland. In particular, the new CWQIP3 plants utilise GAC filters to remove T&O produced by cyanobacteria. This is in accordance with the “multi-barrier treatment” approach of the Australian Drinking Water Guidelines. The GAC filters have the ability to remove these cyanobacterial contaminants through adsorption processes.

However, like any adsorption process, there is a finite limit to the available adsorption sites (Newcombe *et al.*, 1996; Yagi *et al.*, 1988). Fortunately, the GAC filters can harbour organisms that biologically degrade these metabolites, and this may extend the lifetime of the filters indefinitely.

The question that is always raised is how long can these GAC filters last before they need to be replaced and/or regenerated? Factors that impact the operational lifetime include site, quality and make-up of the influent water and filter operational conditions. Overestimating the operational lifetime of the GAC filters poses as a significant risk to drinking water quality during episodes of high cyanobacterial numbers in raw water, as there is the potential for breakthrough. The aim of this monitoring was to obtain enough information on the trends and the performance of the CWQIP3 WTP GAC filters, in terms of physical and biological removal of metabolites, to help inform the decision-making process for the replacement of the GAC.

## 2.0 DISCUSSION

### 2.1 Methodology

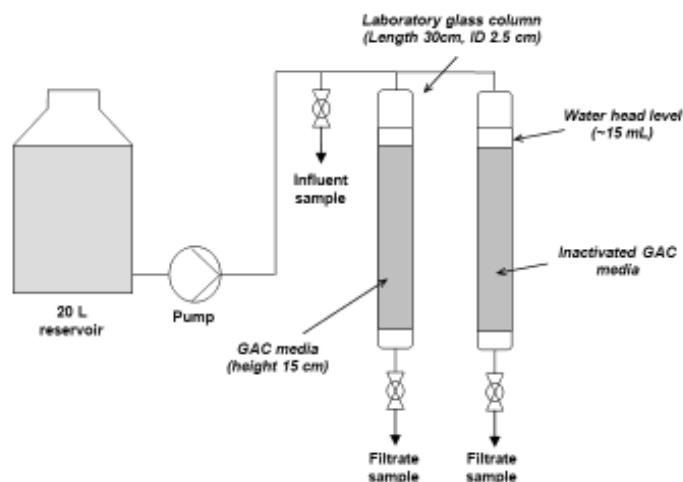
Samples of the GAC from the CWQIP3 WTPs inlet water to the GAC filters were collected for analysis using the standard Biological Filtration Potential test (BFP test, laboratory column work only) according to Sawade *et al.* (2015). In this paper testing results from two WTPs is presented, Woolpunda and Palmer WTPs. Experiments were conducted using laboratory scale glass columns (length 30 cm, internal diameter 2.5 cm). Such columns have been shown to successfully simulate full-scale filter performance for the removal of cyanobacterial metabolites (Ho and Newcombe 2010; Ho *et al.*, 2010).

Two columns are run in parallel, one column holds the GAC filter media as sampled, the other holds an inactivated sample of the GAC filter media (autoclaved 121°C, 30 min). This allowed differentiation of removals due to adsorption and/or biodegradation. The columns are fed with the inlet water to the GAC filter of the relevant WTP spiked with MIB and Geosmin at concentrations consistent with typical River Murray data. The columns were operated at a flow rate of approximately 5 ml/min (equivalent to an empty bed contact time of 15 minutes). The test was undertaken over a period of 2 weeks during which the influent and filtrate concentrations of MIB and Geosmin were determined at regular intervals. MIB and Geosmin samples were concentrated using a solid phase micro extraction (SPME) syringe fibre (Supelco, Australia) and analysed on a Hewlett Packard 5890 Series II Gas Chromatograph with Hewlett Packard 5971 Series Mass Selective Detector (Agilent Technologies, Australia) against quantified labelled internal standards (Ultrafine Chemicals, UK) as described by Graham and Hayes (1998), with a limit of reporting of 4 ng L<sup>-1</sup> for each metabolite.

Figure 1 shows the schematic of the laboratory GAC columns, while the conditions of the columns are described in Table 1.

**Table 1:** *Conditions of the laboratory-scale GAC column trials.*

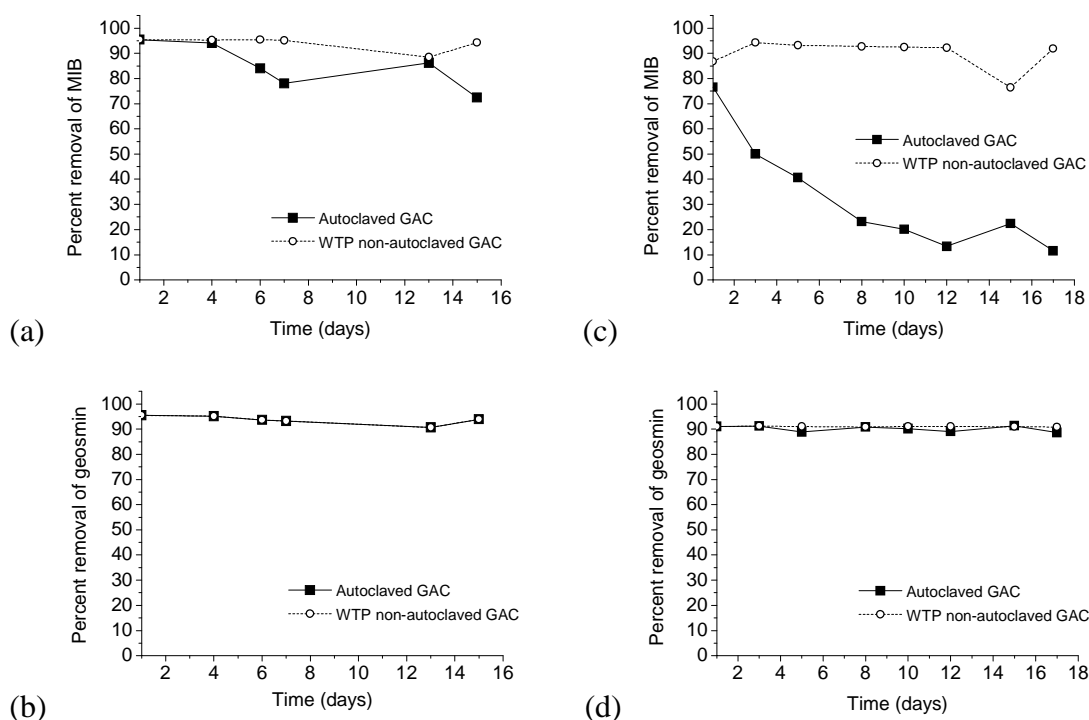
<b>GAC bed height</b>	15 cm
<b>Column I.D.</b>	2.5 cm
<b>GAC volume</b>	75 cm <sup>3</sup>
<b>EBCT</b>	15 min
<b>Flow rate</b>	5 mL min <sup>-1</sup>



**Figure 1:** Schematic of the laboratory GAC filters

## 2.2 Results

Over the past 10 years the CWQIP3 WTPs have been evaluated at various intervals for their removal efficiency of MIB and Geosmin. The two trials are shown for Palmer WTP filters in Figure 2.

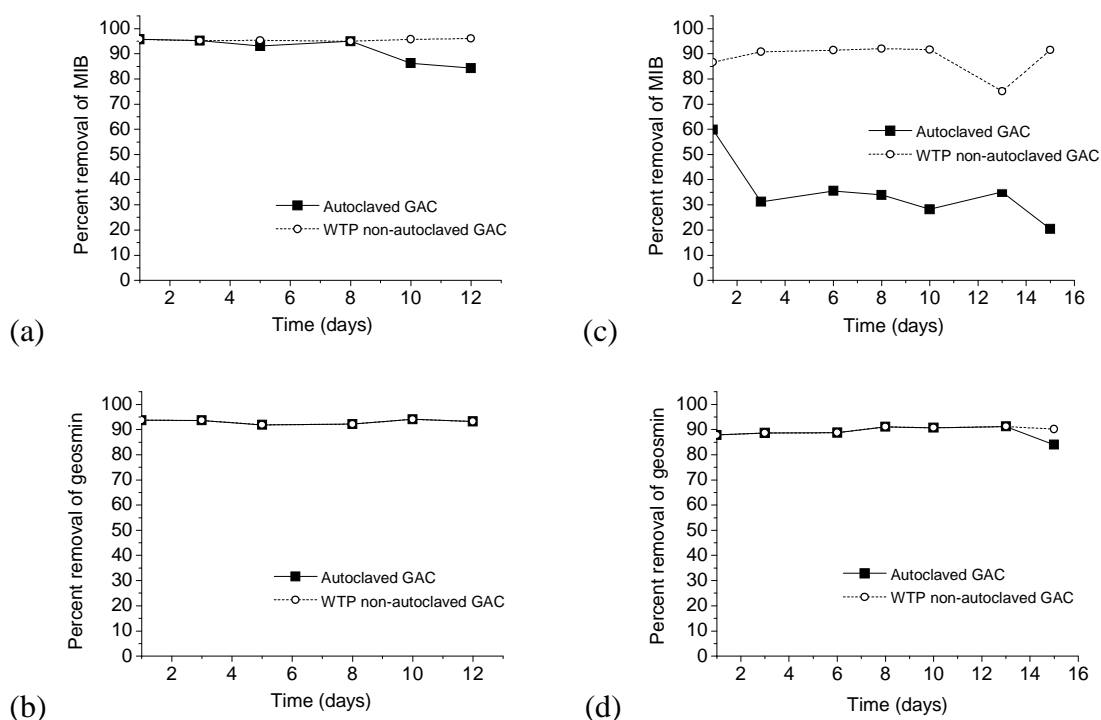


**Figure 2:** Palmer WTP trials (a) April 2011 MIB, (b) April 2011 Geosmin, (c) March 2017 MIB, (d) March 2017 Geosmin.

In 2011 it can be observed that removals for the filter media from the Palmer WTP for both compounds was around the reporting limit, with the exception of the autoclaved sample for MIB where a small decrease was observed, although removals were still greater than 70%. In 2017 the WTP non-autoclaved GAC removed approximately 90% throughout the trials for both compounds once again, representing removal down to the analytical reporting limit of the compounds.

Geosmin was readily removed by the autoclaved Palmer GAC column (~90%) with the removal similar to that of the non-autoclaved sample, indicating the physical adsorption capacity of the GAC has not changed markedly since the trial in 2011. In contrast MIB removals decreased over time in the autoclaved media indicating that the physical adsorption capacity for MIB has declined significantly since commissioning, and if the GAC were functioning in physical mode alone significant breakthrough of MIB would have occurred during the recent prolonged occurrence of MIB in the River Murray.

For Woolpunda WTP GAC media (Figure 3), Geosmin was readily removed in both the autoclaved and non-autoclaved samples. The removals of MIB of the autoclaved media indicated that the physical adsorption capacity had declined significantly in the GAC filter media from 2011 to 2015. Similar results have been seen for other CWQIP3 plants with a decline in physical adsorption capacity since commissioning.



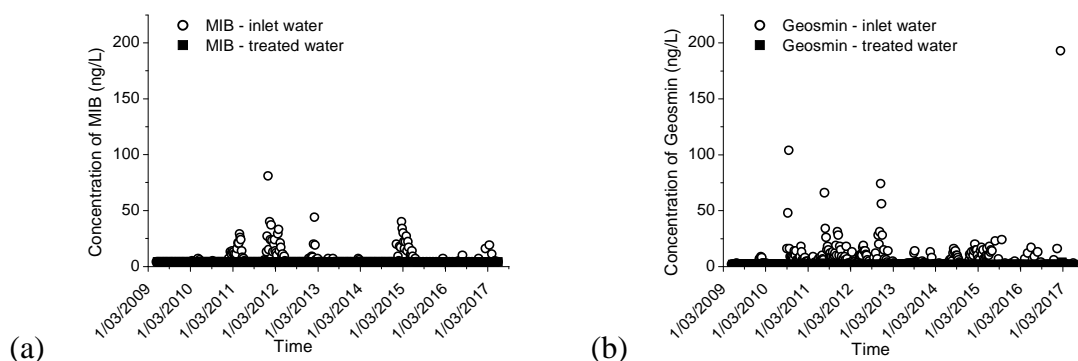
**Figure 3:** *Woolpunda WTP trials (a) May 2011 MIB, (b) May 2011 Geosmin, (c) December 2015 MIB, (d) December 2015 Geosmin*

Overall, the percent removals determined during the testing periods of the WTPs showed that the GAC filters at the plants are still functioning very effectively for both MIB and Geosmin removal as can be seen for the non-autoclaved samples in Figures 2 and 3; where the compounds were either below the limit of reporting or close to the limit in the filtrate. In contrast, the physical removal trend was different for the two compounds. MIB in particular has shown breakthrough and the filters are only capable of removing this compound due to biological activity. Minimal breakthrough of Geosmin is observed, most likely due to the Geosmin being more readily adsorbed than MIB (Newcombe and Cook, 2002; Ho, 2004; Ho *et al.*, 2010). Similar to the removal of MIB, the combination of adsorption and biodegradation renders the GAC filters still very effective for the removal of Geosmin.



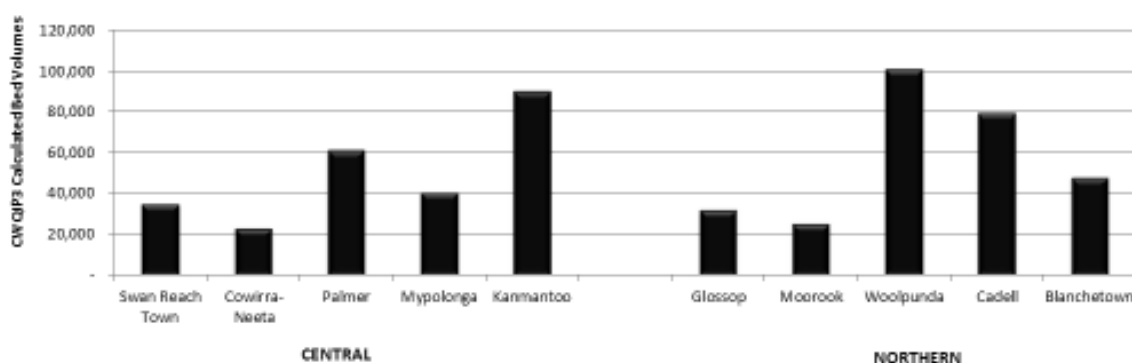
The early results from 2011 were used to support deferral of GAC replacement at the plants and ongoing testing through to 2017 has shown continual effective removal of the compounds due to the biological mode of the GAC filters thus extending the life of the GAC well past the initial time in which replacement was expected. The key to ensuring that the GAC continues to remove these taste and odour compounds efficiently has been communication between stakeholders regarding the operation of these plants so any potential disturbance of the biofilm and consequent impact on water quality can be anticipated and mitigated and any changes are detected prior to breakthrough.

The results are also supported by the full scale MIB and Geosmin data, as can be observed in Figure 4, when the WTP is challenged. It can be seen that neither compound has been detected in the treated water from these plants while relatively high concentrations have been experienced in the River Murray since commissioning.



**Figure 4:** *Full scale WTP removal data from Woolpunda 2009-2017 for taste and odour compounds (a) MIB, (b) Geosmin.*

A comparison of the bed volumes for the CWQIP3 plants as of March 2017 for the two regions (Figure 5) shows Woolpunda to have the “oldest” GAC in terms of bed volumes treated due to the plants running under different flow conditions since commissioning. It has been suggested that Woolpunda GAC filters could be used to predict the performance of the GAC at the other plants. Although all the filters are still functioning very effectively for the removal of these taste and odour compounds, if the biofilm is damaged (e.g. chlorinated) it is possible that the filters will not function as required for MIB removal as the physical removal capacity has decreased.



**Figure 5:** *CWQIP3 GAC calculated bed volumes at 15 March 2017*

### 3.0 CONCLUSION

Performance testing of the GAC filters allows us to monitor the trends in removal of the taste and odour compounds MIB and Geosmin.

This provides operators and key personnel knowledge of the appropriate time for GAC replacement, prior to a challenge at the plant that may compromise water quality. The data from this study has been used to defer expenditure for replacement of GAC filters and it is envisaged that the ongoing performance testing and utilisation of the information from this study, individual filters could be replaced over a longer period of time, spreading the CAPEX over several financial years and ensuring the security of water quality while minimising disruption to the plant and supply.

#### 4.0 ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support of SA Water Corporation, management and operators at the CWQIP3 WTPs, SA Water WTDR staff and Elizabeth Quarrell for her assistance with plant bed volume calculations.

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# **CARTRIDGE FILTER PERFORMANCE ASSESSMENT AND OPTIMISATION IN DUAL MEMBRANE RECYCLED WATER PLANT**



***Paper Presented by:***

**Shanli Zhang**

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**City West Water**



***80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# CARTRIDGE FILTER PERFORMANCE ASSESSMENT AND OPTIMISATION IN DUAL MEMBRANE RECYCLED WATER PLANT

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## ABSTRACT

Altona Salt Reduction Plant (ASRP) is an UF and RO (two pass) recycled water plant, owned and operated by City West Water (CWW). ASRP supplies 2000 ML of recycled water annually to CWW's irrigation and industrial customers. Cartridge filters (5 microns) are installed downstream of the UF for the protection of the RO membranes. It has been observed that the ASRP cartridge filters are subject to biological fouling due to biomass re-growth. As a consumable inventory and process equipment, the cartridge filters contribute a small portion to the plant OPEX cost but have a significant impact on the RO performance and membrane asset life. Developing a method to assess the performance including recognising the trigger signs for cartridge filters replacement, select the right cartridges and optimise the cartridge filter operation would benefit the ASRP operation.

To address the cartridge selection, four different cartridge products were trailed and the performances were assessed in terms of solid holding capacity, throughput, DP, operating life and filtrate quality. Additionally, the cost, delivery and quality control were also considered as part of the assessment. The performance assessment is intended to identify the type of cartridge filters that provides the best RO protection at the lowest total life cost. We have proven to ourselves that the lowest purchase cost cartridge filters does not necessarily provide the lowest total life cost.

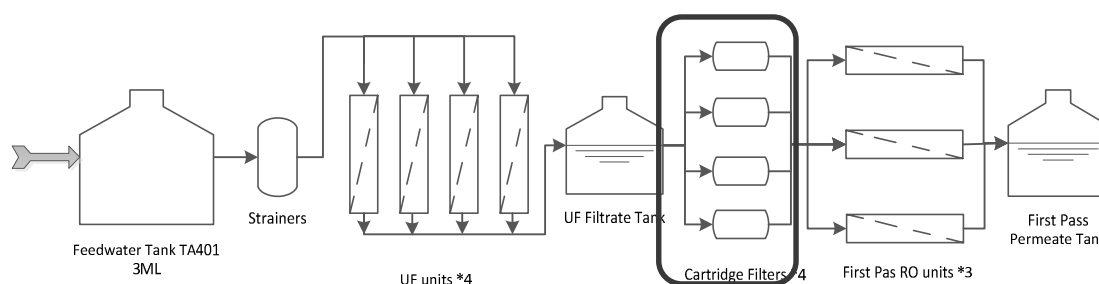
## 1.0 INTRODUCTION

The cartridge filters in ASRP is to protect the RO membranes from particles and biofouling. There are four filter vessels in parallel configuration, and each vessel houses 60 cartridges. Specification of the cartridge is in Table 1.

**Table 1:** *Cartridge Specification*

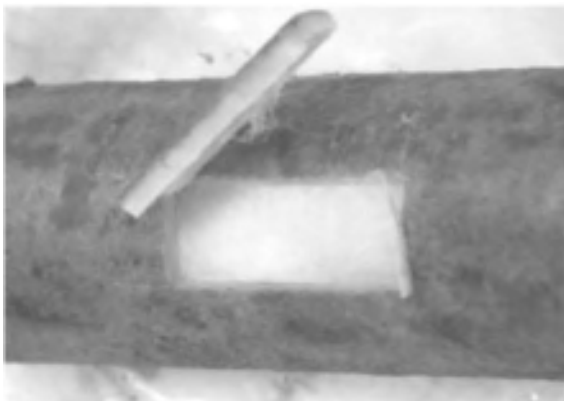
Length	Inner Diameter	Outer Diameter	Micron Rating	End fitting	Type
50 inch	1 inch	2.5 inch	5 micron	Open end	Melt-Blown

A brief flow chart is attached in Figure 1 below showing the location of the cartridge filters, and the maximum flow rate through the cartridges is 555 m<sup>3</sup>/h.

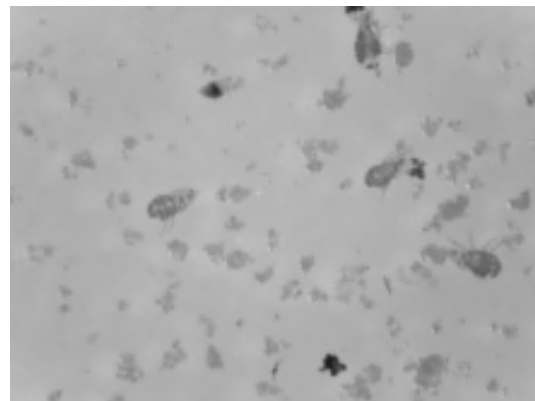


**Figure 1:** *The ASRP Flow Chart*

Since July 2015, the ASRP has been in continuous operation and after the first stock of cartridges were consumed by end of 2015, CWW purchased an alternative product with same specifications. But these cartridges only delivered about 1/3 of service life when compared to the first stock, and RO required more frequent CIP due to fast DP increase. Preliminary investigation showed signs of biomass fouling on the surface of the cartridge as shown in Figure 2. In Figure 3, the slide made from the fouling substance showed the fouling substance consisted of biomass and living arthropods, particles sized from 5-100 microns. The biomass source was traced back to regrowth in the UF filtrate tank, shown in Figure 4. Biofilm was identified on the sun facing internal side of the GRP UF Filtrate Tank. We found the tank was partly translucent from the inside and allowed some sun light to penetrate. Brown/green growth can be observed on the inside of the UF filtrate tank in Figure 4.



**Figure 2:** *Fouled Cartridge*

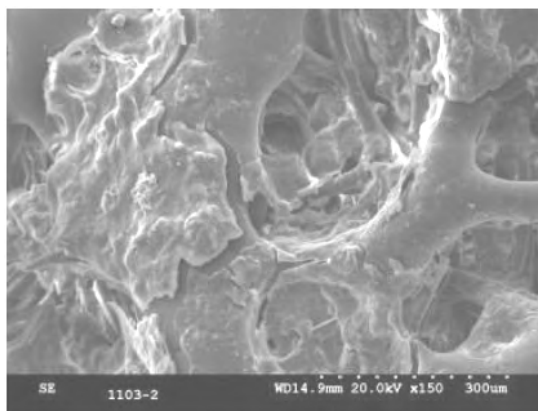


**Figure 3:** *Fouling Solids Under Microscope*

Advanced cartridge autopsy confirmed that fouling substance is mainly organic with presence of manganese, sulphur, phosphorus, chloride, magnesium, calcium and traces of potassium and silicon. The foulant SEM and spectrum analysis are shown in Figure 5 and Table 2. Considering upstream is UF system which would reject all the suspended solid, the identified organic foulant must be the result of dead microbial from the biogrowth in the system.



**Figure 4:** *UF Filtrate Tank Bio-growth*



**Figure 5:** *Fouling Solids Under SEM*

**Table 2:**      *Spectrum Analysis on Fouling Solids*

<b>Element</b>	<b>Approx. Conc.</b>	<b>Intensity orrn.</b>	<b>Weight %</b>	<b>Weight % Sigma</b>	<b>Atomic %</b>
C K	23.48	0.353	53.45	2.04	62.52
O K	13.68	0.2781	39.5	1.88	34.69
Mg K	0.61	0.629	0.78	0.12	0.45
Si K	0	0.8377	0.1	0.07	0.05
P K	1.62	1.2384	1.05	0.17	0.48
S K	1.5	0.8008	1.51	0.17	0.66
Cl K	0.92	0.7186	1.03	0.12	0.41
K K	0.13	0.9451	0.11	0.07	0.04
Ca K	0.81	0.9023	0.72	0.1	0.25
Mn K	1.64	0.756	1.74	0.2	0.45

## 2.0 DISCUSSION

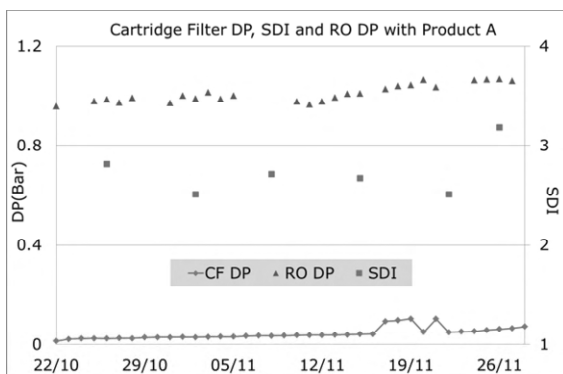
Based on the initial research, there could be two possible approaches to improve the overall cartridge performance, 1 Reduce the biological growth in the process, by additional microbial control method such as apply thicker coating to the tank besides DBNPA dosing<sup>1</sup>. 2 Select the most suitable cartridge for the ASRP application in term of better filtrate quality, higher throughput volume, larger solid holding capacity and lower cost per ML.

To select the right cartridge product, 4 products were assessed from following aspect: solid holding capacity, total volume throughput, quality of built, differential pressure pattern, operating life and filtrate quality pattern. Additionally, the cost, delivery and quality control were also considered as part of the assessment. The assessment was carried out during normal operating for the ASRP, the customer supply was as usual and all parameters were in normal operation range. End of each trial is triggered by either SDI being above 3 or maximum DP set point recommended by manufacturer is reached.

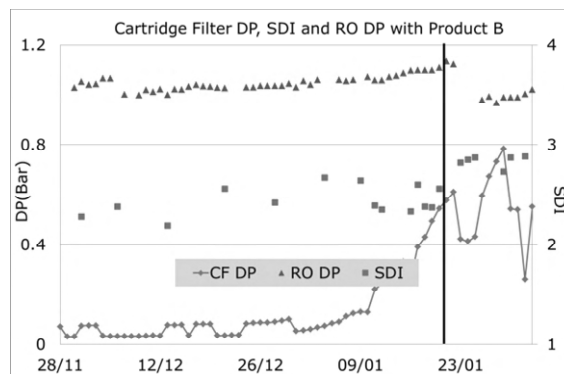
There was some flow demand variation due to variations in irrigation demand. The industrial demand is stable at 370m<sup>3</sup>/hr and the added irrigation demand can vary this flow to a maximum of 555 m<sup>3</sup>/hr. To reflect this variation in flow rate, we used throughput volume instead time in service.

### 2.1 Filtrate Quality and Differential Pressure of the Cartridge Products

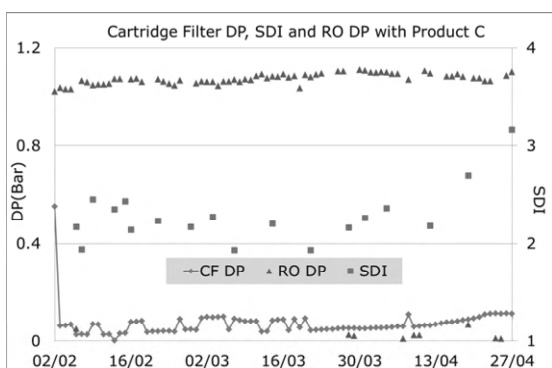
During the trial period, the filtrate quality is assessed by the weekly SDI test. The downstream RO first stage DP is considered as well. And the study found that all four products tested had a maximum DP of less than 0.5 bar @ 370m<sup>3</sup>/hr when the end of their trials were triggered by an SDI of 3 or close to 3. The cartridge filter DP and SDI trend of each product is plotted in Figure 6 to Figure 9. When comparing the trends of SDI and DP, Product A and Product C showed that the SDI started to increase above 3 when DP is above 0.1 Bar. Product D did not have high SDI until DP reached 0.25 Bar. And product B had the highest initial DP and change out DP was 0.4 bar (@ 370 m<sup>3</sup>/h) when the SDI reached about 3. The trends and field operation indicated that when the DP reaches 0.1 Bar, the SDI monitoring should be more frequent, and cartridge replacement should be scheduled within two weeks.



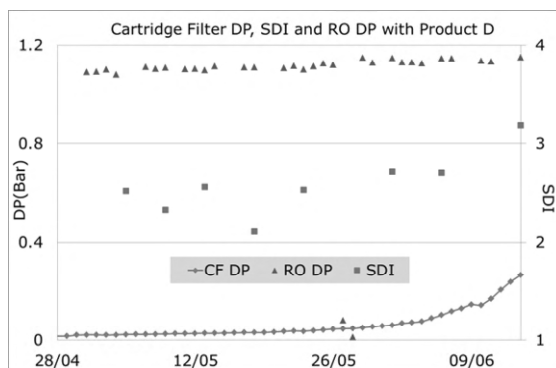
**Figure 6:** CF DP, SDI and RO DP with A



**Figure 7:** CF DP, SDI and RO DP with B



**Figure 8:** CF DP, SDI and RO DP with C



**Figure 9:** CF DP, SDI and RO DP with D

Average SDI of each product during trial period is calculated and shown in table 3. For product B and Product C, as SDI test was applied more frequently close to the end of the trial, only one representative result of the week was taken into the average calculation. Product C ranked the best in filtrate quality and Product A is the worst in terms of the SDI result.

**Table 3:** Average SDI of Trialled Products

Product	A	B	C	D
Average SDI	2.73	2.52	<u>2.29</u>	2.54

The DP trend of RO train A first stage was monitored during the trials and plotted in Figure 6 to Figure 9. When it was close to the end of Product B trial, the RO DP increased rapidly, with the SDI stable around 2.8-2.9 indicating filter efficiency decay during this period. According to the data analysis, for product B, the proper change out time would be on 20/01 when the RO DP still inclined steadily and SDI about to reach 2.8-2.9 which still cause RO DP increased fast.

## 2.2 Service Time Assessment of the Trialled Products

To assess the service time, two factors were considered: 1 the total throughput volume, 2 the solid holding capacity.

The Total throughput volume, solid gain and temperature are shown in Table 4. Product C outperformed all four products. Temperature is a factor which cannot be controlled by the plant, and there was no significant change of temperature during the trial.

**Table 4:** *Throughput, Weight and Temperature of Trialled Products*

	<b>Product A</b>	<b>Product B</b>	<b>Product B adjusted*</b>	<b>Product C</b>	<b>Product D</b>
Throughput (ML)	280	635	542*	<b>697</b>	392
Weight Gain (g)	27.9	68.9	<b>58.8*</b>	47.3	37
Temperature °C	21.5	22.5	22.6	<b>22.7</b>	20.8

To measure the weight gain of the cartridge, 11 locations were selected: two in Vessel A, B and C, and five in Vessel D. During each cartridge change out, the cartridges at those selected locations were weighed and recorded. When each trial was completed, the recorded cartridges were collected, then drained completely and weighed when wet, then the cartridges were dried at 103°C, and the dried weight was recorded.

The final weight gain of each cartridge is calculated by this formula:

$$\text{Weight Gain} = \text{Dried Weight} - \text{New Weight} - (\text{Wet Weight} - \text{Dried Weight}) * \text{TDS}.$$

Based on the average result of 11 cartridges each product's solid holding capacity is shown in Table 4).

\*The adjusted result of Product B is based on the late change-out due to higher SDI and fouling to the RO. The assumption change out time would be 20/01/2017, hence the throughput was adjusted according to the flow transmitter reading on that day, and solid is proportionally reduced according to the throughput value.

## 2.3 Assessment on QC & Delivery and Cost Analysis

The cartridges samples were weighted, and the standard deviation was calculated to assess quality consistency, and defective products were also counted during the change-out process. The quality and delivery information were included in the Table 5:

**Table 5:** *Quality Control and Delivery information*

	<b>Product A</b>	<b>Product B</b>	<b>Product C</b>	<b>Product D</b>
Average Weight (g)	720	808	647	626
Std Dev.	35.48	<b>4.03</b>	7.76	6.05
Lead Time (Week)	<b>13</b>	<b>13</b>	<b>13</b>	13-20
# of Dimensional Defects	15	<b>0</b>	<b>0</b>	18*

\* Supplier replaced defective units for free.

The OPEX is calculated based on the expense per batch and throughput as shown below in Table 6, the Product C is the second most expensive to purchase, but delivered the lowest overall cost per ML filtrate and per gram solid held.



**Table 6:**      *OPEX Involved in CF with Trialled Products*

	<b>Product A</b>	<b>Product B</b>	<b>Product C</b>	<b>Product D</b>
Total cost on hand	\$3120	\$6240	\$4440	\$3456
Cost due to defects	120	0	0	0
Replacement labour cost	900	900	900	900
Waste disposal	300	300	300	300
Total cost per batch	4440	7440	5640	4656
Throughput	280	542	<b>697</b>	392
Cost per ML	15.86	13.7	<b>8.09</b>	11.88
Total Solid Caught g	6696	<b>14112</b>	11352	8880
Cost per g	0.66	0.53	<b>0.50</b>	0.52

### 3.0 CONCLUSION

The source of the fouling was tracked back to the UF filtrate tank, and we recommended to externally recoat the tank to stop UV penetration and reduce some algal re-growth. We also recommended continue to apply biocide slug dose according to previous study.

Based on the study of the cartridges, the Product C delivered the best performance and the lowest whole of life cost. Products B and D had reasonable quality and operational performance and these two products could be alternative solutions when product C is not available. While product A although it is the cheapest to purchase, it failed to deliver a reasonable overall cost and filtrate quality.

We have therefore recommended Product C as the preferred product for the plant. Additionally, based on the trend of SDI and DP, we recommend increasing SDI monitoring frequency to twice a week once DP reaches 0.15 bar, as the SDI tended to increase quickly after that point and can exceed 3 in a short period.

### 4.0 ACKNOWLEDGEMENTS

The authors acknowledge the support from the ASRP operation team: Emily Rahles-Rahbula, Jaldhin Patel, Slavo Teinovic, Jarrod Sanders, Wudineh Habtegiorgis, Dean Glasgow and Maurice Melder as well as the rest of the City West Water Process & Technical Services team.

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*K. HE DBNPA as an Alternative method for Microbial Control in Recycled Water Dual Membrane Plants.*

# TEMPERATURE PHASED ANAEROBIC DIGESTION AT MOUNT MARTHA WATER RECYCLING PLANT



*Paper Presented by:*

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South East Water



*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# TEMPERATURE PHASED ANAEROBIC DIGESTION AT MOUNT MARTHA WATER RECYCLING PLANT

**Sam Mahawithanage**, *Technical Support Project Officer*, South East Water  
**Mary Henry**, *Process Engineer*, South East Water

## ABSTRACT

The mesophilic digestion system at Mt Martha Water Recycling Plant was converted to temperature phased anaerobic digestion in May 2017.

Temperature phased anaerobic digestion (TPAD) is a two-step advanced digestion process where thermophilic digestion (typically at 55°C) precedes mesophilic digestion (at 37°C). This process potentially offers operational benefits that include: a more stable process at higher sludge loading rates, increased volatile solids destruction, reduced risk of digester foaming and increase in pathogen inactivation.

This paper will discuss work carried out to prepare the facility for TPAD and detail the commissioning strategy adopted for transition to thermophilic digestion including monitoring protocols, commissioning methodology, contingency plans, and challenges. Transition to TPAD was successfully carried out within 40 days using a rapid heating method. Plant data demonstrates how the process acclimatised during the start-up phase.

## KEY WORDS

**TPAD, Anaerobic Digestion, Thermophilic, Mesophilic, Commissioning, VFA**

## 1.0 INTRODUCTION

South East Water (SEW) currently operates an anaerobic digestion process at the Mt Martha Water Recycling Plant (MMWRP). This process has historically been maintained at 37°C and relied on a mesophilic biomass for sludge digestion.

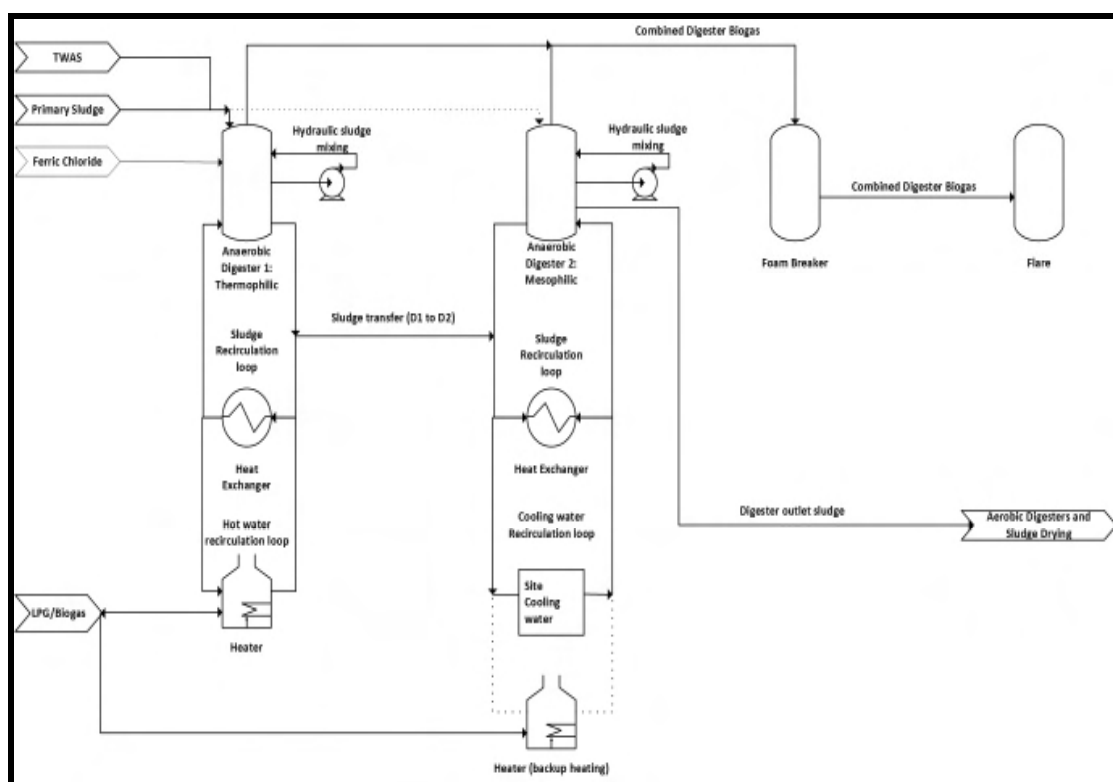
SEW identified Temperature Phased Anaerobic Digestion (TPAD) as a process which may cater for the forecast sludge production while using the existing anaerobic digestion infrastructure. TPAD is a two-step digestion process where thermophilic digestion (typically at 55°C) precedes mesophilic digestion. After a feasibility study, and following confirmation that the existing structures were suitable for elevated temperatures, design and installation of the new equipment to enable conversion to TPAD was carried out.

The works were carried out in two phases. In phase one the existing sludge heating, sludge recirculation, liquefied petroleum gas (LPG), and biogas handling system were refurbished to address reliability concerns. As part of this refurbishment all works were designed to accommodate TPAD operation. Additionally, a new sludge cooling system for the secondary mesophilic digester was installed. Phase two included installation of a new mechanical mixing system and a new sludge thickening facility.

A new aerobic digester system which further treats the anaerobically digested sludge and a sludge solar drying facility, had previously been installed as part of another plant upgrade package.

The anaerobic digester system can now be operated in following modes:

1. The two digesters in parallel at mesophilic temperatures
2. The two digesters in series at mesophilic temperatures
3. The two digesters in series in TPAD mode with the first digester operating at 55°C and the second at 37°C



**Figure 1:** *Simplified Schematic of the MMWRP Digester System*

Once the process is fully commissioned, SEW will investigate whether TPAD facilitates a stable process at higher sludge loading rates, increased volatile solids destruction, reduced risk of foaming and increase in pathogen inactivation.

## 2.0 DISCUSSION

### 2.1 Commissioning Strategy

Selecting a suitable method for establishing a stable thermophilic digestion system was challenging due to limited experience in commissioning or operating this type of process in Australia. However two broad strategies were identified after reviewing the literature related to similar commissioning procedures adopted in other countries (e.g. New Zealand and USA).

One method was to establish a mesophilic digestion process followed by a slow ramping up to thermophilic temperatures while keeping the sludge feed rate constant. Bench scale work carried out using this method indicated failures due to rapid increase in volatile fatty acid (VFA) concentration and subsequent inhibition of the digestion process (Griffith & Alvarez, 2002).

The second method was establishment of a mesophilic digestion process followed by rapid heating to thermophilic temperatures without any sludge feed (De la Rubia, Riau, Raposo, & Borja, 2013). Two plants in New Zealand (Bouman & J, 2011) (Thiele, 2011), and USA (Griffith & Alvarez, 2002) adopted this method and considered it to be effective. Previous work also indicated that the rapid heating method may result in a more stable thermophilic population (Aitken & Mullennix, 1992).

SEW adopted the rapid heating method for transitioning the mesophilic MMWRP digester system to TPAD. A commissioning methodology was prepared on this basis in conjunction with Calibre Consulting.

## **2.2 Monitoring Protocols**

An extensive process monitoring program was carried out during the transition phase to TPAD. The main parameters used as early indicators of process stability were total volatile fatty acid (VFA) concentration, alkalinity and pH which were measured on grab samples collected twice daily. Total solids and volatile solids of sludge feed were measured on grab samples collected daily.

Testing for the concentration of individual VFA components was undertaken by grab sampling and subsequent analysis at an external laboratory three times a week. Comparison of the relative concentrations of the individual VFA components gives information on the interaction and inhibition of the different groups of micro-organisms in the digestion process and can be used to understand process health. Trending of individual VFA component concentrations gave more understanding of the process and helped establish process stability limits for ongoing operation. Due to the slow turnaround time of the individual VFA component concentration analysis the results were not available for immediate process adjustments during the transition phase.

In addition, biogas production (from Digester 1 and combined stream), biogas composition ( $\text{CO}_2/\text{CH}_4$  in combined stream) and digester temperatures, were measured continuously by online instruments.

Guideline limits for different monitoring parameters appropriate for the MMWRP digester system were established and regular staff meetings were held to discuss trends and subsequent operations during commissioning.

## **2.3 Commissioning Methodology**

In preparation of the digester system for the TPAD transition, maintenance was carried out on all the critical equipment including heaters, heat exchangers, sludge thickening equipment, biogas handling systems and all instrumentation. SCADA control and the operation of the cooling water system of Digester 2 was tested. Several standard operating procedures (SOPs) were developed to cater for operational changes and contingency measures during transitioning.

The digester system was operating at mesophilic temperatures in a series configuration prior to TPAD transition. The TPAD transition stages were:

### ***Stage 1 - Starvation of mesophilic biomass in Digester 1***

Feed to Digester 1 was ceased to try to reduce foaming risk during the transition phase.

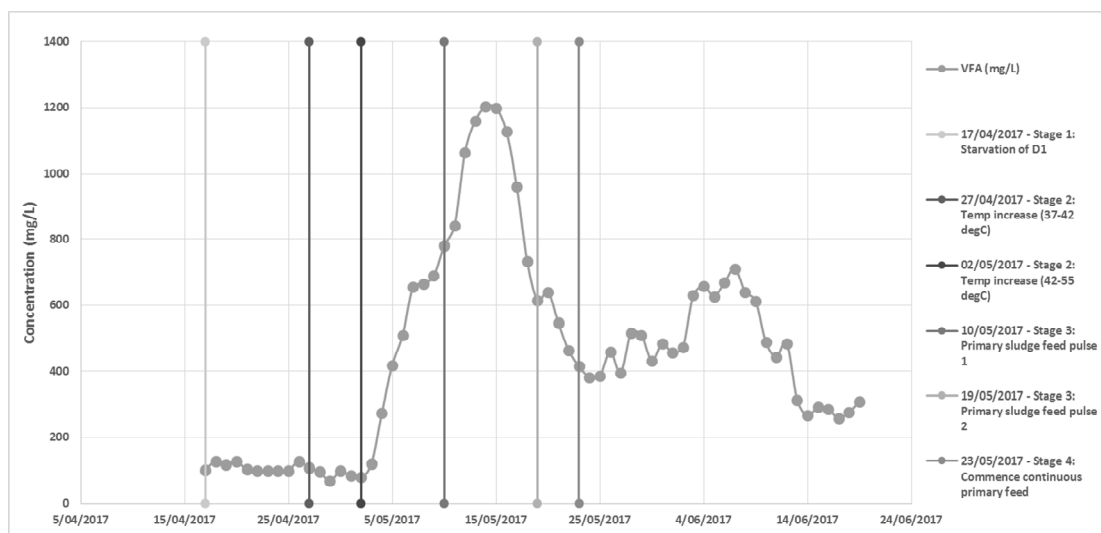
The reduction in biogas production was used as an indicator of reduced digestion activity and successful starvation. A starvation phase of ten days was allowed to ensure an appropriate reduction in digestible material was recognised.

### ***Stage 2 - Temperature increase and stabilisation at 55°C***

Digester 1 continued to operate in starvation phase but the temperature was increased by 1°C/day from 37°C to 42°C which is considered the upper limit for stable mesophilic digestion. In the next phase, temperature was increased rapidly from 42°C to 55°C. This was achieved within two days and Digester 1 was allowed to stabilise for seven days. The VFA concentration of Digester 1 was closely monitored and a stable level below 1000 mg/L was required prior to moving to the next stage.

### ***Stage 3 - Primary sludge pulse feed in Digester 1***

Once stable VFA concentration was achieved an initial dose of primary sludge was introduced into Digester 1. An initial spike in VFA concentration above 1000 mg/L was expected and observed. Following this, a considerable drop in VFA concentration to 600 mg/L was expected. This was used as an indicator of successful thermophilic biomass growth. As shown in Figure 2 this was achieved in eight days. Subsequently a second dose of primary feed was introduced to confirm the thermophilic biomass growth. VFA concentration values again were stable which further indicated the growth of thermophilic biomass.



**Figure 2:**      ***Total VFA concentration in Digester 1 during TPAD transition***

### **Stage 4 –Commence primary sludge feed**

Four days after the second dose of primary sludge, the VFA concentration in Digester 1 dropped below 500 mg/L, indicating stable operation. Continuous primary sludge feed was commenced at this time. Once stable TPAD operation with the entire primary sludge production is achieved, gradual feed of thickened waste activated sludge (TWAS) will be commenced. For successful completion of the project, the TPAD operation should be able to accommodate all the primary sludge and TWAS produced at MMWRP.

## **2.4 Contingency measures**

The following contingency measures were implemented for the TPAD transition operations:

- SCADA controls were put in place to control and direct primary sludge to an excess sludge storage tank which could be transferred to tanker for offsite processing. This was carried out to allow full control of the amount of sludge fed to the digester system during the transition period.
- Odour loggers were installed at several locations in the sludge handling area to monitor for H<sub>2</sub>S concentration as part of addressing health and safety concerns.
- Ferric chloride was dosed to control the Hydrogen Sulphide (H<sub>2</sub>S) concentration in the biogas.
- A temporary sludge line was installed to direct TWAS to the aerobic digester system to reduce amount of offsite sludge processing required.
- During the starvation of mesophilic Digester 1 primary sludge was fed to Digester 2. This reduced the amount of offsite sludge processing required and ensured a viable mesophilic population was maintained should any mesophilic re-seeding of the digestion process be required.
- Sodium bicarbonate dosing was available to control alkalinity. It was necessary to ensure that sufficient quantity was available at MMWRP and SOPs were prepared for dosing into the digester system.
- Historically, excessive foaming had been a major issue which caused plugging of biogas piping especially when TWAS was fed to the digester system. Therefore a flush system was installed on Digester 1 biogas line as a precautionary measure before the TPAD transition.

## 2.5 Challenges

- Excess sludge generated during the transition phase had to be tankered offsite for processing which was a costly exercise. Additionally, managing onsite sludge storages and co-ordinating tanker movements required thorough management.
- LPG had to be used instead of biogas as the fuel source to the boilers in order to avoid boiler fault due to varying composition and production rate of the biogas. This resulted in greatly increased LPG consumption and cost.
- Extensive monitoring and manipulation of the process required significant input by operations staff to manage the digester system. TPAD transition required the attention of two operators on a full time basis, including some weekend input.
- Due to unavailability of data on local plant scale TPAD operations there was uncertainty in limits and typical operating ranges for different process parameters. This resulted in a conservative program for the TPAD transition as operational experience was developed.

## 3.0 CONCLUSION

Starving the biomass prior to rapid heating of Digester 1 proved to be a successful methodology for transitioning from mesophilic digestion to TPAD. Development of robust monitoring protocols and a detail development of the commissioning methodology were key factors to ensure successful TPAD transition. Additionally, a number of contingency plans were developed to ensure a successful TPAD transition. Whilst a successful transition to TPAD was eventually achieved there were some challenges which SEW would consider further prior to any future TPAD transition activities. The effectiveness of the TPAD process in delivering increased digester system stability and operational benefits will continuously be reviewed as sludge loading to the digester system is increased.

## 4.0 ACKNOWLEDGEMENTS

We would like to acknowledge SEW project management team, Maarten Van Herk, James Hampton and Peter Uren for their commitment, support and effort in making this project a success. We wish to thank the SEW commissioning team, Ben Murdoch, Samaka Mendis and the rest of the MMWRP operations team for their hard work and committed efforts during the TPAD transition. We are also grateful for all others at SEW who reviewed an earlier version of this paper and provided valuable comments.

Special thanks to Jürgen H Thiele of Calibre Consulting for providing expert advice on the commissioning plan and process support. We would also like to thank Australian Laboratory Services, Lend Lease, and Melbourne Water for their continued support during this project.

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# IMPROVING ENERGY EFFICIENCY WITH DISC AERATORS AT THE HAHNDORF WASTEWATER TREATMENT PLANT



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**Morgan Cartridge**

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SA Water



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# IMPROVING ENERGY EFFICIENCY WITH DISC AERATORS AT THE HAHNDORF WASTEWATER TREATMENT PLANT

**Morgan Cartridge**, *Wastewater Treatment Plant Operator, SA Water*

## ABSTRACT

SA Water's Hahndorf WWTP comprises two oxidation ditches, Ditch 1 and Ditch 2. Originally, aeration in Ditch 1 was supplied by two sets of horizontal brush type surface aerators in a duty standby arrangement, each powered by a 22 kW electric motor on variable frequency drive. The aerators were low in energy efficiency, approaching its design capacity and failed to consistently achieve the required dissolved oxygen target. A trial was conducted in an attempt to improve aeration energy efficiency as well as to increase treatment capacity of the plant. The success of this trial would improve plant performance but also defer capital upgrades of the WWTP. Objectives of this trial also include providing safe and reliable equipment to operate over the design life with minimal maintenance.

This paper discusses the trial project, results, observations and the positive impact on plant operation to date supported by plant pre and post installation operating data.

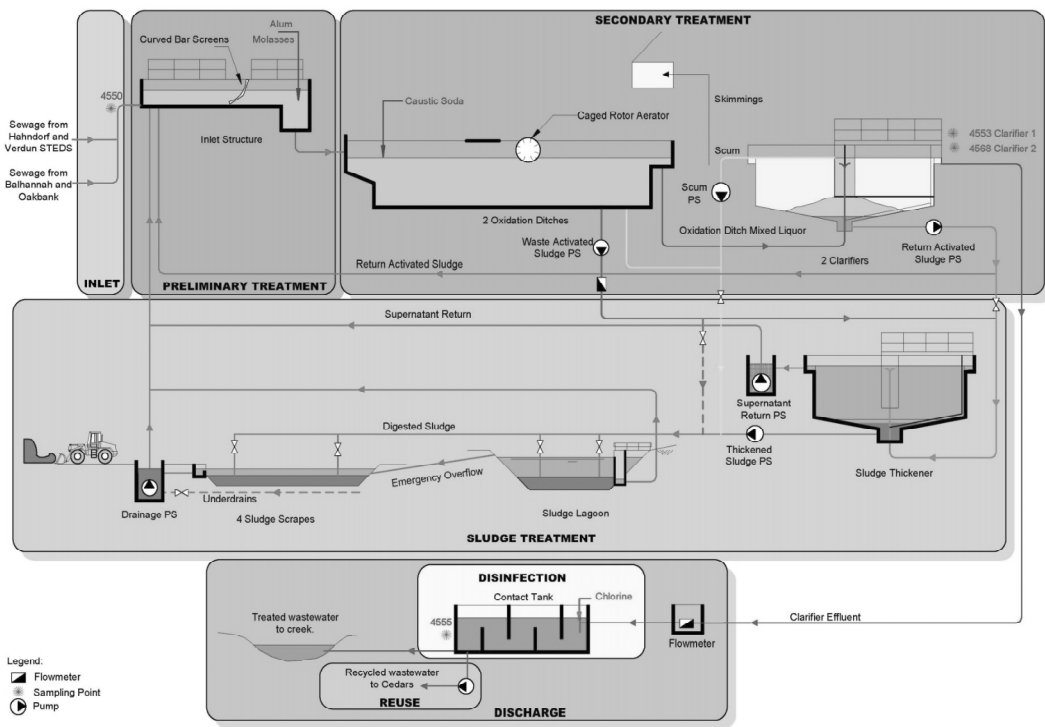
## 1.0 INTRODUCTION

The Hahndorf WWTP was constructed in 1977 to treat domestic waste from the townships of Hahndorf, Balhannah, Oakbank and septic tank effluent from Verdun. The plant was first commissioned for 3,000 PE (AAF 476 kL/d) with the current oxidation ditch 1 and dedicated clarifier. The plant has undergone a series of upgrade works over the years to augment hydraulic capacity and meet performance and operational needs. A major upgrade occurred in 1994 with construction of a new inlet works, a second oxidation ditch and clarifier. The flow split between the two ditches is set approximately to 40% for ditch 1 and 60% for ditch 2. Following this upgrade the plant was rated at 4,600 PE with an annual average flow of 1.0 ML/d. The revised rating of ditch 1 after the upgrade was 1,800 PE, to achieve the new effluent quality goals at that time.

The raw sewage is currently pumped from two network pumping stations to the inlet structure of the WWTP. There it is mixed with the RAS from both trains, split into the above mentioned 40:60 ratio and screened through curved bar screens with an aperture size of 1.2 cm. Following screening sugar solution for N removal and Alum for P removal are added together with caustic for pH correction when required.

The pre treated wastewater is then biologically treated in the two oxidation ditches. Aeration occurs via horizontal shaft aerators, each ditch has a dedicated secondary clarifier where the biomass and the treated wastewater are separated. The RAS is returned to the inlet structure and the treated wastewater flows through a flowmeter to a chlorine contact tank for disinfection. Most of the effluent is then discharged into the Hahndorf creek and a small amount is reused offsite for irrigation.

The waste activated sludge is withdrawn directly from both ditches (MLSS) and pumped to a gravity thickener. The amount of WAS is measured via a flowmeter. Following sludge thickening the thickened sludge is tankered to Heathfield WWTP for further treatment. Treated wastewater quality (6-yr average): BOD = 3.2 mg/L, TN = 5.6 mg/L, NH<sub>3</sub>-N = 0.5 mg/L and TP = 0.3 mg/L.



**Figure 1:** *Schematic of Hahndorf WWTP*



**Figure 2:** *Oxidation Ditch 1*

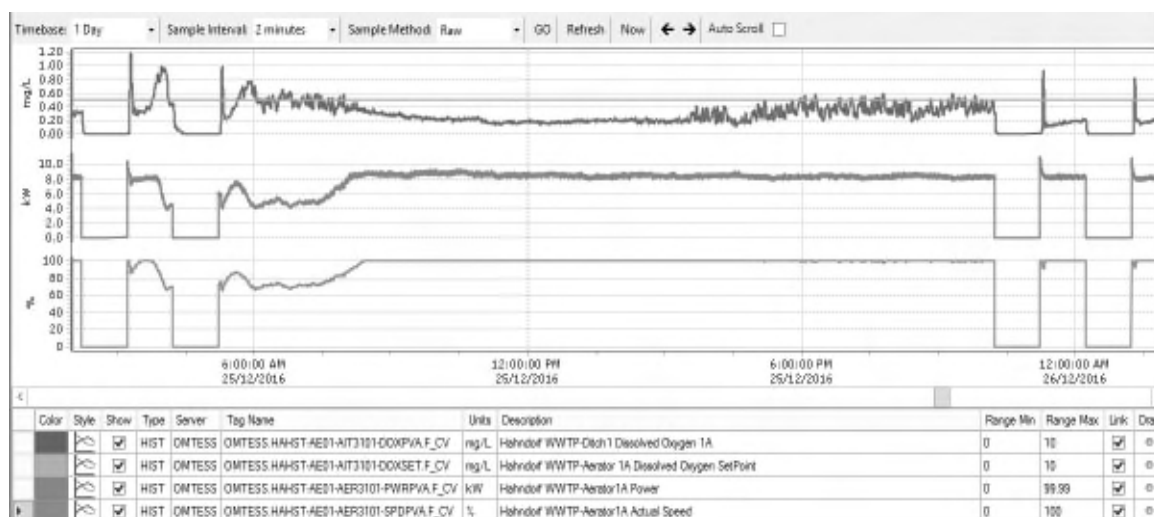
## 2.0 DISCUSSION

Based on Annual Average Flow (AAF) assessment, Hahndorf WWTP Future Process strategy (FPS) indicated sufficient treatment capacity and good historical effluent quality; however various parts of the plant will approach design capacity before 2040, including:

- Aeration capacity of Oxidation Ditch 1 – With the existing rotors Ditch 1 will reach design capacity by 2018 (kg/hr air). therefore something needed to be done now
- Clarifier No.1.

The plant was also not meeting the required DO set points in ditch 1, particularly during the summer months, resulting in elevated effluent ammonia during peak loading. Operationally, a wooden block is used in the inlet chamber to reduce the sewage flow distributed to ditch 1. This attempt to improve the aeration is often ineffective and caused treatment processes using flow pacing such as alum dosing to become inaccurate.

The Mammoth brush aerators, installed in 2009, also show signs of corrosion, and equipment condition is deteriorating with paddles falling off, particularly in ditch 2, and lubrication system not up to standard. The brush aerators also appeared to “smash” the floc in the ditch rather than aerate and mix potentially resulting in a poorer performing floc.

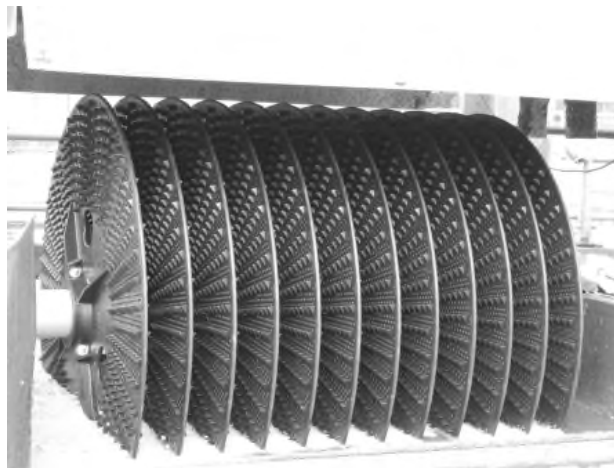


**Figure 3:** SCADA screenshot displaying insufficient aeration even when the aerator rotor is working at full speed (bottom trend). The measured dissolved oxygen (top trend) does not reach the dissolved oxygen set point of 0.6mg/L (horizontal line, top trend) for most of the day.

Across SA Water, there is also a strategic driver to improve both power efficiency as well as process performance. With the aim of improving asset condition, capacity, performance as well as energy efficiency, investigation was undertaken to replace the Mammoth brush aerators with different type of aerator, and disc aerators were determined to be the solution for this.

A capital project was initiated in 2012 to replace 2 of the 4 existing Mammoth brush aerators in ditch 1 with new Disc Aerators:

- 24 x 13mm thick moulded HDPE disc.
- 22 kW motor and gear box set.
- Speed - up to 60 rpm.
- Disc immersion (current) – 312 mm.
- Maximum disc immersion – 530 mm.
- Claimed SOTR at 312 mm & 43 rpm – 11.5 kg O<sub>2</sub>/h.
- Claimed SOTR at 312 mm & 55 rpm – 17.3 kg O<sub>2</sub>/h.
- Design SOTR – 17 kg O<sub>2</sub>/h (single aerator).



**Figure 3:**     *Disc Aerator*

## **2.1 Project Outcome**

The disc aerator was sized, and designed for installation. However, during commissioning, it was found that the aerator was not able to deliver the oxygen transfer rate required, i.e. the DO set points were met, but at the cost of a significant power draw.

This insufficient disc aerator was subsequently replaced the following year with a new disc aerator with a larger diameter and an improved design. However this installation also required further modification to the support structure and guarding as the guarding installed with the first installation was subsequently too high resulting in excess splashing to an unacceptable level. The new model disc aerator has demonstrated improved performance, i.e. achieving DO setpoint and ability to increase aeration when needed operationally.

Further aeration performance assessment was undertaken in February 2017, in order to determine the aeration capacity and compare its performance against the original design intent.

Both tests were performed with the mixed liquor in the ditch utilising a steady state and a non-steady state methods as described in the ASCE 18-96 “Standard Guidelines for In-Process Oxygen Transfer Testing”. Results of the tests related to the assessment of aeration performance, i.e. capacity are discussed below.

## **2.2 Operational Performance**

Ditch 1 can now reach steady DO setpoints quicker than it could with the undersized initial replacement with the same power draw and has further capacity. Increased velocity along the Ditch flow path and greater depth penetration of aeration together with a healthier looking floc has also observed. These all indicate improvement in performance. Over the past 2 months the effluent ammonium concentration has been recorded as 0.2mg/L and total N as 4.3mg/L which demonstrates effective aeration for the incoming N load (average sewage TKN concentration = 77.62mg/L). It must be noted that plant performance has been measured on an overall effluent quality leaving plant basis as individual trains have not been measured historically.

## 2.3 Plant Capacity

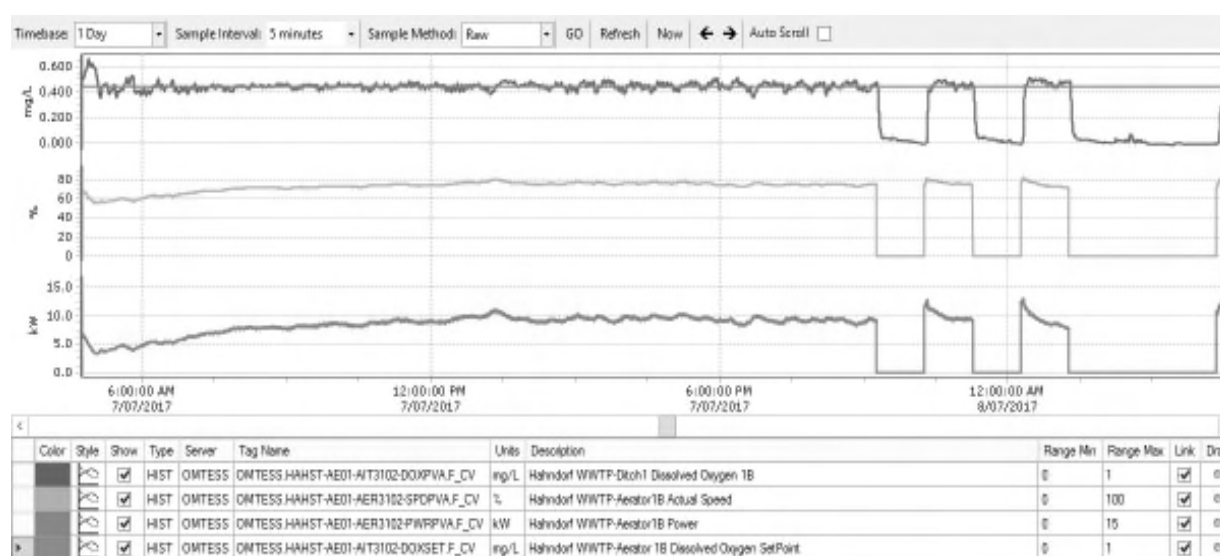
The performance of the new disc aerators in ditch 1 indicates that the ditch can cope with higher flows than previous potentially delaying capital upgrades. In addition to this project new inlet screens, grit removal and upgraded RAS facilities are being procured (currently in detailed design) that should further delay any capital investment in the size of the ditches.

## 2.4 Aeration Performance and Energy Efficiency

Overall the new disc aerator is meeting the original design intent (Table 1) in all aspects and exhibiting excellent performance in both aeration capacity and energy efficiency.

**Table 1:** *New Disc Aerator Performance Summary*

Parameter	CDR Spec	New DISC aerator	
		NSS Test	SS Test
DO Level	0.5-1.0 mg/L	>0.5	
Power density	<27/m3	23.36	
Speed, %		100	67
Oxygen Transfer Rate (OTR), kgO <sub>2</sub> /h	>20 kgO <sub>2</sub> /hr	26.49	9.47
Aeration Efficiency (AE), kgO <sub>2</sub> /kWh	>1.1 kgO <sub>2</sub> /kWh	1.42	1.40
Standard OTR (SOTR), kgO <sub>2</sub> /h	>28 kgO <sub>2</sub> /hr	33.67	12.03
Standard AE (SAE), kgO <sub>2</sub> /kWh	>1.4 kgO <sub>2</sub> /kWh	1.80	1.78



## 3.0 CONCLUSION

The installation of the new disc aerators to ditch 1 at the Hahndorf Wastewater Treatment Plant has shown that the aeration capacity of ditch 1 can be extended without further capital investment in civil infrastructure for the ditches in the near future. The improved plant treatment performance observed during this trial period needs to be taken in context as the improved treatment performance (effluent quality) has been measured on the overall plant and not the individual ditch. The new disc aerators are more energy efficient than the original brush rotors.

There are some lessons to be learnt from this project as follows:

- In order to fully conclude that the treatment process in ditch 1 has been improved a full analysis of the historical performance of individual process trains should have been conducted.
- Future regular monitoring and analysis on individual process trains should occur.
- Continued monitoring and review of the performance of the disc aerators at Hahndorf, particularly with regard to energy efficiency, be undertaken prior to installation of these units at other plants.

#### **4.0 ACKNOWLEDGEMENTS**

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- John Carr, Wastewater Treatment Coordinator, Production & Treatment, South Australian Water Corporation
- Krish Pande, Business Development Manager Evoqua Water Technologies
- Monodelphous Project Team

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# ADDRESSING WATER QUALITY WITH SECONDARY CHLORINATION



*Paper Presented by:*

**Peter Murphy & Max Hadzimdimitriou**

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# ADDRESSING WATER QUALITY WITH SECONDARY CHLORINATION

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**Peter Murphy**, *Integration Senior Technician*, Yarra Valley Water

## ABSTRACT

Yarra Valley Water's (YVW) strategic intent is to deliver exemplary water services to our customers. One aspect of delivering exemplary water is to meet the outcomes set in the Safe Drinking Water Regulations (2015). The regulations were updated in 2015 to include a requirement for tanks to be sampled and for these sample results to meet the defined water quality standards.

To ensure the multiple barrier approach to water quality was maintained and ensure safe delivery of water to customers, it is necessary to:

- Undertake a tank inspection program to identify and rectify possible points of contamination; and
- Maintain a sufficient chlorine residual in the water supply.

Due to several tanks with low chlorine residuals, the change in the water quality regulations and the costs involved in spot dosing, YVW decided to install a number of secondary chlorinators.

Secondary chlorinators are YVW owned chlorine injection plants that are strategically located within the drinking water supply network. Their purpose is to increase chlorine levels in areas where the residual disinfection from the primary chlorination is insufficient. This provides a safe and consistent approach to managing water quality and ensures the health and well-being of YVW customers.

To better understand our exposure to the risk of not meeting the regulations, an analysis of chlorine residuals at each of our water supply tanks was undertaken. The analysis identified 12 tanks which had consistently low chlorine residuals, requiring secondary chlorination – or in simple terms the addition of chlorine on a regular basis.

This presentation will outline the two types of delivery methods for installation of secondary chlorinators, the advantages and disadvantages of both including resourcing, program, cost, and quality. The presentation also addresses some of the unexpected benefits of improved network monitoring with the addition of chlorine analysers.

## 1.0 INTRODUCTION

Chlorine is a very common type of disinfection. Disinfection protects the water by killing harmful pathogens and bacteria (*E. coli*). Water provided to YVW by Melbourne Water has already received primary disinfection. YVW's aim is to maintain an adequate level of disinfection throughout its water supply network through to its customer taps.

However, there are zones in our supply network where water must travel long distances and subsequently the level of residual disinfection drops considerably by the time the water reaches our customers' taps. This body of the water has limited protection against potential contamination subsequently increasing the risk of contamination to the customer.

YVW's reservoirs are an ideal location to install secondary chlorination disinfection units as they are located in regions of the YVW network where water age and recontamination via the tank is of greatest risk. In many cases water is transferred over long distances and is retained in the network for long periods due to low demand in areas where population density is generally low.

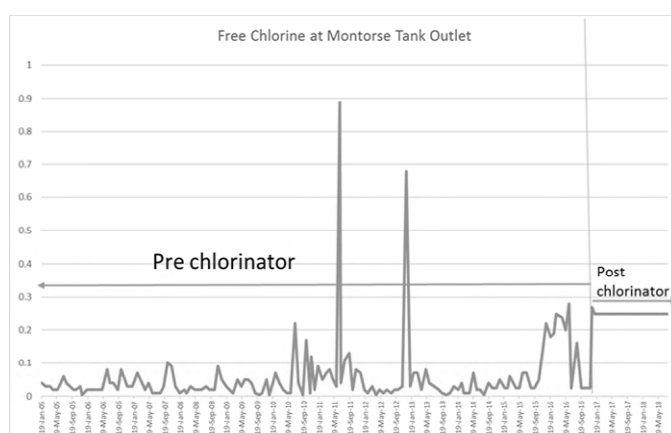
## 2.0 DISCUSSION

YVW has recently installed 10 secondary chlorinators throughout its distribution network with further consideration given to install additional units within the 2017/2018 financial year. The majority of these units are located at reservoir sites contributing to maintaining a multiple barrier approach to water quality, ensuring adequate disinfection throughout the zoned networks prior to reaching customer taps.

### 2.1 The Purpose of Secondary Disinfection

When chlorine residuals are low within the water supply network the water is at risk of not meeting the requirements of the Safe Drinking Water Regulations 2015, as bacteria (e.g. *E. coli*) can survive and be present in the drinking water. Therefore, to eliminate this risk YVW has initiated a program to install secondary chlorinator units to boost the chlorine residuals within “at risk” areas of its supply network.

Figure 1 below compares the chlorine levels prior to, and after the installation of a secondary chlorinator. The levels prior to installation showed low levels of chlorine being ineffectively managed by spot dosing, once the chlorinator was installed a consistent set point of 0.2 mg/L chlorine was maintained.



**Figure 1:** *Tank outlet free chlorine residual levels before and after installation of secondary chlorinator (Jan 2005 to May 2017)*

### 2.2 Types of Secondary Chlorinators

Two different systems of secondary chlorination systems have been adopted for disinfection of YVW's water supply network based on site specific criteria. Both options were advertised for public tender and after evaluating tenders Dioxide Pacific Pty Ltd were awarded the contract to install a single secondary chlorination unit with 2500L chemical storage capacity at WRS062 Craigieburn Reservoir and C-tech Services Pty Ltd were awarded a contract to install nine secondary chlorination units each having a smaller chemical storage holding capacity of 200L.

## 2.3 C-tech Services Pty Ltd

C-tech Services Pty Ltd were the successful tenderer for installing nine “turnkey” secondary chlorinators based on a design and construct (supply and install) contract project managed by the Water Optimisation Team. The nine tanks selected were based on sites having historical low chlorine residuals within YVW’s network. The sites varied in tank sizes ranging between 23KL (elevated steel tanks) and 5ML (steel storage tanks)

Functional design by C-tech Services Pty Ltd was submitted for approval by YVW and submitted for HAZOP assessment. The design process was finalised in early August 2016 and site construction and installation commenced thereafter with the first of the nine units being installed and commissioned in November 2016 and the final unit being commissioned by 30 June 2017.

The overall process took approximately 10 months for design/supply, install and commissioning of the nine units.

### 2.3.1 C-tech Services Pty Ltd (Model Number CRTU-200LP-S-C-2-A7.5-1-0)

This is a 3mm powder coated Aluminium unit consisting of two compartments; the main houses the dosing equipment, chemical tank and P&ID the other has the electrical/ RTU hardware.

The footprint is quite economical with its size measuring 2050mm (L) X 1800mm (H) x 700mm (D) and comes complete as a “turnkey” styled packaged unit that can be positioned on a 4.00m x 2.100m concrete slab platform. To facilitate its operation, it requires 2 x 25mm water tapings (analyser & dosing), a standard 10 or 16 amp electrical supply and a flow signal or a digital run signal. The dosing arrangement consists of 2 x dosing pumps with degassing solenoid valve with automatic duty / standby change over and comes with a 200L HDPE chemical tank and bund and built-in sample return system including re-circulation pump with carrier dosing (max 7 Bar). The self-contained chlorination unit is completed with compliant safety eyewash/shower assembly plumbed into local drainage.

It has PLC control (modbus tcp/ip) communications providing for two-way data interface that can be used for remote set point control, alter upper limits, preventative maintenance alarms, start/stop, dosing pump status plus other features. The system is also connected to YVW’s Clear SCADA telemetry system with the following signal outputs: chemical tank level signal, residual level (high and low limit alarms), dosing pump fail, chemical tank high level alarm and low level alarm, remote set point control, alter upper limits, start/stop dosing pumps and current dosing pump status.

Each site has been commissioned to operate based on site specific criteria. The majority of these units have been set to flow paced dosing and the remaining units are set to flow paced residual trim dosing.

### 2.3.2 Advantages of “Turnkey” Secondary Chlorinator Units

- Significant cost savings between conventional dosing systems vs “turnkey” unit due to homogenised compact design.

- Simplified construction, commissioning and acceptance testing due to the standardised design
- Improvement of operability in maintaining a consistent chlorine residual utilising a standard online automated chlorination system.
- Standardisation of chlorination dosing systems across YVW 's network;
- Adopting a standardised flow paced or flow paced residual trim philosophy based on site specific conditions.
- Complete dosing system delivered to site with minimal civil works required.
- Flexible dosing system that can be either permanent or temporary in nature
- Remote control access for ease of system operation reducing time and costs for maintenance/emergency response

### **2.3.3 Disadvantages of “Turnkey” Secondary Chlorinator Units**

- Limited historical data on plc when trouble shooting; currently unit is limited to 30 days.
- Dosing accuracy when supplying low volume tank fills. Site adjustments required for longer run tank fill times
- Requires additional civil works (i.e. chemical bunding, etc) when storage exceeds 1000 L.

## **2.4 Lessons Learnt**

The unit installed at YVW's WTS001 Kenmare Ave High level tank in Croydon encountered dosing irregularities 3 months after commissioning. The unit overdosed above its set point resulting in necessary flushing of the water mains to reduce the high residual. The chlorine residual signal was lost after a mains power failure of the site however the unit failed to shut off.

Consequently, *all* C-tech secondary chlorinators have been reprogrammed to cease operation preventing the risk of overdosing if and when the following occurs:

- 0.20ppm above process variable (PV) is reached – known as “Upper Limit”
- If Mains Flow has reached greater than 1% of the Max Flow range for greater than 20Secs (the minimum flow rate required to dose).
- If the Sample Water to the analyser flow rate is <0.40L/Min.
- Both dosing pumps are in fault
- Loss of signal OR less than 3.8mA is received from the CL2 Sensor.

## **3.0 DIOXIDE PACIFIC PTY LTD**

The Craigieburn Secondary Chlorinator was delivered under the traditional YVW capital delivery process. This was deemed necessary due to the larger scale of the asset required for current and future secondary chlorination at Craigieburn Reservoir. This is evidenced by the larger volume chemical storage tank and the requirement for a delivery bund suitably sized for bulk chemical delivery.

Like other tank sites in the YVW network, Craigieburn Reservoir has a history of very low free chlorine residuals in the summer months and was identified as a suitable site for secondary chlorination. The site consists of 2 X 12ML steel storage tanks which receive water from either of Melbourne Water's Yuroke Reservoir or Somerton Reservoir.

Craigieburn Reservoir has a direct supply zone and indirectly supplies water to Mount Ridley Reservoir (Craigieburn North), Pretty Sally Reservoir (Wallan and Beveridge), and Pretty Sally High Level (Wallan High Level). Craigieburn Reservoir is therefore part of a rapidly growing supply and transfer network with a current daily turnover in the order of 15-26ML.

YVW engaged its in-house Jacobs design team to produce a standard construction specification for the chlorinator and associated ancillary works. The project commenced 26 March 2015 and was commissioned in February 2017. The overall process took approximately 2 years.

The Craigieburn Secondary Chlorinator project was split into two separate contracts.

### **3.1 Contract 1. Design, Construct and Deliver a Prefabricated Portable Plug-in Chlorinator as per the Specification**

This contract was awarded to Sydney company Dioxide Pacific Pty Ltd, an engineering company specialising in the design, supply and installation of chemical dosing, water treatment and water disinfection systems. In summary, Dioxide Pacific Pty Ltd supplied a concrete construction portable building with the following items:

- Self bunded chemical storage room with 2500 HDPE tank, external fill point with level alarm and level power isolation, tank level sight tube, level instrument, level switches, submersible bund pump, external pump out point, tank vent, passive ventilation and fan forced ventilation, safety shower
- Dosing room fitted with duty and standby dosing pumps, dosing flow meter, pressure regulating valve, pressure relief valve, calibration tube, spill collection bund, passive ventilation, PLC for flow paced and residual trim dosing control and HMI interface, reservoir inlet analyser (total and free residual), reservoir outlet analyser (free residual), sample collection tank and sample return pump
- All mandatory chemical signage and labelling.
- Dosing lance and dosing tubing

### **3.2 Contract 2. Construct Civil Works as per Design**

This contract was awarded to Comdain Infrastructure, a construction and maintenance services business specialising in the gas, irrigation and water sectors. In summary, Comdain Infrastructure provided the following civil components:

- Consolidated foundation pad for the chlorinator building
- Concrete bund for chemical delivery truck and associated drainage pits and paths
- Tapping and connections for site water supply, dosing, sampling and sample return
- Alarmed spill collection pit on dosing line
- Connection of power supply and communications
- Outside safety shower

### **3.3 Advantages of Traditional Capital Delivery Process and Large Scale Chlorinator**

- Large capacity chemical tank has potential for fewer site visits for chemical delivery
- Capability to dose at current and future inlet supply rate
- Large number of points (65) available on SCADA providing improved monitoring and alarming
- Improved ergonomics e.g. indoor standing/working space

- Improved safety features e.g. alarmed safety showers
- Improved environmental consideration e.g. alarmed dosing line spill collection pit
- Robust “permanent” construction
- Remote alarm re-set function

### **3.4 Disadvantages of Traditional Capital Delivery Process & Large Scale Chlorinators**

- Program – greater time to deliver the project
- Project cost -Significant additional costs between conventional dosing systems vs “turnkey” unit
- Resourcing – YVW project resources are not included in the project cost above and were significantly greater than the alternative
- The current maintenance contractor is not the chlorinator supply contractor. This has the potential to impact on commissioning and initial familiarity with the asset
- Two contracts which can cause dispute between parties at the interface points

### **3.5 Lessons Learnt**

#### *Short circuiting of reservoir*

Observation of the outlet analyser on Tank 1 indicates that when chlorinated water is being supplied to Tank 2, a reflux valve between Tank 2 and Tank 1 is letting through a small volume of chlorinated water directly to the outlet main.

#### *Air in the inlet supply main*

The inlet analyser supply tapping was made at 12 o'clock on a very flat grade of pipe work. It was obvious during pump runs from Yuroke Pump Station that air in the main was a significant problem. This led to the realisation that 7 air valves on the transfer main had not been serviced since construction in 2008. Further field investigation revealed that two of the air valves had significant leaks and all seven air valves were in a poor state of maintenance. When maintenance was performed on the air valves the problem was resolved to a satisfactory degree.

## **4.0 CONCLUSIONS**

The multiple barrier approach for disinfection of YVW's water supply network has led to the introduction of secondary chlorinators being installed ensuring consistent chlorine residuals are compliant with the Safe Drinking Water Regulations (2015) delivering safe drinking water to customers.

The C-tech Services Pty Ltd and Dioxide Pacific Pty Ltd secondary chlorinators both perform their functional design. Whilst the C-tech Services Pty Ltd option was delivered within significantly shorter time frame and lower cost, the two units cannot be compared due to the difference in their scope of works and delivery methodology. The units have been of great advantage to the business achieving Opex savings by negating the need to undertake ongoing hazardous and costly spot dosing of reservoirs.

## **5.0 ACKNOWLEDGEMENTS**

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Chris Saliba, Water Optimisation Manager, Yarra Valley Water

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# **‘OPERATOR TO THE FUTURE’**



***Paper Presented by:***

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***80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# ‘OPERATOR TO THE FUTURE’

**Ryan McGowan**, *Manager – Information Systems, Goulburn Valley Water*

## ABSTRACT

*The future is affected by choices made in the present, impacted by those made in the past.*

Predicting the future is difficult and forecasts often fall short. However, failing to plan may equate to planning to fail. Following a *Back to the Future* theme, this paper examines the past and present of water operations to establish a foundation to discuss future challenges for Operators. The challenges will likely come from a number of sources: digital transformation, customer centricity, climate change, regulatory pressures and workforce demographic changes. This paper encourages Operators to take a strategic view of their future, to continue to adapt and help shape it. It is contended this will be achieved by ensuring Operators increase their digital literacy, critical thinking and data analytics capabilities, flexibility, resilience and ongoing professional development.

## 1.0 INTRODUCTION

Flying cars, self-tying shoe laces and hover boards. These were among the many futuristic items depicted in the 1989 film *Back to the Future Part 2*. The creators of the film never set out to accurately predict the future. However, they did intend to show the future was affected by choices made in the present, perhaps impacted by those made in the past.

It is self-evident the essential industry elements of water and wastewater treatment and distribution will always be required, however, various challenges will impact these elements. The underlying theme of the fanciful *Back to the Future* trilogy is a useful model with which to consider the future of water industry operations. An understanding of the industry's past and present will be used as a basis for examining potential challenges to the water industry and appropriate response. The Operator is central to process and delivery, and development of certain skills and capabilities makes them well-placed to be an effective ‘Operator to the Future’.

## 2.0 DISCUSSION

The following information provided about the past and present of water industry operations is not intended to be exhaustive nor complete. It is based on the author’s research and discussion with experienced Victorian water operations staff, with combined industry experience of almost 100 years.

### 2.1 The Past

Water distribution systems have their origins in ancient Rome where a system of canals, aqueducts and pipes were used to distribute water sourced outside the city. The Romans also used water to flush away waste, creating the first sewer system. Advances in water treatment did not take place until the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Initially riverbank filtration led to the development of slow sand filtration. Another significant advance during this time was using chlorine dosing as a disinfectant. Increasing population during the Industrial Revolution necessitated the development of sewer systems, which initially discharged to rivers or oceans. By the start of the 20<sup>th</sup> century wastewater treatment was used in conjunction with discharge.



History is interesting and provides a foundation for further discussion. Following *Back to the Future*, this paper will now concentrate on an approximate timeframe of 30 years in the past to 30 years in the future. Therefore, the time machine is set to the early 1980s. The time traveller observing a water industry Operator in a regional Victorian town would see some interesting features.

The Operator's role was very much mechanical, manual and often relied on using the senses for decision making. In water or wastewater treatment there was very little process automation or instrumentation, save for basic apparatus such as litmus paper or a comparator. As such, an Operator responding to changing raw water conditions would likely adjust dosing as a best guess, based on experience. Machinery, such as plant and equipment, was reasonably sufficient. Yet there was a notable amount of manual handling in treatment and distribution roles, for example, the use of bag chemicals or manual digging for mains replacement. Of significant note was the lack of central information services such as *Dial Before You Dig*, managed instead with good relationships with other local service providers. Work safety was a concern. Various work practices such as Asbestos Cement pipe replacement, lack of confined space gas detection and general lack of personal protective equipment (PPE) would surprise today's workers. Figure 1 shows a distinct difference in PPE requirements.



**Figure 1:** *An operator in the 1980's compared to now.*

Water businesses were generally part of small councils and there was very little specialisation in various fields. Operators worked across all areas as required. Communications were rudimentary by today's standards. Landline phones were generally used, supplemented with two-way radios for mobility. In later years pagers for on-call Operators were employed. The manual nature of the tasks and limited technology necessitated higher staffing numbers.

Interestingly, regulation was very minimal. Water quality was subject to lower standards and enforcement. This was mirrored in environmental management with less extensive rules for discharge. Supervisory Control and Data Acquisition (SCADA) systems were not widely used and where they existed were fairly basic. Consequently customer feedback was the main form of monitoring system operation, in reporting changing water quality or red flashing lights on pump stations.

In many cases the Operator was fairly isolated with minimal networking opportunities. The importance of training sessions and attendance at conferences gradually began to be recognised.

Differences aside, the Operator's focus was, and still is today, to do the best job they could in supplying drinking water, treating wastewater and maintaining the distribution systems.

## 2.2 The Present

Bringing the time machine to the present provides a familiar view to the time traveller. This analysis will focus on the impact the past has played on today.

Technology and legislative directives have positively impacted upon safety issues, health and well-being. For example, advances in dosing systems, hydro-excavation, trenchless boring and valve exercising machines (see figure 2) have greatly reduced manual handling requirements. Enforcing occupational health and safety laws means the Operator today is much safer.



**Figure 2:**     *Vacuum and valve exercising machine (with GPS)*

There have been many events contributing to a changed operations landscape. For example, water reform has seen small council-based water businesses merge into larger, dedicated water businesses. A positive impact of this has allowed Operators to specialise, thereby improving operational outcomes.

Seeking well-being and improved efficiency has seen mobile phones and Internet technologies employed to great effect. Work-life balance has improved, allowing on-call Operators to participate in personal activities away from a landline phone. Greater efficiencies have been realised with this increased connectivity and ability to dispatch work orders electronically.

The advent of sophisticated automation and instrumentation has led to fully automated treatment plants. SCADA systems now monitor many aspects of water operations and allow Operators to deal with potential issues generally before the customers are aware of it. Business demands to 'do more with less' has inevitably reduced staff numbers. This has led to many Operators being time poor and having to prioritise tasks to a greater extent than in the past. Today's Operator's role is much more a monitoring and optimisation one, particularly in treatment areas.

Water quality and environmental regulations have significantly increased as governments ensure public safety and sound environmental management. Related, and not unexpected, consumers have high expectations for safe consistent water and environmental care. This has placed significant pressure on Operators and water businesses. A recent example is the greater focus on maintaining water quality during mains repairs.

This highlights the need for the increased level of training and networking available today which has led to higher skilled, more informed Operators.

It can be seen that past events and choices made to employ new technologies have significantly impacted on water operations. Importantly, the Operator's focus remains on doing the best job possible in their respective area, but better outcomes are being achieved.

## 2.3 The Future

There are a number of challenges on the horizon that are anticipated to impact the Operator's role in the future. These challenges are based on the author's industry knowledge and working papers from the Water Services Association of Australia Workforce Skills of the Future project.

The first of these challenges lies in technological improvements. Commonly known as digital transformation, using digital technologies moves from enhancing existing processes to significantly changing the way they are done. Technologies likely to play the biggest role include the Internet of Things, Augmented/Virtual Reality, Artificial Intelligence and Robotics. While many of these technologies are already here, the impact on water operations will be realised when businesses combine the use of new generation systems to change the way they operate. For example, using increased sensor data from the Internet of Things to feed into an Artificial Intelligence system could provide an Operator with suggested options for a process change. Another scenario might see an Operator employing Augmented/Virtual Reality and Robotics to perform a mains repair from the comfort and safety of their vehicle. However, it is very unlikely in the 30 year time frame that full computerisation of water/wastewater will occur (Frey and Osbourne, 2017). Figure 3 shows the difference between operator interfaces in the past to now, including the use of Augmented Reality.



**Figure 3:** *Differences in operator interfaces over the years*

Customer centricity will be a significant challenge for businesses impacting on water operations. While the purpose of water businesses has always been to provide for customers, the businesses themselves have primarily been asset-focused. Consumer expectations and governmental directives are driving water businesses to place the customer at the centre of their business. Assets need to be managed in accordance with that focus. This could lead to increased service expectations affecting how an Operator completes their work.

Efforts to reduce the impact of climate change will influence water operations. This is driven by ambitious Australian governmental targets to be carbon neutral by 2050. Water businesses relying on electricity for treatment and distribution also have to contend with by-products of wastewater treatment such as methane emissions. Requiring substantial investment and applying new technologies, the Operator is likely to see significant enhancements to water and wastewater processes in the move towards carbon neutrality.

Not surprisingly, regulation will also continue to be a challenge to the industry. The recent implementation of the Victorian Safe Water Drinking Regulations 2015 has seen a move from a prescriptive model to a risk management based approach. Oates (2015) details the improvements this has made and suggests ongoing review is an essential part of regulation. A risk-based approach will mean water businesses are required to base their decisions on data. Operators will require greater data analytical skills. This highlights the importance and need for Operator certification.

Workforce demographic changes will have a significant impact on water operations in the future. Factors involved in this change include an aging workforce and the move towards gender diversity and inclusiveness. The aging workforce will potentially lead to a knowledge gap within the industry. This will possibly have the greatest impact on water operations. Gender diversity and inclusiveness are anticipated to enhance businesses by bringing different views and abilities.

## **2.4 ‘Operator to the Future’**

Clearly there are a wide range of potential challenges facing the future water industry Operator. Following the *Back to the Future* theme, the question is presented:

*What must an Operator do now to ensure they are well placed to flourish and positively impact their workplace in the future?*

Not surprisingly, the answer does not lie in one item but in a number of skills and capabilities.

The first is to ensure Operators increase their digital literacy skills to be able to operate in a digitally transformed environment. For example, the use of smartphones, tablets and laptops to ensure optimal application. A technology enhanced mobile workforce is likely to benefit water operations allowing more work to be performed in the field while ensuring appropriate administrative matters can be completed efficiently.

Decisions often need to be made quickly in response to serious events. Critical thinking skills are increasingly vital as Operators deal with complex scenarios. Operators of the future will effectively gather digital information and also use strong data analytical skills to strengthen decision making.

It is self-evident that in a rapidly changing operational environment, flexibility and resilience will be two key skills; that is, to work around new situations, and to cope with new incidents, respectively. Both of these will help future water Operators navigate the challenges. The task for the industry is to provide mentoring or coaching for these often overlooked capabilities.

Finally, ongoing professional development through certification systems or otherwise will also be required. This will ensure Operators keep up to date with the latest technical and regulatory requirements.

### 3.0 CONCLUSION

Doc Brown in *Back to the Future* famously states “Roads. Where we’re going we don’t need roads!” Whether or not a water-based time traveller might state “Pipes. Where we’re going we don’t need pipes!” remains to be seen. What is clear is the number of challenges facing water operations in the future. These include digital transformation, customer centricity, climate change, regulatory pressures and changing workforce demographics. As highlighted in *Back to the Future*, let us make sure the choices made today position the industry well for the future. Today’s Operator is encouraged to increase their digital literacy, improve critical thinking and data analytical skills, develop flexibility and resilience, and ensure ongoing professional development. This will ensure they are prepared to be an ‘Operator to the Future’.

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Water Services Association of Australia “Workforce Skills of the Future – 2-Day Industry Workshop Outputs Pack”

# ENHANCING RECREATIONAL VALUES AND PROTECTING DRINKING WATER SUPPLIES



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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# ENHANCING RECREATIONAL VALUES AND PROTECTING DRINKING WATER SUPPLIES

**Peter Field**, *Coordinator Catchments*, Central Highlands Water

## ABSTRACT

Water Corporations are stewards of regionally significant land and water assets that provide community services beyond the supply of water. With urban expansion and peri-urban growth, community population is increasing in and around drinking water supplies. Our communities see many recreational values and potential uses of these assets. Some of these uses have industry investment and support whereas other use present hazards to our drinking water quality. All uses need some degree of risk control.

The operational monitoring of catchment hazards provides sanitary surveys with real data and this information is the basis for the establishment of health based targets and the selection of future treatment process for community drinking water supplies.

Chapter 7 of Water for Victoria sets the industry agenda for recognising the recreational values to support community wellbeing. The challenge for asset managers is to deliver enhance recreational experiences for an increasing number of users while protecting water quality and avoiding increased treatment costs.

The aim of this paper is to generate discussion and ideas for consistent, safe and controlled recreational use of land and drinking water supplies. The paper provides real examples from the Central Highlands region of; increased population pressure and asset use; responses to legal and illegal access, working with communities, and risk management techniques and tools.

## 1.0 INTRODUCTION

Public recreation has existed from the first development of water supply reserves in the Central Highlands region. With horses and carriages taken groups of people out to these idyllic landscapes in the 1890's, to 2017 where there continues to be a significant level of recreational interest in the use of land surrounding drinking water supplies. Current water policy (Chapter 7 of Water for Victoria) provides direction to water business in the revitalisation of recreational use however the management of associated risks must be achieved in compliance with the Safe Drinking Water Act 2003

For example there are already limits to activities such as boating and swimming in some water storages to maintain safety and security of supply. We need to manage access to water storages according to risk, particularly at storages used for drinking water supply. To that end water corporations can utilise a model by-law or create rules under sections 160 and 287(ZC) of the Water Act 1989

Water for Victoria states that recreational users and regional communities want to improve certainty of water supply, create new facilities or expand access to popular sites. Many user groups have a clear objective, but require support to make it happen. Water businesses can be proactive in this space through a review of existing assets that are already open and through improving these areas first make some significant improvements to a community's perception and enjoyment of public water assets without changing risk profiles is possible.

Central Highlands Water (CHW) has 29 reservoirs. Of these 15 are open and 14 are closed. In 2017 a review of public use and supporting infrastructure at open reservoirs was completed.

From this CHW is planning to develop actions to the delivers the following Water for Victoria objectives:

- Help communities understand how to achieve their recreational objectives.
- Support recreation at water storages through infrastructure and better information.
- Maintain infrastructure and facilities to support recreational objectives at their water storages under existing arrangements.
- Prepare land and recreation management plans for all major water storages of recreational value.

## 2.0 DISCUSSION

Potable water supply catchments provide water resources to a reservoir (or water storage) used primarily for domestic water supply purposes. There are two types of potable water supply catchments. An ‘open’ catchment is where part or all of the catchment area is in private ownership. A ‘closed’ catchment means that the whole of the catchment area is publicly owned and public access is prohibited.

CHW extracts drinking water from 12 open water supply catchments. CHW aggregates it's 29 reservoirs into 14 surface water systems and these have recently been assessed against the WSSA Manual on Health-Based Treatment Targets in order to determine which of the four categories of water supply protection is currently being achieved.

**Table 1.** *CHW current HBT categorisation of supply protection*

Source Vulnerability	No of CHW Storages
Category 1 Source (Fully Protected)	0
Category 2 Source (Moderately Protected)	4
Category 3 Source (Poorly Protected)	10
Category 4 Source (Unprotected)	0

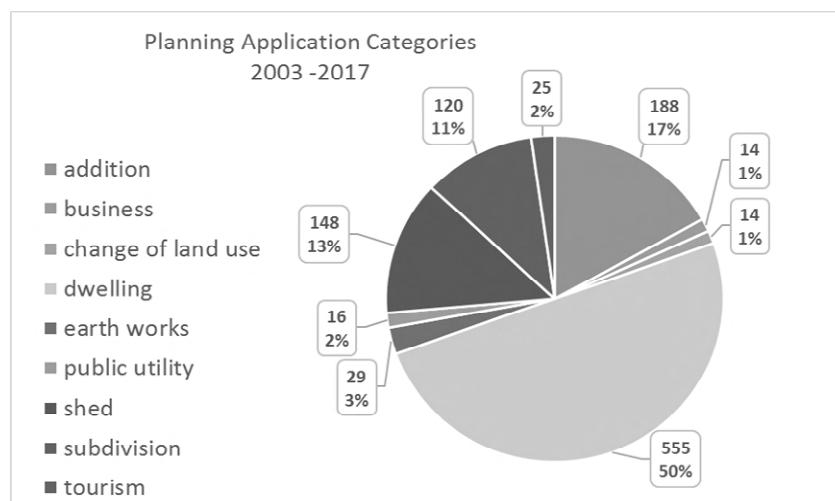
Given this assessment maintaining the current level of protection afforded to surface water supplies in CHW catchments it is important so that any shift downwards in supply categories is prevented. Increases in water quality risks will lead to further treatment process investment and large financial costs.

### 2.1 Population Growth and Increased Recreational Pressure

Ballarat has the largest population in Western Victoria. Between 2011 and 2016 the city's population grew from 84,935 to 104,355 and this is predicted to grow to 145,197 by 2036. Whilst this population is not situated within a declared water supply catchment it sits between the majority of these utilised by CHW.

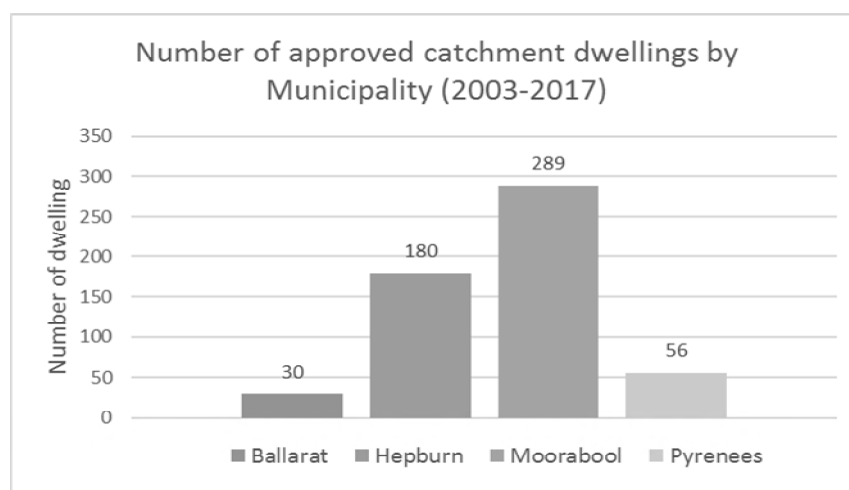
An analysis of 14 years of statutory planning referrals within CHW catchments shows that half of all approved applications are for new dwellings. Using an average of 4 persons per dwelling this is a total habitable capacity increase of 2220 people over that period.





**Figure 1:** *Statutory Planning Approvals in CHW catchments 2003-2017*

The location of these additional dwellings is important. Graph 2 shows that the majority of these new dwellings are located in the municipalities that contain major CHW catchments of Ballarat, Lal Lal and Tullaroop.



**Figure 2:** *Approved Dwellings by Municipality 2003-2017*

The Australian Drinking Water Guidelines (ADWG) have established a number of fundamental industry principles. The sixth principal states that risk management is about making decisions in the face of uncertainty and a continuum of risk. It is also accepted that the more direct that you allow the possibility of human activity into a drinking water source, the greater the risk. It is of paramount importance that this be considered in the development and augmentation of recreational values.

## 2.2 Public Access Review

CHW has a policy for “Public Access to Headworks” which was adopted in 1996. Since that time the policy has not been subject to change. The policy brings together all of the water storages managed by CHW along with historic infrastructure and well established use from local government and water trust management of reservoirs CHW currently manages public access through built infrastructure and the resourcing of field staff who are trained in the safe and effective administration of public access.

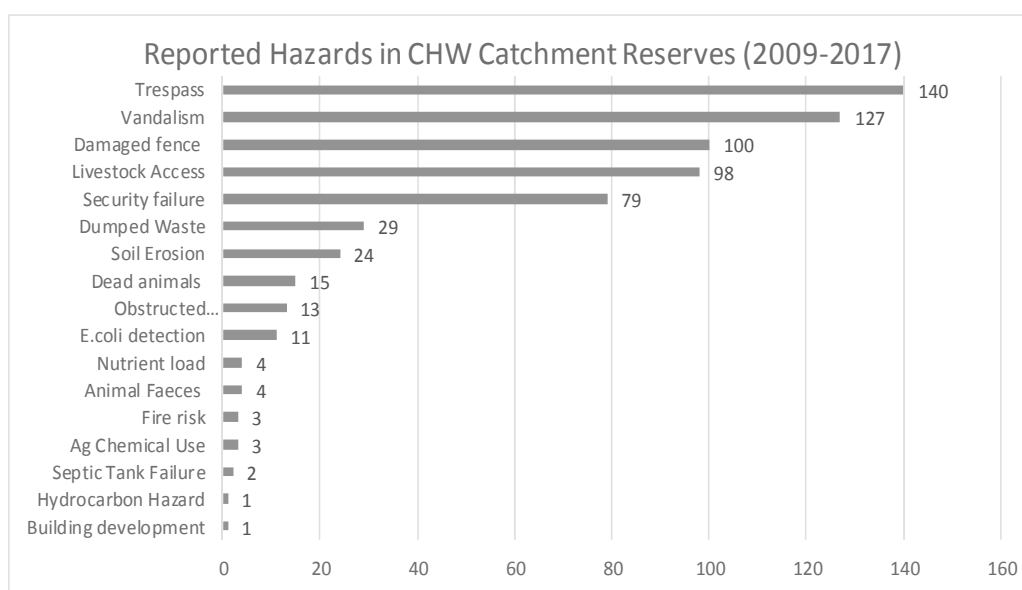
Field operators are consistently presented with the problem of inconsistent signage and unclear direct on the level to which public access rules are to be enforced. Future improvements to existing open reserves need to be designed to be run efficiently and effectively. In 2017 CHW embarked on an internal review of recreational assets and values at all reservoirs open to public access. This review critiqued the following information in Table 2.

**Table 2:** *Rapid Assessment Criteria - Recreational Values and Use*

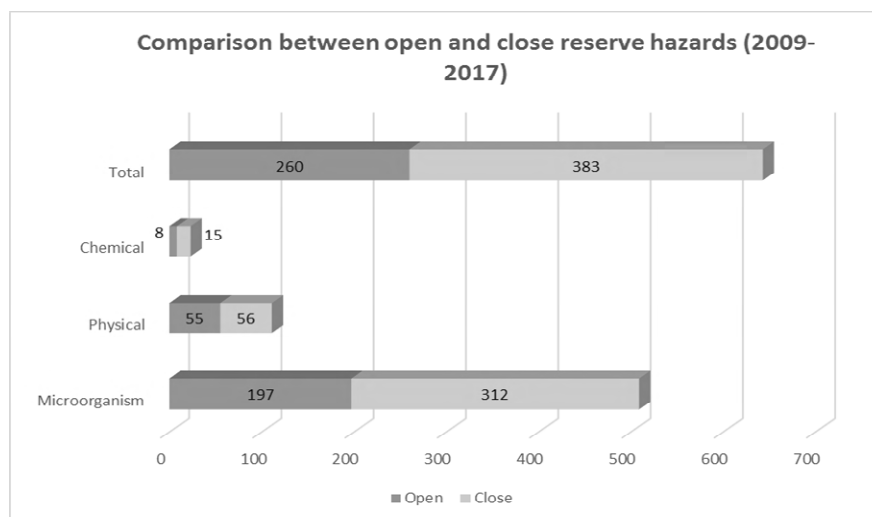
Criteria	Assessment
Community Values	<ul style="list-style-type: none"> <li>Describe the inherent social, environmental and economic value of the reservoir</li> </ul>
Stakeholders	<ul style="list-style-type: none"> <li>Identify current and future users</li> <li>Review existing agreements</li> <li>Determine future needs</li> </ul>
Public Access points & zones	<ul style="list-style-type: none"> <li>Identify all legal and illegal access points</li> <li>Identify public liability and safety risks</li> <li>Review low mobility and disabled access</li> <li>Determine no go zones</li> </ul>
Facilities	<ul style="list-style-type: none"> <li>Asset condition assessment</li> <li>Determine frequency of use</li> <li>Identify public liability and safety risks</li> <li>Determine improvements and upgrades</li> </ul>
Signage	<ul style="list-style-type: none"> <li>Review communication content and style</li> <li>Review location and condition</li> </ul>

### 2.3 Observational Monitoring of Risk

CHW utilises a standard procedure for the calculation of likelihood and risk to drinking water supplies involves operational monitoring of routine microbiological water quality data, and regular catchment surveillance and inspections. A challenge when comparing the data collected from field staff with the policy settings is to determine whether the current approach to managing public access is appropriate and will not lead to an increase in risk. Figure 3 depicts the range and quantity of reported hazards observed.

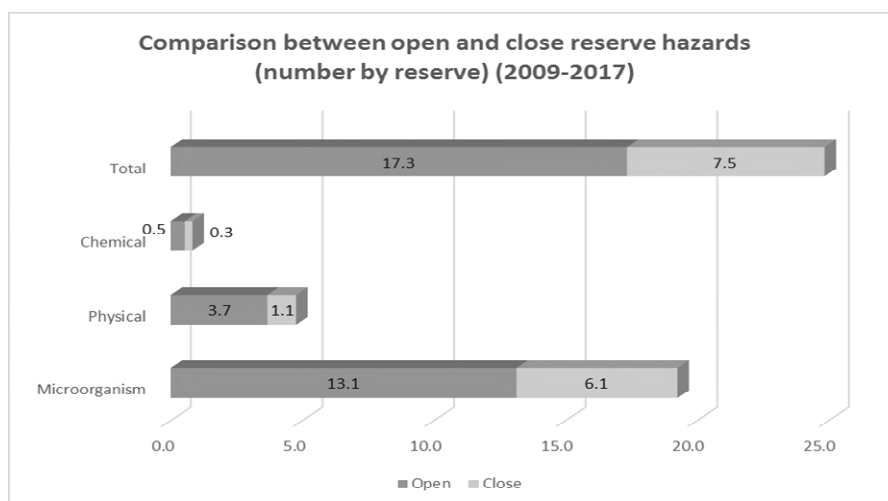


**Figure 3:** *Reported hazards in CHW catchment reserves 2009 - 2017*



**Figure 4:** *Hazard categories for open and closed reserves*

Figure 4 depicts an analysis of entire set of catchment hazard reports. This show a larger proportion of biological hazards entering closed reserves. This is predominantly from trespass of livestock access. However when looking at the number of reports per reserve (Figure 5) it is evident that CHW receives twice the number of biological hazard reports in open reserves than closed reserves. This is due to a larger visitor access to open reserve and number of closed reserves within CHW catchments (land associated upstream of reservoirs). It also indicates a good level of surveillance by CHW staff within open reservoirs.

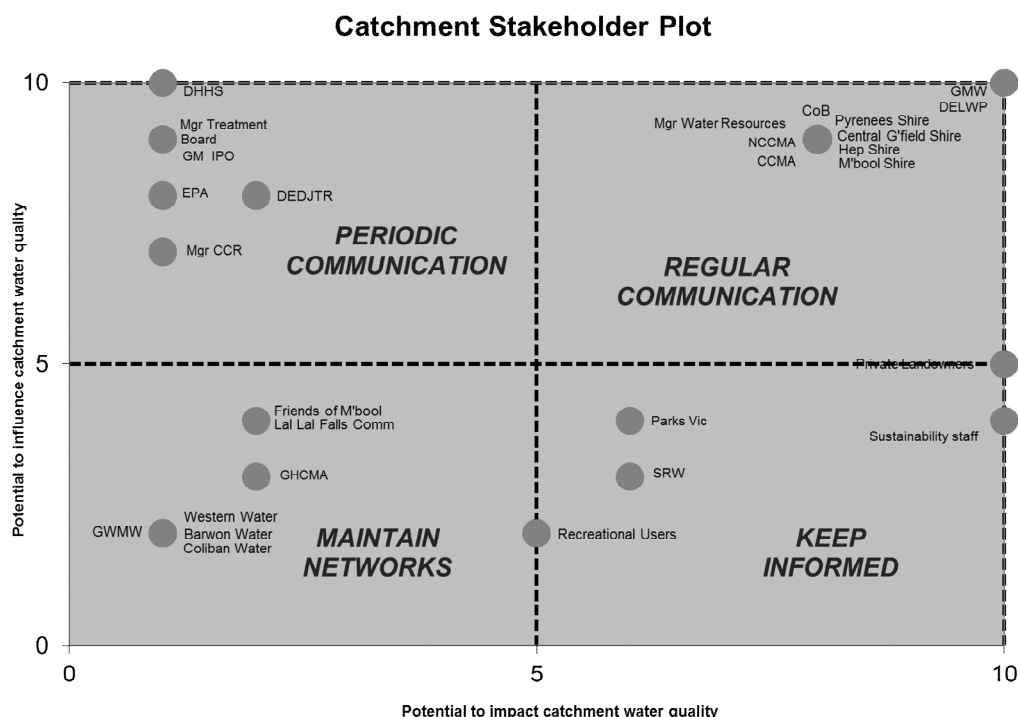


**Figure 5:** *The average number of hazards by categories reported per open and closed reserve*

## 2.4 Catchment Stakeholder Engagement

In the development of future plans to enhance recreational values our organisation needs to better understand each of the user groups and their specific needs. CHW maintains a catchment stakeholder communication plan that will be adopted for that purpose. This plan identifies all the relevant organisations and groups that have the potential to impact on water quality. The plan ranks each organisation on a ten point scale for their ability impact and influence water quality. Figure 6 shows the relative importance of these organisation in the context of water quality and this is then split into four quadrants that influences how CHW communicates.

This methodology is applicable to recreational users and in 2017/18 CHW will complete this exercise specifically for this.



**Figure 6:** *Catchment Stakeholder Communication Plan Summary*

### 3.0 CONCLUSION

With an increasing population living within easy access of drinking water reservoirs there will continue to be ongoing interest in enhanced community access to these assets. Water corporations need to find a balance in the protection of water supplies and the provision of extra value from recreation to the community. In order to plan for this a review of existing policy settings must be completed along with recreational asset conditions assessment. Through understanding and managing the needs of users groups, water corporations can effectively communicate and collaborate at sites on uses that have an inherent low risk to water quality. This will provide a win-win for both the ongoing protection of community water supplies and for the future enjoyment of these by our customers.

### 4.0 ACKNOWLEDGEMENTS

I would like to gratefully acknowledge the assistance of CHW colleagues Mark Lehne, Hamish Dixon and our international tertiary placement student Noel Picard

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<https://www.wsaa.asn.au/publication/health-based-targets-manual>

*Population Australia Ballarat Population 2017* <http://www.population.net.au/ballarat-population/>  
*Water for Victoria DELWP 2016*

# UNDERSTANDING BACKFLOW PREVENTION – THE THINGS YOU NEED TO KNOW



*Paper Presented by:*

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*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
Conference and Exhibition  
Bendigo Exhibition Centre  
6 September to 7 September, 2017*

# UNDERSTANDING BACKFLOW PREVENTION – THE THINGS YOU NEED TO KNOW

**Peter McLennan**, *President*, the Backflow Prevention Association of Australia Inc.

## ABSTRACT

Design, installation and hydraulics of backflow prevention devices. Understanding the pressure drop and flow restrictions.

Backflow prevention devices have become an integral part of the water supply asset. With the protection of the drinking water being paramount, backflow prevention is required by the Plumbing Code at any connection that is subject to being affected by a cross connection. The operation and subsequent restraints backflow prevention devices present is not well understood. This paper discusses the design requirements and the performance characteristics of Reduced Pressure Zone backflow prevention devices so that water supply personnel can be cognisant with potential issues before they occur.

Topics covered include:

- Backflow Basics
- Pressure drop Vs flow rate and the issues
- Installation guidelines
- Discharge from Reduced Pressure Zone valves

Backflow prevention devices are like smoke detectors. They both save lives. Ignorance in understanding how they operate within your network is not an excuse when the coroner knocks at your door.

## 1.0 INTRODUCTION

Backflow is the term used to describe the reversal of flow in a water supply pipe or system. Backflow prevention devices are used to protect drinking water from contamination where cross connections occur.

The Australian Plumbing Code Section 4 relates to Cross Connection Control and covers the design and use of backflow prevention devices. Australian State and Territory Governments reference the Australian Plumbing Code in their regulations therefore mandating the management and use of backflow prevention devices.

Since the introduction of backflow prevention devices to the plumbing code in 1998, it is estimated that there are more than 500,000 testable backflow prevention devices installed across Australia. Other than a few in the plumbing industry, many people responsible for managing and maintaining drinking water systems know little of backflow and how the devices affect the system.

This paper attempts to demystify backflow and presents the basics so that even non-plumbing people can understand how they interact with the water supply.

## 2.0 DISCUSSION

Whether a plumber, hydraulic designer, plumbing consultant, water officer, water engineer, contractor or property owner, there are several things you must understand when considering installing or requiring the installation of a backflow prevention device.

A backflow prevention device is a safety valve that protects the drinking water supply. They are used extensively but many people don't understand the operation or the limitations and constraints applicable to these devices.

The following topics need to be addressed when considering the use of a Reduced Pressure Zone Valve (RPZ) backflow prevention device.

- Backflow Basics
- Pressure Drop
- Flow rates
- Discharge from RPZs
- Installation Guidelines

### 2.1 Backflow Basics

#### **The Plumbing Code:**

AS/NZS3500.1-2015 is referenced in the National Construction Code, Volume 3, the Plumbing Code of Australia. Section 4 is Cross Connection Control and lays out the backflow prevention requirements mandated through legislation. When a State or Territory references the National Construction Code in their plumbing regulations, unless otherwise stipulated, it makes the use of backflow prevention devices mandatory.

#### **The Standard:**

Backflow prevention devices are Watermarked to AS/NZS2845.1-2010 or AS/NZS2845.1-1998. The Watermark is your assurance that the device has been manufactured and tested in accordance with the relevant Standard. If it does not have a Watermark it should not be installed in the drinking water network.

#### **Hazard Ratings:**

The Standard identifies 3 levels of hazard (the contamination or pollutant that can come in contact with the drinking water)

*High Hazard* – The pollutant or contaminant if ingested could kill you. Facilities connected to the water supply likely to have this level of potential contamination would include mineral processing, meat processing plant, hospital, mortuaries, plating works, etc.

*Medium* – The pollutant or contaminant if ingested is unpleasant and may make you ill. Facilities connected to the water supply likely to have this level of potential contamination include commercial buildings, schools, public parks, food processing plants etc.

*Low* – The pollutant or contaminant is non-toxic but is objectionable and should not be present in drinking water. Facilities connected to the water supply likely to have this level of contamination include residential homes, rainwater tanks etc.

### **Two types of cross connections:**

1- A direct connection. This is where the cross connection is 'hard piped' and is often installed by people unaware of the possible consequences. It could be a bypass line or a submerged tank filling connection.

2- An in-direct connection. The most common cross connection is a hose. A hose is an in-direct connection as the outlet can be used and left in all sorts of situations. For example, drain cleaning, chemical mixing, pipe flushing, pool filling etc.

### **Two types of backflow:**

Backsiphonage – the pressure in the supply line is reversed causing the water to be sucked or run backwards. This is usually caused by a water main break in the street but can be caused by mechanical devices that rely on venturi action to draw water from the supply line.

Backpressure – the water pressure within the facility is greater than the supply pressure. Causes can include high head pressure found in high rise building and at the top of hills and mechanical equipment failures.

### **Two types of backflow preventer:**

1-Testable – for use in high, medium or low hazard applications

2- Non- testable – for use in low hazard applications

Testable backflow prevention devices are designed to be able to be tested for operation effectiveness and for maintenance whilst installed inline and are suitable for use in high, medium or low hazard applications.

Non-testable devices need to be removed from line for maintenance and testing hence they are only suitable for installation in low hazard applications (see Table 1 for a list of common devices and the applicable hazard ratings).

**Table 1:**      *Common devices and the applicable hazard ratings*

Reduced Pressure Zone Device (RPZ)	Testable	High hazard applications
Double Check Valve (DCV)	Testable	Medium hazard applications
Pressure Type Vacuum Breaker (PVB)	Testable	Low hazard applications
Dual Check Valve (DUCV)	Non-Testable	Low hazard applications
Vented Dual Check Valve (DCAP)	Non-Testable	Low hazard applications
Atmospheric Vacuum Breaker (AVB)	Non-Testable	Low hazard applications
Hose Connection Vacuum Breaker (HCVB)	Non-Testable	Low hazard applications
Single Check Valve Testable (SCVT)	Testable	Medium hazard applications only on fire lines



## 2.2 Pressure Drop & Flow Rates

Backflow prevention devices rely upon pressure drop across the check valves for effective operation. The minimum spring differentials are stipulated in the Standard and all Watermarked devices must comply.

Testable backflow prevention devices are field tested for effective operation upon commissioning and at least annually by an accredited tester trained in backflow prevention.

Always check the manufacturers published literature for the pressure drop curve to ensure you have enough available pressure to supply the amount of water required. It is especially important where a fire connection is concerned.

The following examples are from manufacturers published literature and should be used as a minimum.

- 100mm Reduced Pressure Zone Valve at 20 L/s has a head loss of 68 kPa (*Apollo Valves All Valve Industries product catalogue page 7*)
- 100mm Double Check Valve at 20 L/s has a head loss of 20 kPa (*Apollo Valves All Valve Industries product catalogue page 6*)
- 100mm Double Detector Check Valve at 20 L/s has a head loss of 68 kPa (*Apollo Valves All Valve Industries product catalogue page 8*)
- 100 Single Check Valve Detector Testable at 20 L/s has a head loss of 57 kPa (*Pentair Valcheq backflow prevention catalogue page 4*)

These figures are devices only and do not include strainers or isolating valves. These values must be considered where pressure is limited. It is not unusual for a complete assembly comprising of isolating valves, strainer and the RPZ having a pressure drop close to 100 kPa.

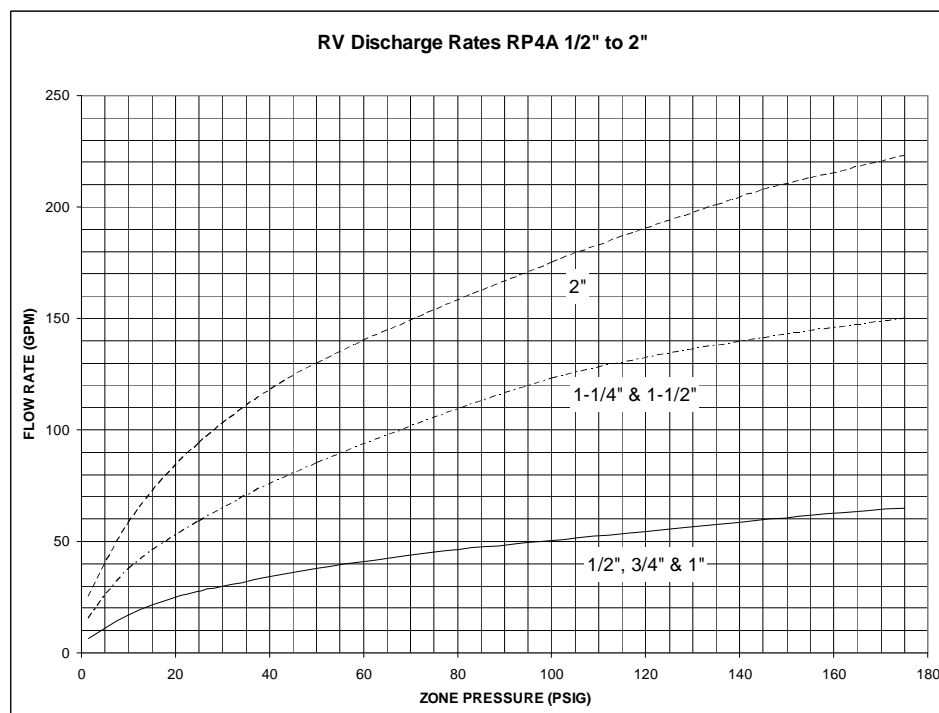
## 2.3 Discharge From RPZ Valves

All RPZ backflow prevention devices will dump water through the vent in the valve. It is a safety feature that ensures that if the device fails or there is a backflow event, the drinking water is protected.

The spillage of water is often inconvenient, but when installed where it cannot get away, it can become dangerous to property and humans.

All manufacturers publish the discharge rates applicable to their devices so be aware of these when you install an RPZ.

Otherwise you may have a flood on your hands as for example, a 50mm RPZ with a pressure of 700 kPa can discharge around 660 l/min, sufficient water to empty an Olympic sized swimming pool in 6 hours. See figure 1.



**Figure 1:** *Apollo Valves RPZ discharge Rates*

### 3.0 INSTALLATION GUIDELINES

Backflow prevention devices are mechanical devices that require regular testing and maintenance. To facilitate this, they must be installed where ease of access is available. The Standard addresses some aspects, but each manufacturer outlines specific installation requirements in their published literature.

The three questions you need to ask yourself are:

- 1 Is the device I am installing suitable for vertical and horizontal installation or just horizontal?  
Reduced Pressure Zone backflow prevention devices are designed to discharge water either during pressure fluctuations or mechanical failure. To not compromise the level of safety, they are to be only installed in the horizontal plane. There is no Watermarked RPZ device approved for vertical installation.
- 2 Is the device I am installing suitable for concealing in a valve box or pit?  
Due to the discharging of water, a valve box is susceptible to flooding. Once the water level covers the discharge vent, the valve is compromised and the safety reduced.
- 3 Does the device I am installing have ease of access for regular testing and maintenance without the need for special equipment or dismantling from the line?  
AS/NZS2845.1 2010 stipulates that testable backflow prevention devices are to be commissioned upon installation and tested at least annually to ensure effective operation. Work place health and safety guidelines would dictate that backflow prevention devices not be installed in confined spaces, near hazards, in elevated positions or in ceiling cavities.

## 4.0 CONCLUSION

It is an everyday occurrence where the installation of a backflow prevention device is utilised to protect the drinking water, but to other than a few trained professionals in the industry backflow prevention devices remain confusing and are not understood by the very people responsible for providing the safe drinking water.

With the Australian Plumbing Code being referenced in most State and Territory legislation, it is mandatory for backflow prevention devices to be installed to protect the drinking water.

Understanding what backflow is and the limitations of the various devices will not only allow you to satisfy your duty of care where these devices are used, but to be able to understand the impacts the installation of these have within your network.

Backflow prevention devices are like smoke detectors. They both save lives.

## 5.0 ACKNOWLEDGEMENTS

Thanks to Apollo Valves / Conbraco Industries and the numerous ‘unsung heroes’, the dedicated backflow professionals who have inspired me to develop this presentation.

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# IMPLEMENTING STRUCTURED SYSTEMS & PROCESSES TO SUCCESSFULLY MANAGE BACKFLOW



*Paper Presented by:*

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Central Highlands Water



*80<sup>th</sup> Annual WIOA Victorian Water Industry Operations  
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# IMPLEMENTING STRUCTURED SYSTEMS & PROCESSES TO SUCCESSFULLY MANAGE BACKFLOW

**Robert Dwyer**, *Technical Advisor Backflow Prevention*, Central Highlands Water

## ABSTRACT

Central Highlands Water (CHW) is one of Victoria's largest regional Water Corporations, providing water and wastewater services to a population of approximately 142,000 people, through almost 70,000 water connections.

CHW, like all Victorian Water Corporations, is responsible for delivering safe quality drinking water to its customers and communities.

Victorian Water Corporations are heavily regulated and must be able to demonstrate that they have systems and processes in place to eliminate any potential for contaminants to enter its potable water supplies, by way of backflow.

Backflow is referred to as the reversed flow of water from its intended direction, and is safeguarded by installing Backflow Prevention Devices (BPD's) to metered water supplies of properties posing a risk to the drinking water networks.

The aim of my presentation is to provide an insight into implementing structured systems and processes to successfully manage backflow, enhancing our ability to effectively manage risks, deliver safe quality drinking water to our communities, and comply with regulations.

## 1.0 INTRODUCTION

In November 2010, CHW identified that in order to deliver safe drinking water to its communities, it needed to increase its focus in the area of backflow prevention by implementing a dedicated 'Backflow Prevention Program'.

Although backflow prevention had been managed within the business previously, the focus and accountability needed to be clearer to enhance our ability to demonstrate regulatory compliance.

The program was implemented in May 2011, with three existing in-house Civil Maintenance Employees seconded to the role as Backflow Officers (in addition to their substantive roles). The intention was for the Backflow Officers to rotate through the program on a weekly basis, ensuring that the program was managed with full time coverage (40 hour week).

The main objectives of the Backflow Prevention Program would be to protect the community's drinking water supplies by applying a risk based approach and ensuring CHW could demonstrate regulatory compliance by:

- Identifying industrial and commercial properties that had the potential of contaminating potable water supplies through the processes conducted on site
- Assessing the on-site productions / activities being undertaken at these properties
- Advising property owners of their obligation to install and test BPD's to the water supply at the property boundary (connected to the water meter – also referred to as containment devices within this paper).

- Monitoring the progress of BPD installations within the Backflow Device Management System (BDMS)
- Entering BPD installation details into the Backflow Device Register (BDR)
- Maintaining the BDR (ensuring information was captured for all containment devices connected to potable water supplies)
- Receiving and filing Backflow Test / Inspection Reports and,
- Creating annual test inspection schedules.

In October 2015, an internal review of CHW's Backflow Prevention Program found that after conducting on-site assessments at almost 1200 properties, 235 metered water supplies were identified as requiring backflow protection (19.6%).

Of the 235 identified services requiring backflow protection, approximately 60 services still required backflow protection, equating to almost 25% of the identified water supplies still posing a risk to potable water supplies.

The review also uncovered that we needed to increase our focus towards the administrative aspects of the program such as the receipt of Backflow Test Reports.

The initial outcome of the internal review resulted in CHW advertising internally the position of 'Technical Advisor Backflow Prevention', with the successful candidate being appointed to the 6 month secondment role in November 2015, to provide focus, energy and outcomes.



**Figure 1:** *A Carwash was identified as requiring the installation of a 50mm RPZD Backflow Prevention Device – connected to water meter*

## **2.0 DISCUSSION**

### **2.1 Technical Advisor Backflow Prevention – 6 Month Secondment**

The role of Technical Advisor Backflow Prevention was created to achieve a number of business objectives, with the key accountabilities of the role being:

- Ensure that the remaining 60 identified water supplies requiring backflow protection were installed prior to the next Safe Drinking Water Act Audit (conducted by independent approved auditor in May 2016)
- Enhance the capability of backflow management by creating a Backflow Device Register within the newly installed Asset and Property Information database (Infor Public Sector – IPS)

- Implement structured processes to successfully manage CHW's Backflow Prevention Program
- Maintain a register of all containment devices connected within CHW's water networks
- Improve CHW's compliance performance around receiving and filing Test Reports and,
- Be able to demonstrate regulatory compliance.

At the completion of the 6 month secondment period (31 May 2016), all but 5 of the remaining BPD's to be installed had been connected, increasing the number of containment devices registered within CHW's Backflow Device Register to approximately 700.

New systems and processes had been implemented enhancing our ability to record BPD details within the BDR, receive and file test reports, create testing schedules, and link the location of all containment devices to be viewed within CHW's Geographical Information System (Dekho).

Although we were unable to quantify our compliance performance prior to the review, our process around collection and filing of test reports had improved to the point where 100% compliance was now an achievable target.

The business recognised that the intended objectives of our Backflow Prevention Program were being achieved, and the secondment period was extended until the position was advertised and filled as a full time role in March 2017.

## **2.2 Implementing Structured Systems to Successfully Manage Backflow**

The success of managing backflow relies heavily on the implementation of structured systems that are easy to use.

Ideally, backflow prevention would be managed within a single system however, due to the complexity of the task, multiple systems are generally necessary.

Systems need to have the capability of storing accurate information that enables water corporations to effectively manage their backflow programs and demonstrate regulatory compliance through an auditable process.

The systems must be capable of recording property information including up to date property ownership and contact details for communication purposes. This may require system integration.

Regulatory compliance also requires the systems to record and store information such as:

- Containment device details (size, type, model and serial numbers)
- Location of device (property address – description of location is also valuable example: McDonalds Restaurant - located at water meter in garden area, inside cage, off Albert Street – connected to service number 73407)
- Annual testing schedules
- Copy of annual test reports (including date of test)
- Evidence of annual test reminder letters sent to property owners.

Water Backflow Preventer				
Backflow ID* 294				
Asset Description				
32MM CONBRACO BACKFLOW PREVENTION DEVICE - SERIAL NUMBER SM697				
Water Backflow Address				
Address	Flat #	House #	Street Name	Type
		32	Albert	ST
		Cross Street		
		Cross Street		
		City, State, Postal Code	SEBASTOPOL	
Backflow Type* RPZD		Model #	CONBRACO	
Backflow Size		32.00	Serial #	SM697
Location				
RESTAURANT - LOCATED AT METER IN GARDEN AREA, INSIDE CAGE, OFF ALBERT STREET - CONNECTED TO SERVICE ID 73407				

SCHEDULE INFORMATION	
Schedule Type	Months
Interval	12
Next Scheduled	9/05/2018
Last Completed	9/05/2017

**Figure 2:** *Example of information required within the Backflow Device Register*

## 2.3 Implementing Structured Processes to Successfully Manage Backflow

The success of managing backflow is also reliant on the implementation of structured processes.

As previously mentioned in the introduction, there are numerous processes required to ensure that water corporations deliver safe quality drinking water to its communities and comply with regulations.

For example, there are existing industrial and commercial businesses within CHW's region that pose a risk to the potable water supplies through their on-site processes and activities.

A large majority of these businesses have BPD's connected to their metered water supplies however, many do not.

There are also new properties and businesses being developed that require backflow protection.

Although the processes for the abovementioned scenarios have similarities, the processes do vary, and could be categorised as:

- Existing device process (managed through the BDR)
- Retrofitting process (installing containment devices to existing properties identified as posing a risk to the potable water supply)
- New connections process (managed through the application to connect / consent process).

## 2.4 New Connections Process (CHW)

Copies of consent applications are forwarded to the Technical Advisor Backflow Prevention (TABP).



Where backflow protection is required, the TABP:

- Contacts Plumber and records intended date of connection on the consent application
- Creates a backflow device for the property within the BDR as 'PENDING'
- Enters device details upon receiving the installation / test report (status updated from PENDING to IN SERVICE)
- Creates an inspection and enters date of inspection within the BDR
- Test Report filed electronically under individual property file (within Records Management System - TRIM)
- Create annual inspection within BDR (12 months from installation / initial test date)
- Link Test Report from TRIM into the device history page of BDR.

## **2.5 Retrofitting Process**

Industrial and commercial properties are identified as requiring backflow protection through a process targeting high risk properties. Occasionally, water corporations will be advised by qualified plumbers of properties requiring backflow protection.

The process is the same as the new connections process apart from the initial steps in that:

- The property owner is advised of their obligation to have a BPD connected to their metered water supply/s within 28 days of being notified
- Payment arrangements are offered to property owners where the cost of the installation may be unaffordable (subject to a signed letter of agreement)
- CHW pays the Plumber for the installation and recovers costs by way of invoice (under payment arrangement process only).

## **3.0 CONCLUSION**

In summary, the number one focus of any Backflow Prevention Program should be to deliver safe quality drinking water to our customers and communities.

Although the success of the program will be measured by the water corporation's ability to demonstrate regulatory compliance through an auditable process, it is the structured systems and processes that are most critical to achieving the desired outcomes of delivering safe quality drinking water and complying with Safe Drinking Water regulations.

The programs require dedicated resources, with a heightened focus and energy towards customer engagement and collaboration to ensure property owners comply with their obligations and the Corporations requests.

The role in which qualified plumbers perform should also not be underestimated, as their contribution from the assessment and installation stage through to providing test reports and compliance certificates to the water corporations is critical to the success of our Backflow Prevention Programs.

Finally, strive to achieve the desired outcomes. Be innovative in your approach and regularly review the performance of your program (at least annually).

#### **4.0 ACKNOWLEDGEMENTS**

I would like to acknowledge and thank Central Highlands Water and all of the people within the business that have provided me with on-going support and guidance.

A special thank you my industry peers Jim Fontana (Yarra Valley Water), Guy Russo (City West Water), Trevor Hayes (Western Water) and Colin Vickers (South East Water) for their support and willingness to share information.

To the Plumbers that have contributed to the success of CHW's Backflow Prevention Program – thank you.

And finally, I would like to thank Peter McLennan (National President) and Andrew Meade (National Secretary) of the Backflow Prevention Association of Australia for their support and the opportunities in which they have afforded me.

# **HAPPY NEW HARE – HAVE YOU HEARD ABOUT THE RABBIT IN THE BASIN?**



***Paper Presented by:***

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# HAPPY NEW HARE – HAVE YOU HEARD ABOUT THE RABBIT IN THE BASIN?

**Rachael Brownstein**, *Treatment and Environment Systems Officer*, East Gippsland Water  
**Renwick Chan**, *Technical Compliance Officer*, Department of Health and Human Services

## ABSTRACT

On 3 January 2017, a dead rabbit was found in the Cann River clear water storage (CWS) during routine water sampling. Due to the potential risk of contamination in Cann River's drinking water supply a section 22 report was issued under the *Safe Drinking Water Act 2003*. In consultation with the Department of Health & Human Services (the department), East Gippsland Water (EGW) issued a boil water advisory (BWA) to the Cann River community. This paper highlights the collaborative partnership between EGW, the department and the community in managing the incident to protect public health and discusses challenges encountered during the process. This case study also highlights the effective communication of a BWA to a small community.

## 1.0 INTRODUCTION

Cann River is small town located 165 km east of Bairnsdale, Victoria, Australia and approximately 450 km east of Melbourne (Figure 1). EGW provides drinking water services to 180 connections in Cann River by extracting raw water from Cann River, treating the water through a Dissolved Air Flotation and Filtration treatment process before storing the treated water in a shade cloth covered CWS. Treated water is then disinfected with Sodium Hypochlorite prior to supply.



**Figure 1:** *Cann River Location Map*

On 3 January 2017, routine water sampling was conducted at the Cann River CWS. A visual inspection inside the CWS identified a dead rabbit. The rabbit had dug under the shade cloth of the CWS and made its way into the treated water and drowned (Figure 2). The dead rabbit was removed immediately from the CWS. On inspection it was evident that the rabbit had not been in the storage too long as there was no sign of decay.

As a result of the potential health risks posed by this event, EGW reported the issue under section 22 of the *Safe Drinking Water Act 2003* to the department at 12 pm on 3 January 2017. EGW and the department then worked together to analyse any potential risks associated with the dead rabbit in the CWS and the corrective actions required to manage these risks.

Based on the available information, in consultation with the department, EGW issued a BWA to the Cann River community on 3 January 2017. This BWA was lifted in consultation with the department on 13 January 2017 when these risks were mitigated.

## **2.0 DISCUSSION**

Upon being notified of the incident, the department worked with EGW to identify the potential *Cryptosporidium* risk to the Cann River drinking water supply and the corrective actions necessary to ensure the safe supply of drinking water to Cann River. The following describes the thought process, decisions and actions taken by EGW and the department during the incident.

### **2.1 Management**

The presence of the dead rabbit in the CWS triggered EGW to respond by initiating an Emergency Operations Centre at the head office in Bairnsdale. The incident was treated as a moderate (Level 2) incident due to external agency involvement. The incident management team consisted of an incident controller, operations coordinator, planning coordinator, communications coordinator and site managers. This structure was effective in ensuring consistency and defined communications lines for managing the incident.

For the department, the incident was managed by the Water Unit and communication materials through its Media Unit. Incident updates were provided by EGW via emails and teleconference calls. The department's Secretary, Chief Health Officer and the Minister for Health were kept informed throughout the incident.

### **2.2 Controlling the Potential Risk - Implementing the Boil Water Advisory**

The following factors were considered in assessing the potential risk to the Cann River drinking water supply:

- Precedence – Pitsford, UK *Cryptosporidium* Outbreak (June 2008) – A single rabbit gaining access to a water tank resulted in a boil water alert for 250,000 people.
- Uncertainty – Unknown duration of the dead rabbit in Cann River's CWS basin. The uncertainty relating to the prevalence of pathogenic micro-organisms including *Cryptosporidium cuniculus* in rabbits.
- Precautionary approach – The need to isolate and remove the contamination source, flush the reticulation system, verify the safety of the drinking water through water sampling following completion of corrective actions.

Based on these factors, EGW and the department agreed a BWA for this incident was appropriate. Following advice from EGW's communications team, relevant stakeholders and the community were notified via messages on the EGW website, Facebook and a comprehensive door knock and letter drop program to the 180 connections. This strategy for informing the community was supported by the department, with all published information reviewed by the department and the Department of Environment, Land, Water and Planning (DELWP) prior to its distribution.

EGW personally delivered letters to the Cann River community during the incident which commenced on the afternoon of 3 January 2017. The letter drops were frequent to ensure the community was well informed.

Bottled water was also delivered to each property and the town by EGW.

The Cann River community centre was a key stakeholder to assist with the delivery of the BWA messages. It published EGW's situation updates on its Facebook page. The page's already strong following from the community made it a more suitable platform to inform residents than EGW's Facebook page. The community centre also acted as a central point for the delivery of bottled water to residents, who were able to access the water 24 hours a day without EGW supervision.

The response from the Cann River community was positive with the majority remaining un-phased by the need to boil their water. EGW was transparent in outlining the cause of the issue, which often resulted in community members telling their personal experiences with their private water tank. The delivery of bottled water by EGW was much appreciated by the community, with approximately 2,700 bottles of water delivered to Cann River by EGW over the period of the BWA. This was necessary to ensure the community continued to have access to sufficient drinking water, particularly given the warm weather conditions experienced at the time.

The department commended EGW on its efforts in rolling out the community engagement plan for this incident, an excellent example on how to effectively engage with a small community. The BWA was lifted on 13 January 2017, 10 days after it was issued.

## **2.3 Isolation and Containment**

Due to the design of the Cann River Water Treatment Plant and low water demand at the time, EGW was able to isolate the CWS by allowing treated water to bypass the CWS and be directly fed through small storage tanks and into the reticulation system after chlorination. This was advantageous as EGW could address the CWS and reticulation system separately. This minimised the impact to customers by maintaining an uninterrupted water supply. Once the reticulation system was flushed and the safety of the water supply was guaranteed, the BWA could be lifted.

## **2.4 Rectification**

### **2.4.1 Reticulation System**

EGW initially experienced some difficulties with isolating the CWS due to a valve leak in the connection between the CWS and the reticulation system. This allowed a very small amount of water from the CWS to continue to enter the reticulation system.

Once the CWS was fully isolated, EGW and the department determined how best to rectify the reticulated system. Super chlorination of the system was considered by maintaining a free chlorine concentration greater than 10.0 mg/L for a time adequate to inactivate any *Cryptosporidium* which potentially may have been present. However, it was agreed by both parties that the risk of chlorine residuals above the Australian Drinking Water Guidelines (ADWG) chlorine health based guideline value of 5.0 mg/L posed too great a risk regarding potential consumption.

It was determined flushing the reticulation with a volume of water equivalent to three times its capacity, along with an increased free chlorine level (below 5.0 mg/L), would be appropriate.

This would flush approximately 212 kL of water through the system and ensure any potentially contaminated water was removed. During this flushing, an elevated free chlorine residual (greater than 2.0 mg/L) in the reticulation system was maintained. Following flushing, sampling and analysis was carried out in the reticulation system to verify that the water met drinking water quality parameters prior to lifting the BWA.

#### **2.4.2 Clear Water Storage**

Cann River's CWS has a volume of 3.4 ML. It is clay lined with rock beaching and has a maximum depth of 2.5m. The CWS is covered with an Ozone 2000 shade cloth with a UV rating of ~95%. To manage contamination risks posed, super chlorination was determined necessary.

Studies have shown a chlorine residual and contact time (Ct) between 10,400 mg.min/L and 15,300 mg.min/L with free chlorine at pH 7.5 is required to achieve a 3 log reduction of *Cryptosporidium* oocysts<sup>2</sup>. For the Cann River CWS basin, a target Ct of 14,400 mg.min/L was selected. This was achieved by dosing a free chlorine residual of 10.0 mg/L for 24 hours (1,440 minutes). The minimum 10.0 mg/L free chlorine was selected, as 1.7ML of diluted super chlorinated basin water would need to be supplied and the residual at the customer must be below the ADWG health-based guideline value of 5.0 mg/L.

To achieve the Ct of 14,400 mg.min/L in the CWS, it was calculated 250 L of Sodium Hypochlorite would be needed. Dosing was initially conducted by pumping the Sodium Hypochlorite from a chemical delivery truck into the basin. Sodium Hypochlorite was also manually added using carboys into the CWS. To determine the dose effectiveness, monitoring was conducted at 6 sample points in the CWS (Figure 3). Difficulties were encountered in evenly distributing the chlorine through the basin due to a lack of mixing. Monitoring revealed a difference in chlorine residual between basin levels. However, at no point was 10.0 mg/L close to being reached. Results close to 0.0 mg/L of residual chlorine resulted following the 250 L dosing. It was theorised that organic components in the CWS had absorbed all the chlorine.



**Figure 2:**      *Sample locations in Cann River CWS*

Super chlorination continued with another 300 L of Sodium Hypochlorite added to the CWS over a 24 hour period (Table 1).

This was achieved through an operator manually emptying 20 Sodium Hypochlorite carboys into the CWS over a 24 hour period. A mixing pump was also deployed to distribute the chemical throughout the basin. This achieved a chlorine residual greater than 10.0 mg/L for all 6 sample sites (Table 2). Sodium Hypochlorite was added at sample point 6 (Figure 3), which was located at the bottom of the CWS. Because Sodium Hypochlorite sinks, the chlorine residual was much higher at sample point 6 than any other sample site (Table 2).

**Table 1:** *Volume of Sodium Hypochlorite added*

Time added <b>Tuesday 10 January 2017</b>	Volume of Sodium Hypochlorite added (L) (13.3% available Chlorine)
10:30	75 L
12:00	45 L
13:30	30 L
15:00	30 L
16:30	30 L
18:00	90 L
<b>Total</b>	300 L

**Table 2:** *CWS free chlorine residual results over a 24 hour period*

Date	Time	Sample Point Free Chlorine Residual (mg/L)					
		1	2	3	4	5	6
10 January 2017	10:30	11.4	10.2	15.6	11.6	15.1	18.7
	12:00	10.8	13.2	13.8	12.0	12.6	15.6
	13:30	10.2	11.4	12.6	10.8	10.6	13.8
	15:00	11.6	13.7	13.2	11.6	11.2	15.9
	16:30	10.2	10.6	10.8	10.2	10.6	12.6
	18:00	10.4	11.8	11.2	10.4	16.4	21.8
	23:00	12.6	14.2	13.6	12.6	12.4	23.6
11 January 2017	06:00	13.8	11.9	12.6	10.8	14.7	31.4
	09:00	11.8	12.9	12.0	13.2	12.8	14.6
	10:30	10.9	11.8	11.8	12.7	12.1	13.6

After the Ct of 14,400 mg.min/L was achieved, the CWS was half emptied by pumping the super chlorinated water out of the basin and releasing it within the surrounding farm paddocks with approval from the farmer. EGW determined this to have a low environmental impact. The CWS was then refilled with treated water. The CWS returned to service on the 6 February 2017, following sampling results that verified the safety of the water where all parameters were confirmed to be well within water quality parameter limits in the ADWG.

The use of Sodium Thiosulphate to reduce chlorine residual in the basin water and increase EGW's ability to flush the reticulation system was discussed. This was not adopted as the water quality risk associated with the addition of Sodium Thiosulphate into the drinking water supply was unknown, given it is currently not an authorised drinking water chemical in the ADWG.

Operationally, flushing the system and super chlorinating the basin was resource intensive. Cann River is run by staff in Mallacoota, one hour's drive away.



It is also a two hour drive from the Bairnsdale head office. As a result of its distance, multiple staff were required to make long trips, work long days and in some instances have a night over at Cann River. Consequently EGW was highly conscious of fatigue management and Occupational Health and Safety impacts.

## **2.5 Monitoring**

Water quality monitoring took place before, during and after rectification. In addition to regular chlorine monitoring in the CWS and the reticulation system, EGW sampled for E.coli, *Cryptosporidium* and *Giardia*. This was also a resource intensive process, requiring staff to drive a whole day to hand deliver samples on time and directly to the laboratory in Melbourne from Cann River.

*Cryptosporidium/Giardia* sampling and testing pre- and post-super chlorination returned negative results. The pre-testing result indicated the protozoan risk from the contaminated water was likely to be low. Despite these results, the precautionary approach was to super chlorinate the CWS and flush the Cann River water supply system to address any potential protozoan risk.

## **3.0 CONCLUSION**

To prevent a similar incident, EGW has completed remedial works on all shade cloth-covered storages to further restrict animal access. EGW has also initiated works to replace the CWS basin with a tank to minimise the risk of animal access.

EGW has inspected all shade cloth covered CWSs across its network and repaired or modified a number of the shade cloths. EGW has also included the replacement of a number of shade cloth CWS's with tanks within its draft 2018 Price Submission to the Essential Services Commission.

EGW and the department look positively on how this incident was managed. Not only was public health protected. The outcome of the intensive efforts involved in communicating and collaborating with the small Cann River community and relevant stakeholders has built on the relationship EGW has with the community, the department and DELWP. Trust and satisfaction in EGW's services and ability to manage water quality incidents have been enhanced as a result of this incident.

## **4.0 ACKNOWLEDGEMENTS**

EGW and the department would like to thank all staff members and the Cann River community who assisted in this incident.

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# **CASE STUDY: HAVELOCK NORTH, NEW ZEALAND – WATERBORNE DISEASE OUTBREAK**



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# CASE STUDY: HAVELOCK NORTH, NEW ZEALAND – WATERBORNE DISEASE OUTBREAK

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## ABSTRACT

In August 2016 the town of Havelock North, New Zealand, witnessed the worst recorded waterborne disease outbreak in the country's history. The incident occurred after a period of heavy rain involving a groundwater source that was believed to be secure. The outbreak resulted in more than 5,500 individuals becoming ill from *Campylobacter jejuni*. More than 40 individuals were hospitalised and 3 deaths have been attributed to the outbreak.

The management of the water supply system and responsibilities for public health protection in the region are complex and the initial media response and blaming for the outbreak resulted in confusion amongst the residents. Conclusions from multiple investigations showed that sheep manure from a farm located close to the drinking water supply caused the outbreak.

In September 2016, an independent inquiry was established into the incident. Stage 1 of the inquiry sought firstly to clarify responsibilities, establish the cause of the incident, the facts of the outbreak and how it was managed, and then to consider this in the context of what should have happened, what should have been known and if any fault or systematic failures could be identified. Stage 1 of the inquiry has concluded with a report published in May 2017.

Stage 1 of the Inquiry attributed failings to all parties who had duties to protect the safety of the drinking water supply and found there had been significant failures in the assessment of risk. The report also suggests that a more collaborative relationship between the District Council and Regional Council may have prevented the outbreak.

## 1.0 INTRODUCTION

Information for this paper has been drawn from multiple web sites that are listed in the Appendix and the evidence presented at the Government Inquiry into North Havelock Drinking-Water at [www.dia.govt.nz/Government-Inquiry-into-Havelock-North-Drinking-Water](http://www.dia.govt.nz/Government-Inquiry-into-Havelock-North-Drinking-Water)

Havelock North is a town of approximately 14,000 people on the East Coast of the North Island of New Zealand. It is part of the tourist area of Hawke's Bay and within the urban area of Hastings District which has a population of more than 75,000. It is a wine growing and farming region with approximately 800mm annual rainfall.

The drinking water supply for Havelock North comprises groundwater from three bores in the Brookvale borefield that draws water from the Te Mata aquifer (Figure 1). According to the Drinking Water Standards for New Zealand, the water supply is considered "secure". Of the three bores, one is 17 years old and two are 30 years old. The water was supplied to consumers fluoridated but not chlorinated, with *E.coli* monitoring undertaken every 2 days. The bores are operated by the Hastings District Council and it has been reported that one of the bores was shut down in 2015 due to detection of *E.coli*.

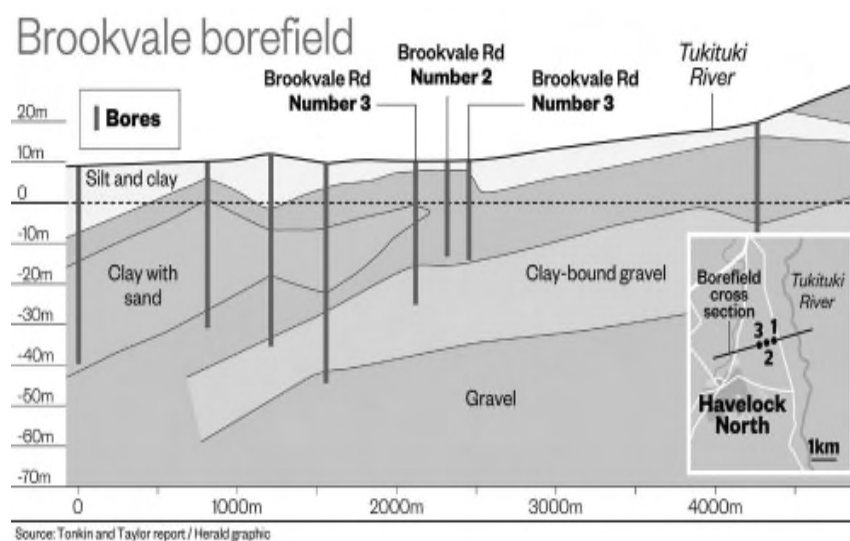
The waterborne disease outbreak occurred over a two week period in August 2016.

New Zealand has about 50 waterborne outbreaks associated with drinking water per year with the Havelock North event representing the largest recorded outbreak. Recorded outbreaks are generally small, with an average of about 8 people affected.

The Brookvale borefield that was the centre of the 2016 incident had previously been implicated in a waterborne disease outbreak. In July 1998, 80 individuals were sickened from *Campylobacter* and Bore 2 was implicated.

The 2016 outbreak has been linked to heavy rain on Friday 5 August, which inundated paddocks and filled a pond in proximity to Bore 1. This contaminated water then entered the aquifer. During the rain event, there was significant local flooding and power failures. Routine *E.coli* testing was all clear from samples analysed on Tuesday 9 August but presumptive *E.coli* was reported in water samples on Friday 12 August – received at 10:30am. The Hastings district council Mayor was notified on that same afternoon and a decision to chlorinate was made at 3pm. A boil water advisory was issued at 6pm on Friday 12 August.

Additional monitoring detected *E.coli* in Bores 1 and 2 on Saturday 13 August and over the weekend *Campylobacter* was confirmed as the cause of the outbreak. By the time the agent for the outbreak had been identified, dozens of individuals had been hospitalised and several thousand had experienced gastroenteritis. As early as Thursday 11 August, local schools were noticing absences, with up to 120 students reporting as being ill.



**Figure 1:** *Brookvale Borefield*

## 1.1 Water Utility Response

The Hastings District Council quickly moved to chlorinate the affected water supply and provided tankers of drinking water from nearby Hastings. In an unrelated incident, one of the tankers returned a presumptive positive result for *E.coli*. This resulted in the Hastings water supply having to be chlorinated and boiled as well. The boil water order was lifted on 3 December, but chlorination was to remain in place for 3 months. A UV treatment system as now been commissioned for the borefield.

A detailed investigation of the borefield and potential sources of contamination was undertaken after the outbreak.

Media speculation and finger pointing at first suggested a local mushroom farm was responsible, then ingress from the Tuki Tuki River. Dye tracer tests carried out in 2017 at a small dam the “Mangateretere Pond” situated approximately 90m from Bore 1 identified the pond water as impacting the bore. *E.coli* and *Campylobacter* were detected in the pond and the outbreak genotype detected in sheep nearby.

## **1.2 Community Costs**

As of January 2017, the costs to the community were considered to be approximately \$2.7M as follows. These costs do not include compensation from individuals or the final outcomes from the Government inquiry.

- Clinical supplies - \$31,000
- Hydration management - \$18,000
- Administration and communication expenses - \$28,000
- Lab expenses - \$8000
- Legal expenses - \$270,000
- Surveys - \$36,000
- Staff sickness - \$216,000
- Staff cover and costs - \$330,000 - (e.g. covers public health, SMO cover, ED and ICU expenses)
- Government Inquiry - \$637,000 (Jan 2017).

## **1.3 Regulatory Framework**

New Zealand’s *Health Act 1956* is the primary legislation for the safety of drinking water supplies and is supported by *Guidelines for Drinking-water Quality Management for New Zealand* and *Drinking-water Standards for New Zealand 2005 (revised 2008)*. The framework establishes a role for drinking water assessors to ensure compliance of water suppliers with the legislation and standards, and monitor implementation of their water safety plans. Drinking water suppliers include district councils and communities.

Water suppliers may gain access to water sources managed by regional councils through a resource consent permit issued under the *Resource Management Act 1991*. Regional councils are able to apply conditions on a consent.

In this case, the water supplier was the district council who had a resource consent permit from the regional council for extraction from the aquifer.

## **1.4 Government Inquiry**

On 12 September 2016, New Zealand’s Attorney General announced the establishment of an independent inquiry into Havelock North Drinking Water Supply contamination incident. Stage 1 of the inquiry has concluded with a report published in May 2017. However the inquiry continues and Stage 2 takes on a much broader focus including the scope and efficacy of the regulatory framework.

Stage 1 of the inquiry sought firstly to clarify responsibilities, establish the cause of the incident, the facts of the outbreak and how it was managed and then to consider this in the context of what should have happened, what should have been known and if any fault or systematic failures could be identified. The findings of the inquiry (Stage 1) are discussed in the following section.

## 2.0 DISCUSSION

The Stage 1 Inquiry report, released in May 2017, confirmed that the cause of the outbreak was *campylobacter* from sheep faeces being washed into a pond as a result of heavy rain which then infiltrated the aquifer and potentially flooded the bore chambers.

The Inquiry proceeded to attribute failings to both persons and organisations involved in the safety of the drinking water supplies including a consultancy operating as a technical adviser. This analysis recognised the importance of a multi-barrier approach and the multiple organisations involved in implementing this.

The key themes that emerged were:

- Regulatory oversight
- Quality of risk assessments
- Cross-agency collaboration
- Contingency planning.

The following discussion will summarise the elements identified under each of these themes by the inquiry and consider this in the Victorian context.

### 2.1 Regulatory Oversight

The District Council's Water Safety Plans were required to be approved, and their implementation monitored, by a drinking water assessor. Water safety plans remain in force for a maximum of 5 years. The district council had an approved Water Safety Plan (2015) at the time of the outbreak, however the adequacy of the plan and its implementation was found to be insufficient by the Inquiry.

The inquiry found that the drinking water assessor's approach was not forceful enough both in applying the drinking water standards and ensuring the district council met its responsibilities of its water safety plan and emergency response plan. The drinking water assessor had knowledge of significant information missing from the plan including a previous outbreak and a large number of *E.coli* detections in the system. The contingency planning by the district council was known to be lacking and various requests had been made to the district council over previous years to request one be developed and implemented.

Regulatory oversight in a risk-based management model, as is applied to drinking water supplies both in Victoria and elsewhere, relies on proactive engagement and requires a significant amount of liaison between the water supplier and the regulator. The investment in this type of regulatory relationship is a joint effort from both parties to see the value this can bring. The nature of Victoria's water industry lends itself to development of significant expertise within water businesses and therefore this regulatory model. Stronger approaches involving the use of statutory powers may be necessary at times to protect public health.

### 2.2 Quality of Risk Assessments

The Havelock North drinking water supply had been the cause of a *campylobacter* outbreak in 1998. The district council had repeatedly detected *E.coli* in the Havelock North system as well as an adjacent water supply drawing from the same aquifer.

This information was known to the district council but had not been shared with the regional council. The district council relied on the security of the source and the regional council was responsible for managing risks to the aquifer. Information sharing may have provided the regional council the opportunity to reassess the risks to drinking water safety with regard to the aquifer.

Regardless, the Inquiry found the regional council's knowledge and awareness of aquifer contamination risks to be below the required standard. The Inquiry stated "it appears nothing was learned from the July 1998 outbreak. The District Council, as the water supplier, did not take the 1998 outbreak seriously enough and implement enduring, systemic changes. Memory of the earlier outbreak simply faded."

The district council did not record the 1998 outbreak in its risk assessment. The Inquiry said that the risk rating assigned for the consequence of contamination "substantially underrated the impact of a waterborne contamination incident on the community." The district council had engaged a technical advisor to assess bore head security but did not provide a copy of the water safety plan.

The regional council, the district council and the district council's technical advisors each had roles in the assessment of risks to the drinking water supply and the inquiry found that in varied ways all three parties failed to adequately assess these risks.

The Inquiry provides an opportunity to reflect on the risk assessment approach. Robust risk assessment of drinking water supplies requires assessment of the evidence and past performance, participation from all relevant organisations involved in the management of the multi-barrier system and an adequate understanding of the consequences.

In the Victorian regulatory model a culture of continuous review and improvement is embedded in the requirement of risk management plans. This approach, in comparison to a review every five years, encourages timely updates to plans in light of new evidence and recent events. Examples such as this case study provide the industry with an opportunity to reflect on the true nature of the severity of the consequences for their risk management plans.

## **2.3 Cross-agency Collaboration**

In order to manage the risks to the safety of the drinking water supply, the district council and regional council needed to have a collaborative and cooperative relationship. The Inquiry found that this was not the case for the Havelock North supply and that a better relationship with meaningful collaboration between the two agencies may have resulted in a different outcome.

The district council's water safety plan identified the need to work with the regional council, however this had not been implemented. Notably the regional council remained unaware of the significant number of *E.coli* detections by the district council which could have prompted further investigation on source security.

This provides the Victorian water sector with an opportunity to reflect on the quality and nature of relationships with other organisations who should be involved with the management of drinking water supplies. Particularly in the protection of source waters, there may be further opportunities for information sharing and meaningful engagement.

## **2.4 Contingency Planning**

The Inquiry found that the district council had no emergency response plan to deal with an event such as the Havelock North outbreak. There was no contingency plan, draft boil water notices or communications plans prepared though the water safety plan referred to these and the drinking water assessors had requested their preparation on various occasions.

The Victorian framework requires contingency plans to be prepared by water agencies as a part of their risk management plans. While all water agencies in Victoria have contingency plans in place, these plans have rarely been tested in anger. These plans also need to be kept under continuous review to consider changes to availability of contingency arrangements, currency of boil water advisory content and adequacy of communication plans as communication methods expand and evolve. The complexity of community demographics and varied access to communication tools requires careful consideration in such plans.

## **3.0 CONCLUSION**

The Havelock North Government Inquiry provides an opportunity for water agencies in Victoria to reflect on the practices and approaches to management of drinking water supplies and assessment of risk. It is a timely reminder about the importance of collaborative relationships with other organisations, quality of risk assessments and preparedness for management of events affecting the safety of drinking water supplies. The costs to the community are too high if the system fails and confidence in the safety of the water supply may never be regained.

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