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WaterWorks
OFFICIAL JOURNAL OF THE WATER INDUSTRY OPERATORS ASSOCIATION OF AUSTRALIA

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WaterWorks welcomes the submission of articles relating to any operations area associated with the water industry. Articles can include brief accounts of one-off experiences or longer articles describing detailed studies or events. Submissions may be emailed to peter.mosse@gmail.com or info@wioa.org.au

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OPERATOR CERTIFICATION – ARE YOU ON BOARD?

George Wall

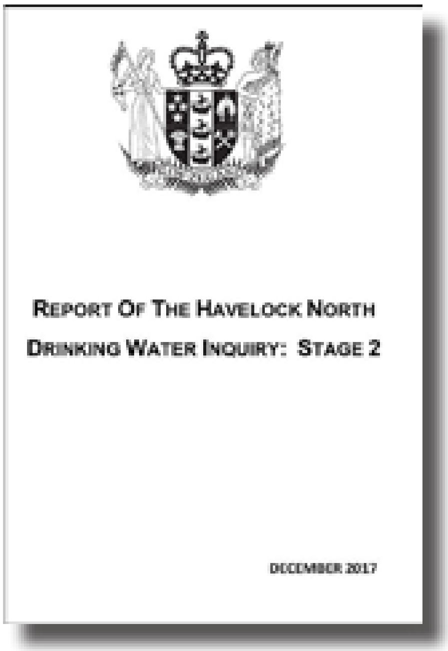
We live in a highly regulated society. There are laws, rules and regulations that control almost every activity we undertake in our daily lives. Our water industry is no exception, with a myriad of Acts, regulations, policies and procedures that all must follow to ensure the safety and quality of our services to the community.

Amongst all these external requirements, at present none of our health or environmental regulators have mandated minimum levels of training or experience for water, wastewater or recycled water operators. Although referred to in some regulatory documents, in the main, the decision about what is appropriate operator training, skills development and experience is left for the determination of the individual Water Utilities.

The situation in Australia seems to be mirrored overseas as well. The recently released Stage 2 Report from the Inquiry into the Havelock North water quality incident in New Zealand, which occurred in August 2016, caused illness to over 5000 residents and was linked to three possible deaths, contains 51 recommendations to government. In part, recommendation 23 reads as follows:

"A mandatory qualification system should involve a programme of qualifications that addresses the different disciplines involved in water supply and provide for qualifications, experience and continued professional development".

Although this and many other Inquiry recommendations are still to be implemented, the release of the Stage 2 Report is significant for the water industry in the sense that a lack of mandatory training and ongoing skills development has been formally recognised and highlighted as an area for improvement.


REPORT OF THE HAVELOCK NORTH DRINKING WATER INQUIRY: STAGE 2

DECEMBER 2017

It is a shame that it took a water quality incident of this magnitude for such an important issue to receive any action. Hopefully, the outcomes from New Zealand may be a signal to the Australian water industry that we need to be proactive rather than reactive on this issue.

Having an appropriately trained and competent workforce is one of the cornerstones for a Water Utility to assist in the reduction of risk to public health and the environment from their water, wastewater and recycled water operations.

Given that there are over 300 Utilities or organisations responsible for the provision of water or wastewater services to our communities Australia wide, it is interesting to consider how many of them have an appropriately skilled and competent operational workforce right now.

OUR COVER

Our cover shot shows Ben Ciantar from Western Water disinfecting a section of pipe prior to using it as a part of a water main repair. The repair was undertaken as a best practice demonstration for participants in WIOA's Victorian Network Operator Development Program.

The phrase "appropriately skilled and competent" is extremely important. In the absence of any regulatory or other requirements, many organisations have adopted the Certificate III from the National Water Training Package (NWP) as the benchmark training level for their operators. Although a good start, if we posed the question "Have these same operators completed all the units of competence from the NWP that correspond to the individual process steps in the plants they are responsible for operating?" we are certain that, in the majority of cases, the answer would be "No". A Certificate III requires the completion of 11 Units of Competence from NWP. At more complex plants, or for operators responsible for multiple treatment plants, completing just the 11 units from the NWP can leave them with a significant skills shortfall.

If we posed the additional question to Water Utilities of "How do you ensure that your trained operators are keeping their skills current and increasing their knowledge once they have completed their qualification?", the responses would vary significantly. Some Utilities have a mature ongoing professional development process, whilst others have nothing at all.

The first group of wastewater certified operators, June 2017.

Certifying operators under the national Water or Wastewater and Recycled Water Frameworks can go a long way towards rectifying any training and ongoing skill development gaps, and will help employers manage risks around their public health and environmental duties with greater confidence. Put simply, the national Certification Framework sets the minimum standards for training, education and ongoing professional development for various water industry operational roles. In doing so, the Framework aims to improve the consistency and portability of skills, access to professional development and career paths for these critical staff.

There are already more than 120 operators from 24 Australian organisations who have met the requirements and are now classified as Certified Water or Wastewater Treatment Operators. There are numerous other operators who are currently undertaking "gap" training to enable them to be certified in the future.

We encourage all Utilities to get on board with the national Certification Framework to create a safer and more professional water industry.

SAMPLING SYSTEM SOLUTION FOR GAS MEASUREMENT IN WASTEWATER APPLICATIONS

Water and wastewater organisations have, for many years, struggled with measuring gases and vapours in sewers over long periods of time.

The physical nature of the application creates high levels of corrosive gases, heat, water and high humidity, which negatively impact all sensors, including catalytic, electrochemical and photo-ionisation sensors.

In recent years, photo-ionisation detector (PID) technology has advanced, but the sensor is still directly affected by humidity, creating inaccurate readings in this application.

There have been many attempts to create filters within sensor housing and externally, but most of these have proven ineffective.

The need for sampling in sewer applications has increased over the years with the desire to use gas sampling as a method to track and trace polluters. By measuring low volatile organic compound (VOC) concentrations, regulatory bodies can determine when an offender has discharged chemicals or solvents into the sewer. PID technology is perfect for this application, but the sensor is not useful unless the humidity and water vapour are eliminated from the sampling stream.

Several utilities have been on the forefront in attempting to find a solution. The key to a successful solution is having a system that can eliminate the particulate as well as reduce humidity and water to a level that the sensors can withstand. These essentials will allow accurate measurement and long-term sensor life.

The Harsh Area Gas Sampling System (HASS), distributed by CAC Gas & Instrumentation, has been designed to solve these issues.

The key elements of liquid, humidity, dust and dirt are managed by the HASS.

Designed as a sampling system, the HASS can incorporate single- or multiple-sensor detection. It is suited to monitoring gas and vapour atmospheres in extreme environments containing temperature, humidity, particulate and pressure challenges. Any sensor technology or manufacturer can be incorporated into the HASS.

Transportable Sampling System used with handheld instruments

A powerful air aspirator pulls samples from distances up to 50 metres (longer if required). These are then filtered and conditioned before being passed across one or multiple sensors.

System integrity is maintained at all times using flow fail monitoring devices. These provide dry contacts that activate if the sample line becomes blocked, damaged or interrupted. Onboard communication systems provide information to key personnel.

The system can be designed to accommodate any number of sensors, or can function as a transportable sampling system that can be used with portable handheld instruments.

For applications where a liquid sample is required at the time of high gas exposure, a second pump will be activated, drawing up the liquid sample and storing it in a locked compartment of the sampling system. This provides a real-time liquid sample and gas measurement, even when the regulatory team is a distance away.

Each system is designed for specific customer requirements.

With more than seven years of experience in water and wastewater applications, the HASS is a proven solution to challenging monitoring applications.

REDUCING BGA AND NUTRIENTS

Simon Tannock

Water storage management will vary depending on several factors. The type of water (raw water, stormwater, wastewater or treated effluent), the size of the storage, the physico-chemical and biological conditions, site history and the influent source(s) all have an influence. For example, wastewater effluent with high nutrient levels in Bendigo is going to have more issues relating to blue-green algae than a raw water reservoir near Hobart.

The management options for a site are wide ranging. There is the 'do nothing' approach, with no monitoring or treatment, or perhaps where monitoring is simply a spectator sport. This involves taking no action on the results of monitoring, and not using data to understand how the water changes over time and how the nutrient profiles, pH and turbidity are likely to affect the seasonal algal blooms. The alternative is that monitoring is used to inform managers and operators of the current conditions and allows them to make decisions on what to expect in coming weeks. Proactive management and monitoring will assist in guiding how to maintain the water in a condition that meets user and licence requirements. With an active management approach, using data to inform decisions and methods of treatment, consideration is given to how to lower nutrients, reduce chlorophyll a and b, stabilise pH and manage blue-green algae blooms. These are all outcomes that are considered desirable, but are often difficult to achieve. There is a wide range of treatment systems available, such as aeration and mixing systems, ultrasonics and lagoon covers, each with pros, cons and different costs. The water storage site environment, its construction method and liner (if any), the influent type and its residence time are among the many characteristics that affect how a system behaves. This is especially true during the spring to autumn period when algae and blue-green algae become more active, and the conditions can change on a weekly basis!

Nutrient levels, particularly nitrogen (N) and phosphorus (P) play a big part. The more N and P, the more algae that grow and the bigger the problem can be in regard to odours, scum layers, toxic blue-green algae blooms, low dissolved oxygen and high suspended solids.

The options for water managers and operators aiming to reduce the N and P entering the system commonly depend on the influent sources, but once these nutrients are in the storage they are much harder to manage or remove. N and P will usually cycle within the storage system, from one algal bloom to another, with one bloom dying away and another type of algae taking up the released nutrients, and a new bloom occurring. By changing the pathway of the N and P and manipulating the types of algae that grow, it is possible to better manage both the nutrients and the blooms.

Diatomix is a unique liquid fertiliser that contains all the micronutrients required for the growth of only one type of algae, called diatoms. The reason it makes sense to encourage the growth of diatom algae, rather than other types of algae (e.g. green algae and blue-green algae) is that diatom algae make up a large part of the bottom of the food chain. There is no sense in having algal blooms occurring where the algae have a bloom and then die back, re-releasing the N and P that was taken up in the initial bloom. Overall, nothing about the water has changed and there is still N and P available for the next algae to bloom.

Diatomix is only bio-available to diatom algae and provides a boost of micronutrients like iron, boron, and manganese to the diatoms. The micronutrient boost sees diatoms take up more N and P. Before the diatom bloom dies away, a wide range of animals, from microscopic zooplankton through to insects and snails begin to graze, filter and feed on the diatoms. This new pathway for N and P means that instead of them being cycled through multiple algal blooms, the N and P enters the animal food chain and becomes part of a more stable ecosystem in the waterbody.

Animal life cycles are much longer than algae cycles, so the N and P stays organically 'fixed' in the animals for much longer periods of time and can move further up the food chain as each animal gets eaten by something larger. The missing step in managing nutrients in waterbodies has been how to consistently promote the growth of diatom algae, based on the available N and P. All algae require N and P, but they also require a wide range of other nutrients to ensure growth. The micronutrients iron, boron, molybdenum, cobalt and others are needed in tiny amounts, but they are vital to stable, long-term algae growth. When these nutrients run low, it limits a bloom's growth and that bloom will die off. As all these macronutrients and micronutrients are released, then the next bloom occurs.

A consistent supply of these vital micronutrients means the diatom bloom can continue, and the uptake of N and P will also continue, resulting in a lowering of ammonia, nitrate and phosphate. The knock-on effect of a consistent, low-level diatom bloom is that the animals feeding on the diatoms can grow and enter their breeding cycles, further stabilising the ecosystem within the water. The animals feeding at the next level above can then respond in the same way, as their food source becomes more stable and regular. This continuous shift of N and P into the animals reduces the inorganic nutrient levels. This in turn means the available levels for other types of algae, like blue-green algae, is limited and therefore so are the blooms of these algae.

The following case studies are for a water storage, a wastewater treatment lagoon and a wastewater effluent storage lagoon. Each is unique in its initial nutrient profile and how it responded to the *Diatomix* treatment. The volume of *Diatomix* dosed during these case studies was dependent upon the amount of N and P in the lagoon or dam system, as well as the N and P in the influent.

Case Study 1

Case Study 1 was two raw water storage dams near Albury, in NSW. The dams were 3.3 and 1.4 hectares in size, respectively.

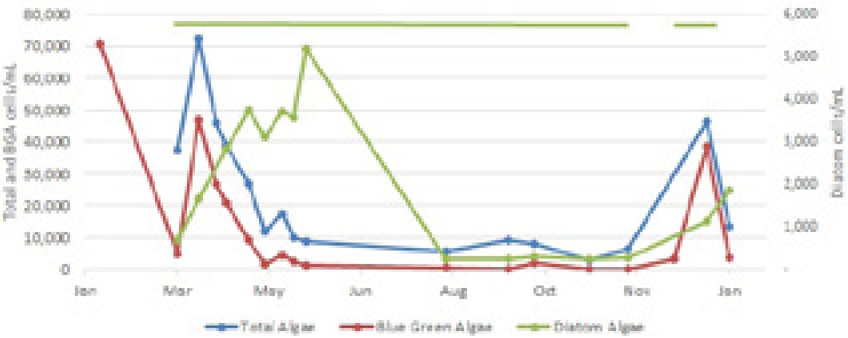


Figure 1. Algal cell counts in Dam 1. *Diatomix* was dosed at a rate of 0.6 L/week over the periods indicated by the green lines across the top of the graph.

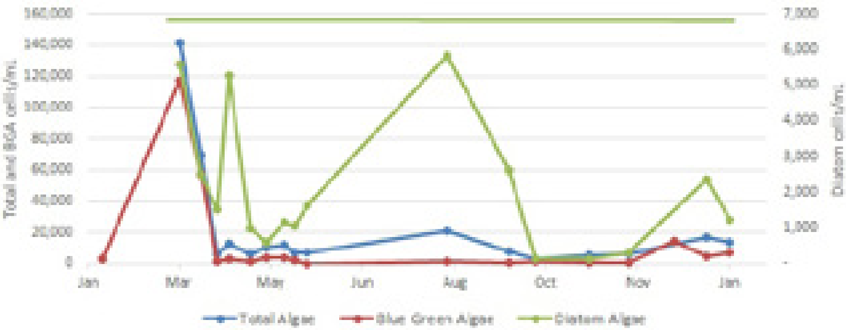


Figure 2. Algal cell counts in Dam 2. *Diatomix* was dosed at a rate of 0.3 L/week over the period indicated by the green line across the top of the graph.

As is common in water bodies over the spring to autumn season, the blue-green algae (BGA) counts fluctuate from high to low, to high again on a regular basis every few weeks. For example, Dam 1 (Figure 1), which was initially above 70,000 blue-green cells/mL, dropped to 4,700 cells/mL and then bounced back up to 46,600 cells/mL within 50 days, before *Diatomix* dosing started. In Dam 2 (Figure 2) the BGA count was initially low at 2,700 BGA cells/mL in February. On the day *Diatomix* dosing started, six weeks later, there were 117,000 BGA cells/mL. Once *Diatomix* dosing started, in both dams the BGA counts reduced to average values of 1,885 BGA cells/mL and 2,025 BGA cells/mL respectively. Over the December period in Dam 1, dosing was overlooked for a couple of weeks. (See the gap in the horizontal green line at the top of Figure 1). When a bloom was observed in Dam 1 at the end of December, dosing was reinstated and BGA numbers dropped again, while diatom numbers increased.

As the diatom bloom became established and the diatoms made use of the available nutrients, the BGA did not bloom again in such high numbers.

The bloom of diatoms does not, however, appear to be extensive in the results. This is because many diatoms that bloom when *Diatomix* is dosed grow on the biofilms and dam bottom (benthic area), so the suspended algae result recorded in standard sampling does not consist of large numbers of diatoms. This explains why the diatom numbers are on the right-hand axis in Figures 1 and 2, as the cell counts are so much lower than the Total and BGA cell numbers on the left-hand axis.

As well as the growth of many diatoms on the biofilms, the other reason for lower diatom cell counts is the feeding pressure on the diatoms. As they are eaten, the inorganic N and P taken up by diatoms is changed into organic N and P in the animal ecosystem (zooplankton, insects and invertebrates, fish, eels, turtles, birds). This is one of the long-term benefits of using *Diatomix*: a stable, healthy ecosystem that is less susceptible to BGA blooms.

The managers responsible for these raw water dams moved to long-term dosing of their water storages in order to ensure the ongoing health of the drinking water supplies.

Dosing can be managed in a range of ways. With the minimum number of doses being three times per week, greater frequency is up to the operator, and can even be up to several times a day by using a solar-powered, automated dosing system (Figure 3). The unit holds 10 litres of *Diatomix*, which can be enough for one week, or more than 6 months, depending on the site. The dosing unit is mounted on a post or similar at the site.

The *Diatomix* treatment method does require small, frequent doses instead of one bulk dose occasionally. The low-level frequent dosing is essential as dosing is encouraging a new biological ecosystem to grow and manage the uptake and shift of nutrients into the diatom and animal biomass of the waterbody.

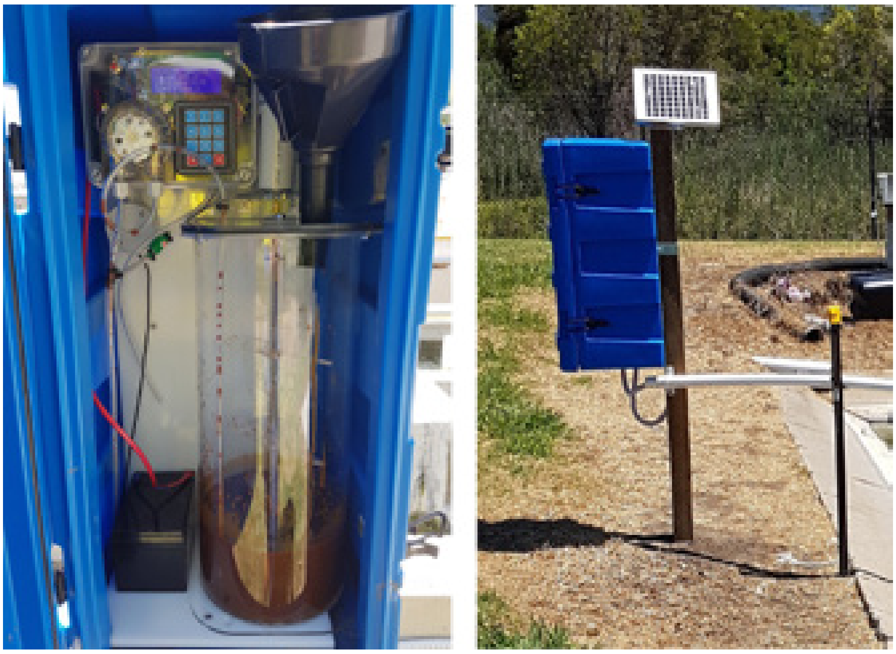


Figure 3. The solar powered and programmable *Diatomix* dosing unit.

The way the *Diatomix* is dosed depends on the site and the inflow to the site. With a regular influent flow into a lagoon or dam, the dosing can occur with the influent flow itself providing the mixing for the *Diatomix* into the water. With irregular inflows, dosing into the main body of the lagoon is better. Manual dosing is best done by dispersing the dose along one or two edges of the dam or lagoon. If automated dosing is in use with irregular flows, then a 6mm pipeline is positioned out 10 to 20 metres from the bank and the dosing unit uses an air mixer to mix the dose into the water. Natural water movement/circulation achieves further mixing into a lagoon up to about one hectare. With larger sites, more than one automated dosing unit is the better option. For the future, a dosing drone is being developed, which will fly a set pattern over the water surface and dose the *Diatomix* daily.

Case Study 2

The Council managing the wastewater treatment lagoon described in this case study had been having BGA issues in the lagoon for several months prior to commencing *Diatomix* dosing. The site also had a history of high level BGA blooms each year from spring through to autumn. There was no background data available on cell counts, as the situation at the lagoon was considered 'situation normal', with high summer BGA.

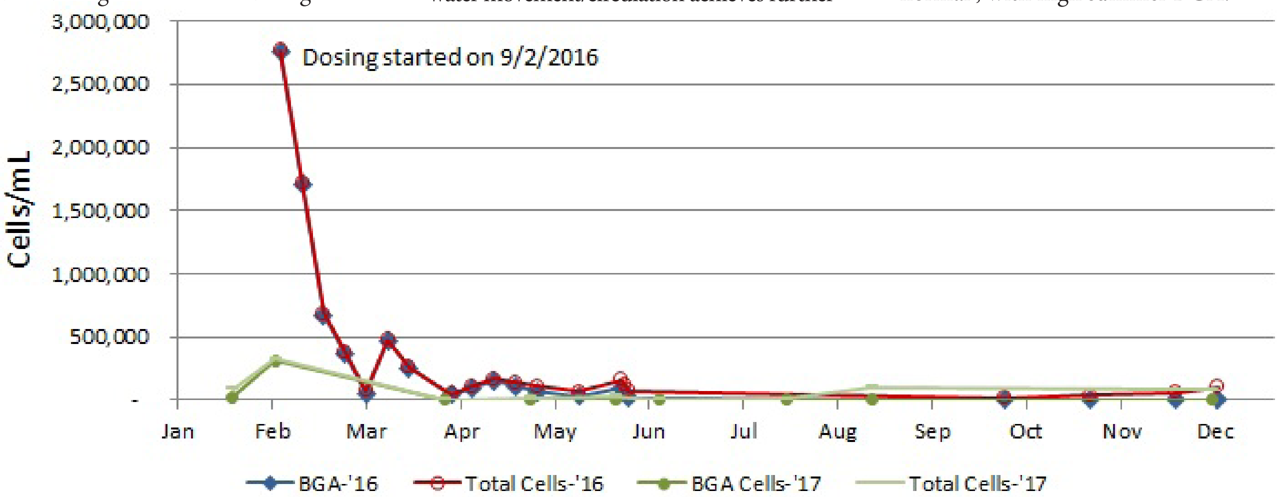


Figure 4. Algal cell counts in the wastewater treatment lagoon over a period of 68 weeks during which time *Diatomix* was dosed twice.

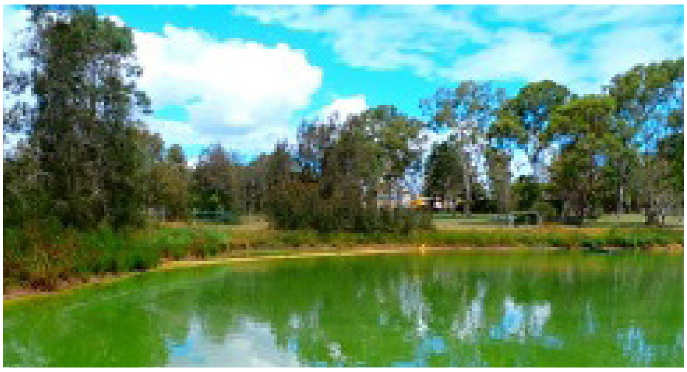


Figure 5. The wastewater treatment lagoon at the start of the case study prior to dosing *Diatomix* (top) and 14 months later (bottom).

Sampling started once *Diatomix* dosing was initiated. As demonstrated in Figure 4, the Total Cell Count began to reduce quickly once Diatomix was dosed. Arguably this could have been caused by the normal 'crash' of an intense bloom, but this was not followed up by a BGA recovery and a subsequent high bloom. The 'bloom, crash, bloom' behaviour so often seen during the warmer months did not occur. Once diatoms establish in a lagoon system, they are more stable and help reduce or hold back the BGA populations. During this case study, the BGA cell count reduced by 99.4% from the first sample to the last one in the first dosing period. The first dosing period was from February 2016 until June 2016 when the initial trial ended. Dosing restarted in October 2016 and, since then, the highest BGA Cell Count was 311,000 cells/mL.

Since October 2016 this site has instigated a permanent dosing plan, with dosing of *Diatomix* being managed through an automated, solar-powered dosing system (see Figure 3). The average Total Cell Count has been 67,000 cells/mL, a 93% reduction in Total Cell Count. Eighteen per cent of algae are diatoms and 39% are blue-green algae. The effect of dosing *Diatomix* in this wastewater lagoon is clearly shown in Figure 5.

There was a massive reduction in Total Cell Count and a change in the dominant type of algae from the bright green of the blue-green algae (left) to the browner diatom algae (right).

Site operators monitor the ammonia and nitrate levels in the influent to the lagoon, as well as the values within the lagoon. This lagoon is currently on a dose of one litre per week, but if the results show increased nitrogen values, the operators increase the dose by 10 to 20% until the levels settle again in a week or two. At any time that operators are unsure of the best option, they are welcome to contact the supplier to discuss any possible changes. Changes are simply made on the keypad of the fully programmable dosing unit.

Case Study 3

This case study shows the effect of *Diatomix* dosing on the concentration of ammonia and nitrate in the third lagoon of a series of three lagoons in a sewage treatment plant. The second and third lagoons were monitored during this study and the *Diatomix* was dosed into the influent stream of Lagoon 3 (i.e. Lagoon 2 effluent). The results are shown in Figure 6.

The influent ammonia from Lagoon 2 had remained steadily high. Ammonia reduction in Lagoon 3 was rapid after *Diatomix* dosing, with some increase in nitrate observed after the ammonia reduced from 20 mg/L to below 5 mg/L. For the first month of the treatment, dosing was high, at 1.3 L/day, but as the ammonia levels reduced, dosing was lowered to 0.65 L/day. Dosing is calculated on the moving average of the nitrogen values of the influent and the lagoon conditions. As operators become familiar with the new conditions in the lagoons, they are often able to visually determine whether the system is in balance or whether dosing rates need to be re-checked.

The average ammonia concentration was reduced by 80%, from 20.5 mg/L, and the lowest reading from a sample showed ammonia at less than 0.1 mg/L. While Nitrate-N has increased, it has only increased to an average of 3.8 mg/L, showing that the reduction of nitrogen from ammonia was not simply due to nitrification (conversion of ammonia to nitrate), it was uptake by diatoms and most likely then higher trophic levels.

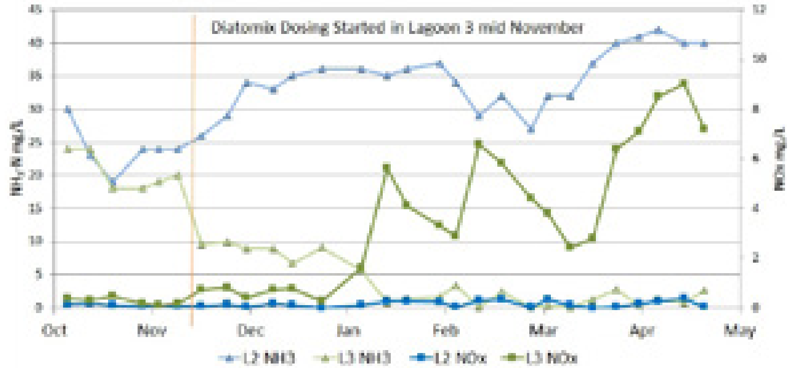


Figure 6. Ammonia and nitrate concentration in Lagoon 2 and Lagoon 3 during dosing of *Diatomix*.

Conclusions

The three case studies presented above clearly show significant improvement in the quality of the water during dosing of *Diatomix* measured either as reduction in Total Algal Cell Count or ammonia concentration.

These studies are strongly indicative that the use of *Diatomix* is a simple and effective pathway to achieve these desirable outcomes in both raw water, wastewater treatment and treated effluent storages.

The Author

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OVERSEAS EXPERIENCE

ADDING DISSOLVED OXYGEN TO WASTEWATER TREATMENT PLANT EFFLUENT TO COMPLY WITH REVISED STANDARDS

As part of a planned upgrade, a small (4.5-megalitre-per-day) wastewater treatment plant (WWTP) in Pennsylvania needed to maintain a greater than 6.0 milligram-per-litre level of dissolved oxygen (DO) in their effluent discharge. The effluent flows into a stream and the DO requirement is to support biota in the stream. To comply, the design engineer selected a Venturi Aerator system to add the required DO. The Venturi Aerator was selected because of its simple design, and because it could utilise the existing pump so that no additional power was required.

The plant used the existing pump to pump the effluent into the receiving stream. This effluent contained almost no residual DO due to the dechlorination process. The engineer used this pump to pump into an aeration chamber after passing through a new Venturi Aerator.

The Venturi Aerator adds DO to water by aspirating ambient air into the water. The aspirated air is mixed under partial pressure in an internal mixing zone in a highly turbulent flow of air and water.

Using this Venturi Aerator configuration, the WWTP is able to maintain DO levels of greater than 10.0 milligrams per litre in winter months when oxygen is more soluble, while in the summer months they consistently exceed 7.0 milligrams per litre, exceeding their licence requirements.

Larger plants can be catered for by using larger pumps and multiple Venturi Aerators.

PROMINENT COVERS ALL BASES

ProMinent has been supporting various industries and applications throughout Australia with solutions and expertise in chemical feed and water treatment equipment since 1976. ProMinent has always considered that a strong connection with our customers through the service and experience we provide is imperative to each other's overall success.

From humble beginnings, ProMinent has flourished from a manufacturer of metering pumps to a manufacturer of systems for fluid metering technology, water treatment and water disinfection. In addition, ProMinent has introduced the full Tomal® product range for liquid and powder polymer, soda ash and potassium permanganate preparation and dosing systems.

Through our people's smart innovation, ProMinent has recently released the DULCOMETER® diaLog DACb Multi Parameter Controller. This controller is a compact all-rounder for your water analysis needs. We have also released our new Gamma X Solenoid Driven Metering Pump for your precise, controlled chemical dosing applications.

Our service personnel and key distributors are strategically located throughout Australia so that we can provide support wherever required.

The scope of our equipment supply, coupled with our extensive experience and after-sales support, make ProMinent a market leader that covers all bases in various chemical feed and water treatment industries.

UNDERSTANDING BACKFLOW PREVENTION

Peter McLennan

A study on waterborne illness between 1971 and 1998 in the United States attributed to the distribution system showed approximately 50% of 21,000 illnesses were a result of backflow or cross connections (Figure 1). There were also 13 deaths.

A study in Switzerland analysing waterborne illnesses between 1998 and 2006 showed that, of 10 outbreaks, 6 were due to backflow from Sewage Treatment Plants to the city drinking water supply.

In another well documented event in 2007 in Nokia, Finland, 400 kL of treated effluent entered the distribution system, resulting in around 1000 illnesses.

Clearly, backflow can cause illness and potentially death. The water industry therefore must manage backflow and cross connection to prevent adverse impacts on public health.

Backflow is the term used to describe the reversal of flow in a water supply pipe. A Backflow Prevention Device (BFPD) is used to protect drinking water from contamination where cross connections occur. To put it simply, a BFPD is a safety valve that protects the drinking water supply. They are like smoke detectors in buildings: they both save lives.

Since the introduction of BFPD to the Australian Plumbing Code (AS/NZS3500.1-2015) in 1998 (Section 4 Cross Connection Control), it is estimated that more than 500,000 testable BFPDs have been installed across Australia.

Other than a few individuals in the plumbing industry, many people responsible for managing and maintaining drinking water systems know little of backflow and how the BFPDs affect their system.

This article discusses the design requirements and the performance characteristics of BFPDs. The aim is to inform the non-plumbers about how the BFPDs interact with the water supply and help to reduce the number of illnesses resulting from backflow and cross connection.

Backflow Basics

BFPDs are watermarked to AS/NZS2845.1-2010 or AS/NZS2845.1-1998. WaterMark is the industry mark of approval licensed by the Australian Building Codes Board and shows that products have been tested and comply with the relevant Standards. 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:

- High Hazard. The pollutant or contaminant, if ingested, could kill you. High hazard sites typically include mineral processing, meat processing plants, hospitals, mortuaries, plating works and sewage treatment plants. Indeed, most industrial processing plants that use water as part of their processes either for cleaning or make up contain harmful chemicals. Generally, a Water Utility will insist on a Reduced Pressure Zone (RPZ) device at the boundary of an industrial site, purely because of the potential for a hazardous cross connection occurring.
- Medium. The pollutant or contaminant, if ingested, is unpleasant and may make you ill. Medium hazard sites include commercial buildings, schools, public parks, commercial swimming pools and food processing plants.
- Low. The pollutant or contaminant is non-toxic but is objectionable and should not be present in drinking water. This typically includes residential homes and rainwater tanks.

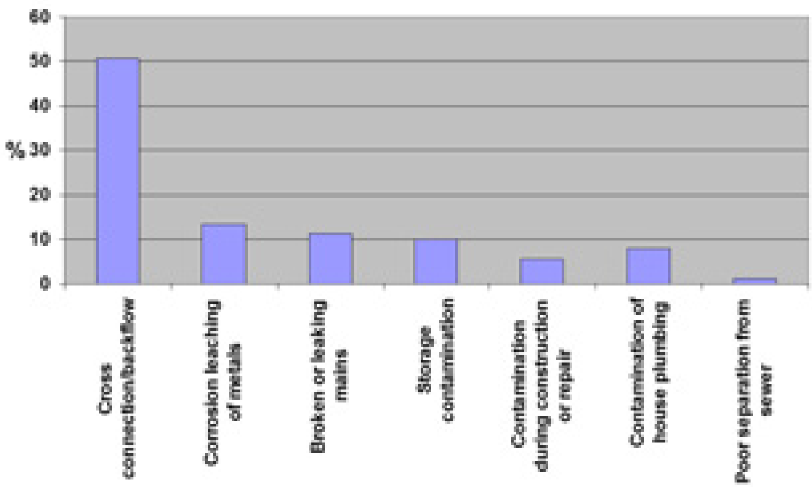

Figure 1. Causes of illness due to the distribution system in the US between 1971 and 1998 (Data taken from Craun and Calderon, Waterborne disease outbreaks caused by distribution system deficiencies. AWWA Journal September 2001).

Types of Cross Connections

Two types of cross connections are identified.

- 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. It is not unusual to see filtration systems or valve sets in an industrial facility that have a bypass line around the equipment. This is so the facility can still have water if the equipment needs repair or maintenance.
- Indirect connection. The most common cross connection is a hose. A hose is an indirect connection as the outlet can be used and left in all sorts of situations. For example, drain cleaning, chemical mixing, pipe flushing or pool filling.

A good example of an indirect connection was at an abattoir in central Victoria where a hose was used to prime a pump that transferred blood and gut contents to a waste treatment plant on site. The hose was left in the pump and once the pump started, the higher pump discharge pressure forced the waste materials into the water distribution system.

Another example from central Victoria involved a cheese factory where there were two sources of water for washing down trucks on site, separated by a single valve.

One source was the city drinking water supply, the other was from a bore on site. The bore was only about 20 m from the discharge area of a septic tank. The single valve was left open, allowing the contaminated bore water to enter the factory supply, contaminating the water with faecal coliforms.

Types of Backflow

Two types of backflow are identified:

- Back siphonage:
  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. This is the major source of backflow events, and broken water mains are the major cause. By way of example, in one large Australian water utility there are in excess of 5000 water main breaks a year, that is around 14 per day across the network. Every time a break occurs, there is back siphonage in the main.
- Backpressure:
  The water pressure within the facility is greater than the supply pressure. Causes can include high head pressure found in high-rise buildings, at the top of hills, and from mechanical equipment failures. As an example, there is an industrial facility on a hill outside town. The elevation is greater than the head pressure in the reticulated supply due to heavy usage in town. We could see the water from the industrial facility being pushed back downhill.

Types of Backflow Prevention Devices

- Testable:
  These devices are designed to be able to be tested for operational effectiveness and for maintenance whilst installed inline. They are suitable for use in high, medium or low hazard applications. BFPDs are field tested for effective operation on commissioning and at least annually by an accredited tester trained in backflow prevention.
- Non-testable:
  Non-testable devices need to be removed from the line for maintenance and testing, therefore they are only suitable for installation in low hazard applications.

Device	Type	Application
Reduced Pressure Zone Device (RPZ)	Testable	High hazard
Double Check Valve (DCV)	Testable	Medium hazard
Pressure Type Vacuum Breaker (PVB)	Testable	Low hazard
Dual Check Valve (DUCV)	Non-Testable	Low hazard
Vented Dual Check Valve (DCAP)	Non-Testable	Low hazard
Atmospheric Vacuum Breaker (AVB)	Non-Testable	Low hazard
Hose Connection Vacuum Breaker (HCVB)	Non-Testable	Low hazard
Single Check Valve Testable (SCVT)	Testable	Low hazard only on fire lines
Single Check Detector Assembly Testable (SCDAT)	Testable	Low hazard only on fire lines
Double Check Detector Assembly. (DCDA)	Testable	Medium hazard only on fire lines
Reduced Pressure Detector Assy. (RPDA)	Testable	High hazard only on fire lines

Table 1. Common devices and the applicable hazard ratings.

Table 1 provides a list of common devices and the applicable hazard ratings.

Many people are confused by the number of types of devices available, but each device listed in the table provides backflow protection in either specific applications, or against specific levels of hazard. For example:

- RPZ:
  The Reduced Pressure Zone (RPZ) device offers the highest level of protection found in a mechanical device. They are considered fail safe. This device has two check valves and a differential relief valve incorporated into the one body (Figure 2). The effective operation of the device relies on the water pressure on one side of the relief valve being higher than the other. This higher water pressure closes the spring-loaded relief valve. The term 'reduced pressure zone' relates to the area of the device between the first and second check valve.

This reduced pressure is caused by the head loss across the first check valve and results in the water pressure in the device being less than the water pressure closing the relief valve.

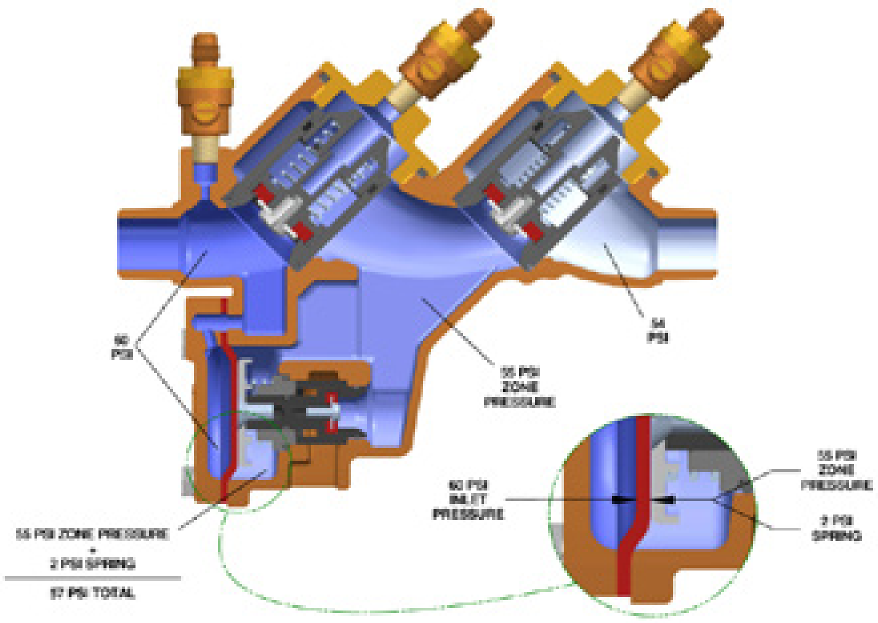

Figure 2. A schematic of an RPZ device.

Should either a back siphonage or a backpressure event occur, the device will fail safe and open the vent at the relief valve to discharge any water in the device (Figure 3).

The photograph was taken in a suburban street. Why the valve was closed as indicated by the arrow in Figure 3 is not known. Part of the test procedure is to close the outlet isolating valve. If it dumps water as shown, it generally means it has debris on the first check valve and needs repair.

Figure 4 shows a site where both a large and small RPZD are installed. This is at a university campus. The large RPZ device is used to supply general drinking water. The small device is on the irrigation system, which utilises pop-up sprinklers. Once the sprinkler is turned off, the head withdraws and there is a chance contaminants can pool around the head. If a back siphonage event occurred and the device was fouled (as in Figure 3), the contaminants could be sucked back into the water supply.

Note that, in contrast to Figure 3, the concrete at the base of the RPZDs shown in Figure 4 is dry. RPZ devices will only dump water in a backflow event, or if something is wrong with the device.

- Double Check Valves and Dual Check Valves:
  These perform similar tasks and both are essentially the same (Figure 5). The difference is that the Double Check Valve has test points so that it can be checked for operational effectiveness whilst installed in line, whereas the Dual Check Valve needs to be removed from the line and tested in the workshop. This confirms why the Double Check Valve is suitable for medium hazard and the Dual Check Valve is only for low hazard applications.

Figure 6 shows a large Double Detector Check Valve. The detector assemblies are used in fire services and have a bypass line fitted with a water meter for detecting any unauthorised water usage.

Basic Principles of Testing

As BFPDs are mechanical devices, they are open to failure of internal components through either debris build-up (Figure 7) or mechanical fatigue.

For this reason, BFPDs installed in medium or high hazard installations are required by the Code to be tested upon installation and at least annually thereafter. The testing, although seemingly complex, is essentially quite simple. A differential pressure gauge is used to measure the differential pressure either side of each check valve (Figure 8).

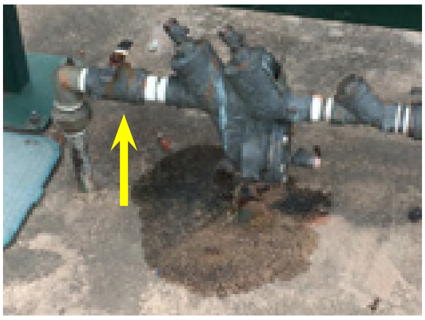

Figure 3. An RPZ device with water coming from the vent indicating that it is doing what it is supposed to and dumping the water.

Figure 4. A large and small RPZ device installed at a university campus.

Figure 5. Double Check Valve on the left and a Dual Check Valve on the right.

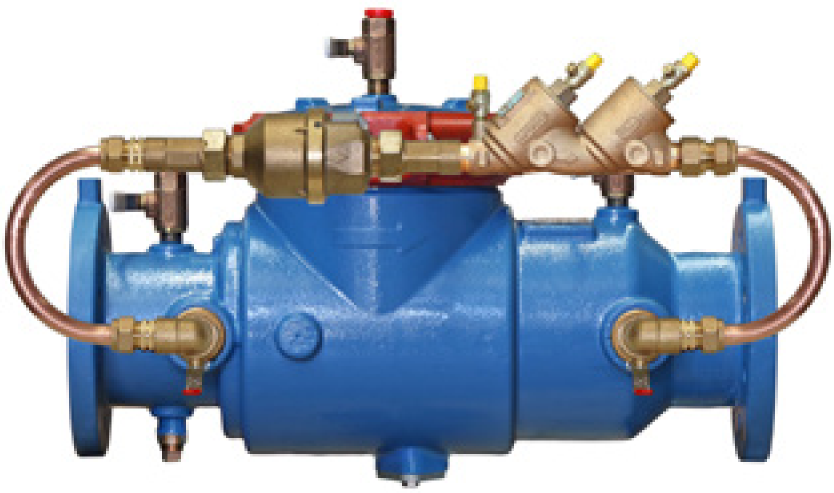

Figure 6. A large Double Detector Check Valve.

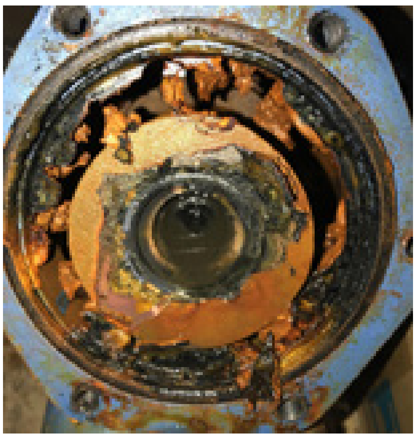

Figure 7. Significant build-up of debris in a device. This confirms why they need testing annually.

Figure 8. A Double Check Valve being tested.

The results will identify if the check valve springs are good and that the check valve meets the minimum pressure drop required by the Standard.

In the case of the RPZ device, an additional part of the test is to introduce higher pressure water into the zone to actuate the relief valve and ensure it is operating effectively. The mains pressure water with the aid of the spring in the relief valve opens the vent and allows the water to discharge.

Pressure Drop and Flow Rates

Backflow prevention devices rely on pressure drop across the valves for effective operation. The minimum spring differentials are stipulated in the Australian Standard and all WaterMarked devices must comply.

Always check the manufacturer's published literature for the pressure drop curve to ensure there is enough available pressure to supply the amount of water required (Figure 9). It is especially important where a fire connection is concerned, as it is essential that any BFPD does not compromise the necessary minimum fire flows.

From Figure 9, for a 25mm diameter device at a flow rate of 110 L/m, the pressure drop across the device is 78 kPa. Note this is for the device only and does not include the isolating valves or strainer when installed.

The following examples are taken from various 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
- 100mm Double Check Valve at 20 L/s has a head loss of 20 kPa
- 100mm Double Detector Check Valve at 20 L/s has a head loss of 68 kPa
- 100mm Single Check Valve Detector Testable at 20 L/s has a head loss of 57 kPa.

These figures are for the 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.

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. For the water to dump, something has affected the hydraulics of the valve that operates the relief valve. This can be caused by several things including back siphonage, pressure fluctuations or debris in the valve.

The dumped water is often inconvenient, and when installed where it cannot drain away, it can become dangerous to property and humans. It is therefore important to install the devices where any discharged water does not create a hazard.

All manufacturers publish the discharge rates applicable to their devices, so be aware of these when installing an RPZ, otherwise they may cause an unwanted flood. For example, a 50mm RPZ with a pressure of 700 kPa can discharge around 660 L/min during a backflow event.

Installation Guidelines

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. Workplace 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.

The Standard addresses some aspects, but each manufacturer outlines specific installation requirements in their published literature.

The three main questions to ask when planning to install a RPZD are:

1. Is the device being installed 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 being installed 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 being installed have ease of access for regular testing and maintenance without the need for special equipment or dismantling from the line?

The Author

Peter McLennan (petermcl@vivoaqua.com) is President of the Backflow Prevention Association of Australia Inc.
Visit www.bpaa.org.au for more information.

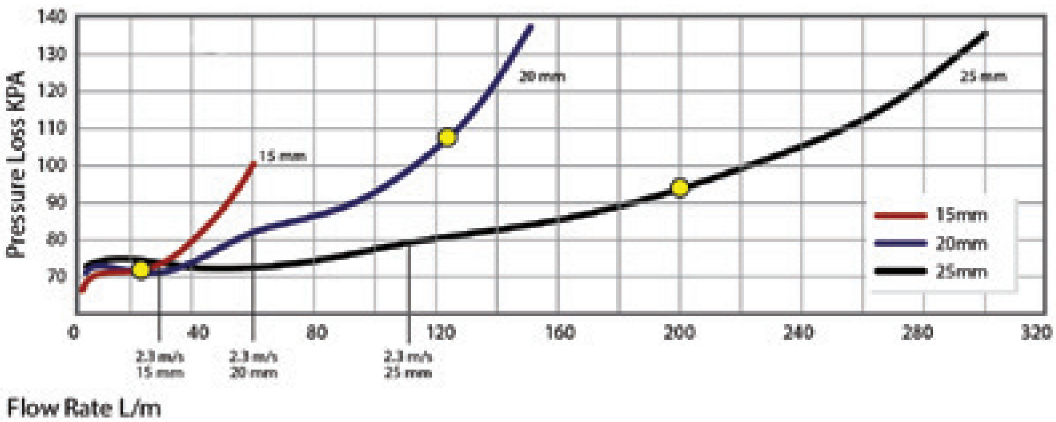

Figure 9. An example of a pressure drop curve.

BEAT THE HEAT WITH MECHANICAL PIPE JOINING

The crew was able to completely install each Style 908 coupling in just 10 minutes.

Oaky Creek's polyethylene raw water pipeline beats the heat of North Queensland with an innovative pipe-joining method.

The Oaky Creek raw water pipeline is an eight-kilometre-long pipeline consisting of 400-millimetre PN12.5 and PN10 high-density polyethylene (HDPE) piping. A critical line for the successful and safe operation of the mine, the raw water pipeline transports process water from the mine site catchment areas to the reverse osmosis plant. Leaks or failures in the pipeline could create a critical situation where a shutdown of mine operations could occur. Therefore, joint integrity was of paramount concern.

Due to the harsh environment of the region (reaching temperatures of more than 50 degrees Celsius), previously installed HDPE water pipelines have experienced ongoing failures. With a goal of ongoing improvement, Oaky Creek sought a solution boasting high-quality joints with a reduced risk of failure in extreme weather conditions.

With a long, proven history of mechanical pipe-joining, Victaulic products were chosen to be installed throughout the length of the pipeline. The Refuse-to-Fuse™ Style 908 coupling provided a mechanical joint designed and tested to withstand the required end-loads and thermal movement of the system. Pipes were pre-fabricated and grooved off site, allowing for quality assurance procedures to be completed on every pipe. The system has been installed and commissioned with a 100 per cent joint success rate and zero leaks reported.

The proven value of reduced installation time of the mechanical joint was evident on site. The crew was able to completely install each Style 908 coupling in just 10 minutes. The use of Style 908 couplings resulted in a time saving of 55 per cent – reducing days required for fusing from 80 days to 35 days for coupling installation. The pipeline became functional 45 days earlier than expected, allowing the site to begin pumping water immediately.

The 80-day schedule for fusing the pipeline was estimated under ideal conditions. Inclement weather or other delays would have pushed back the schedule even further. With the Refuse-to-Fuse system, Style 908 couplings were installed rain or shine in any temperature without the need for special tents, screens or additional cool-down time. In addition, no specialist polyethylene pipe welders or certified fusion experts were required – Style 908 mechanical couplings can be installed with minimal training.

The pipeline became functional 45 days earlier than expected and has been commissioned with a 100 per cent joint success rate with zero leaks reported.

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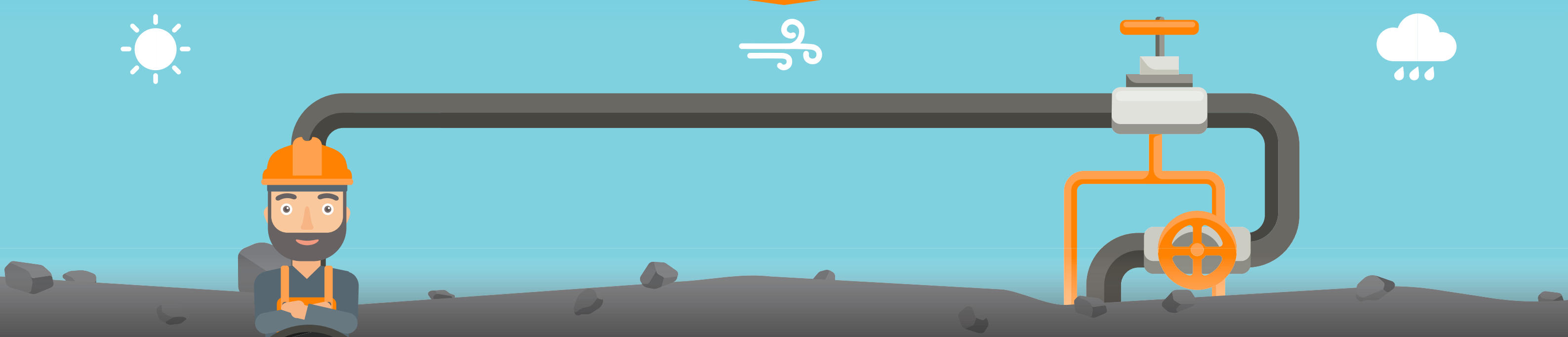
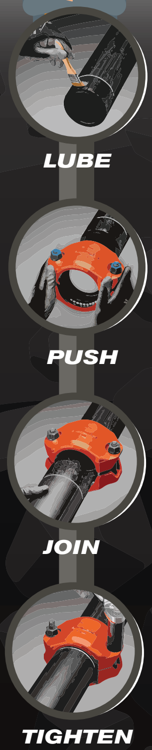
THE FASTEST WAY TO JOIN HDPE PIPE





Victaulic has developed a new *joining method* for high density polyethylene pipe (HDPE) that *eliminates fusion*.

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REDUCING *E. COLI* DETECTIONS AT COLIBAN

Andrew Telfer

The detection of *Escherichia coli* (*E. coli*) in treated drinking water is a widely known cause of public health concern. This is because *E. coli* is regarded as the most specific indicator of recent faecal contamination of drinking water.

In the 7 years preceding 2014, there were on average 10 positive *E. coli* detections each year in various drinking water supplies operated by Coliban Water in central Victoria.

This article describes the development of a simple, yet broad-ranging and effective set of measures, which has seen only a single *E. coli* detection being recorded in Coliban Water's drinking water supplies between 22 October 2014 and December 2017.

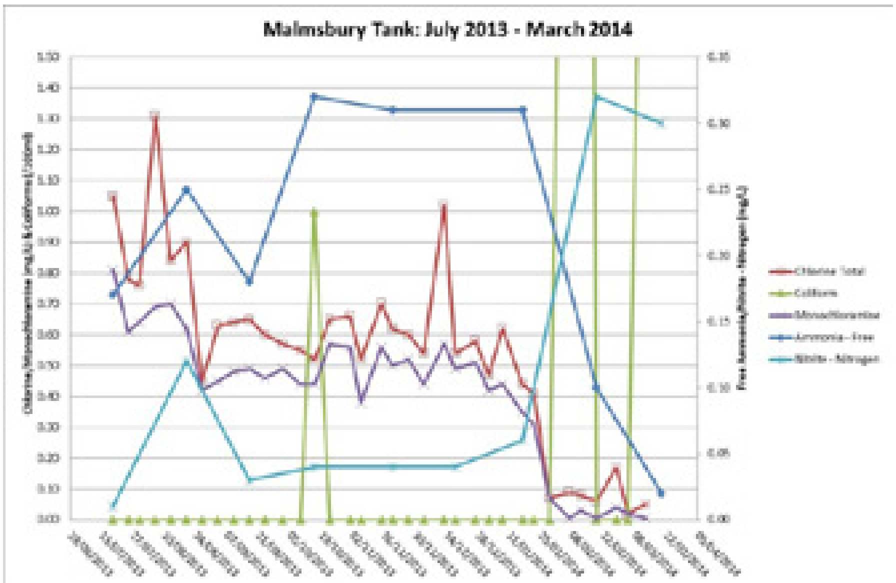

Figure 1. Malmsbury Tank nitrification trends.

A Series of Events

As the new Water Quality Manager commencing work in March 2014, I started by monitoring the Water Quality Exceedance reports. Wanting to take a conservative approach in a new role, I requested chlorine dosing of several treated water storage tanks in the distribution system that regularly had low chlorine residuals and which showed some evidence of nitrification. This was questioned by operators who had not previously been requested to dose one of these treated water storage tanks at the township of Malmsbury.

This prompted the slightly nervous Water Quality Manager to double check the results and look at longer-term trends. This revealed that indeed nitrification had only appeared in the Malmsbury Tank in recent months and that prior to this, sufficient residual chlorine had been measured in this tank, as shown in Figure 1. Over the next month, several attempts were made to bring the nitrification and low level detections of coliform bacteria in the Malmsbury tank under control by the addition of sodium hypochlorite, but this had limited success.

On 10 April 2014, *E. coli* was detected in the Malmsbury Tank, as well in the downstream distribution system. As a standard response, repeat samples were collected, the Malmsbury Tank was dosed again with sodium hypochlorite and the distribution system flushed to draw free chlorine through the network. The repeat samples were also positive for *E. coli* in the Malmsbury Tank. As a result, a Boil Water Notice was issued and corrective actions were carried out to remove *E. coli* from the drinking water to make it safe for consumption. These included dosing and flushing the tank and distribution system in Malmsbury township to ensure that all areas of the distribution network received an adequate level of free chlorine.

Figure 2. Hatch latch with potential ingress point.

Another action was to carry out a thorough inspection of the tank. This seemed particularly appropriate since there had been some rainfall in the days preceding the *E. coli* detection. The inspection revealed a number of issues with the integrity of the tank roof (Figures 2 to 8) that were the likely source of the contamination. The issues with the integrity of the tank roof had largely been masked by the presence of an adequate chloramine residual, but as nitrification had taken hold in the tank, the integrity issues in the roof began to compromise the safety of the drinking water supply.

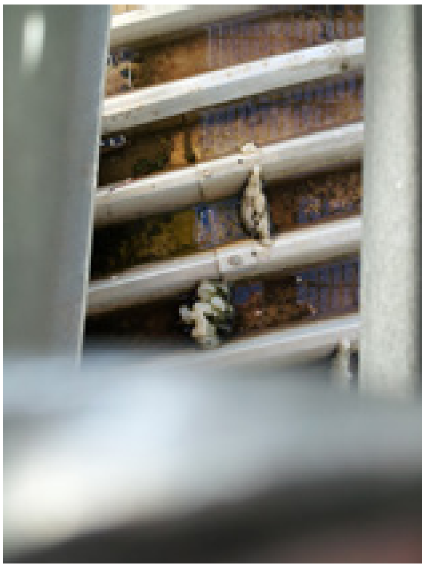

Figure 3. Water pooling on the dirty roof, with roof sheet joins not adequately sealed, and holes in top of roofing ridges.

Figure 4. Roofing around the hatch not adequately sealed leaving an ingress point.

This highlights the importance of multiple barriers in drinking water quality risk management. Some of the tank roof integrity issues identified in the pictures include:

- The roof had been cut for the installation of a safety walkway, but not suitably sealed following completion of the works
- Inadequate sealant around the roof
- Holes in the roof in both the top and bottom of corrugations
- The corrugations were not sealed
- The hatch latch was not suitably sealed
- Water was pooling on the roof
- The roof was dirty in places.

On the same day, there was a second positive *E. coli* result recorded in the treated water tank that services the nearby township of Tylden, but in this case the repeat samples did not give a positive result. A tank inspection was nonetheless conducted of this tank. The inspection revealed some similar issues, the most serious of which is shown in Figure 8.

Clearly, repair works were urgently required on these tanks to prevent further contamination of the drinking water. These were undertaken promptly, but it was concerning to note that the problems at the Malmsbury Tank had been previously identified but not actioned!

This series of events led to several questions:

- If the roofs of these two tanks had been found to have serious integrity issues, how many other tanks across the Coliban Water network had similar issues?
- If the issue with roof condition at the Malmsbury Tank was already known, why had action not previously been taken?
- It was apparent from the inspections that the faults with Malmsbury and Tylden tanks had occurred as a result of works that had not occurred recently. Therefore, if tank inspections were being undertaken at least annually, why were issues such as those found at Malmsbury and Tylden not being identified and addressed?
- Why were works carried out, and the tank roofs then left in such apparently poor condition?
- If nitrification had occurred previously, what action was usually taken to control it?

As answers to these questions were sought, a program of corrective actions was developed and implemented.

A Series of Actions

The first and obvious action was to inspect all the roofs of all the storages across the Coliban Water drinking water supply system.

Thankfully, there were no tanks that were found to be in as poor a condition as the Malmsbury Tank, but there were some problems and a list of actions were drawn up and implemented to seal all the tanks.

Given that the issues identified at both the Malmsbury and Tylden Tanks were not new issues, it was clear that the annual tank inspection tasks were not achieving their intended purpose. Therefore, the process for completing these jobs was analysed, and it was identified that the checklist in use required significant improvement to provide greater direction to those conducting the inspections of what to look for when inspecting a tank.

As a result, a new inspection form was developed. The rollout of this form was coupled with training sessions for operators who were responsible for tank inspections, to highlight what they should be looking for when conducting inspections, along with what actions should be taken when issues were identified during the inspection.

Secondly, it became evident that nitrification was an issue that had been largely ignored, primarily because of consistent drought conditions (1999 to 2010), followed by 18 months of severe flooding (2010-2011) in Coliban Water's region, which hampered mains cleaning efforts.

Figure 5. Water and dirt pooling around the roof access point, a possible ingress point.


Figure 6. Ends of the roofing ridges not sealed after the roof walkway installation leaving a point of ingress.

A Nitrification Management Plan was developed. The plan included distribution of a weekly report summarising the results of water quality testing, which highlighted areas where nitrification may be developing or had developed. Other strategies included training of operators regarding nitrification and its management, regular dosing of tanks, and system-wide free chlorine burns where entire systems were switched from chloramine dosing to free chlorine dosing for 1–2 months to enable free chlorine penetration. This was often accompanied by a targeted flushing program to assist with free chlorine penetration. On occasion, parts of the systems were dosed with free chlorine to assist with nitrification management. In all cases chlorine dosing was at controlled rates <5mg/L.

Another One! Similar But Different!

With the tank inspections completed and most of the roofs fully sealed, an *E. coli* detection at the Tarnagulla Tank on 22 October 2014 was a bit of a disappointment, but it seemed likely that the roof wasn't at fault this time.

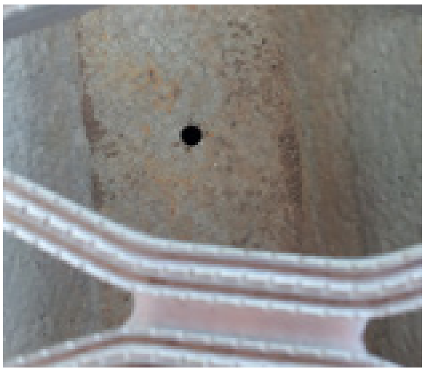

Figure 7. Hole in the bottom of roofing ridge.

Examination of water quality trends revealed that a chlorine residual had not been seen at the Tarnagulla Tank for a long time, although in this case, nitrification was not the cause of the lack of chlorine in the tank. Discussions with other management and operations personnel suggested that the likely source of contamination was the main from the water treatment plant (WTP) to the tank. The small-diameter, 6.5 km long main was quite old with several air valves of questionable integrity. The consensus was that the main probably had significant biofilm build-up inside.

Plans were developed to increase chlorine penetration to the Tarnagulla Tank. The operating range was such that it took several tank fills to turn over the entire pipe volume. Consequently, the tank operating range was increased to 30% to help turn over the water in the pipeline and ensure that treated water fresh from the WTP was received at the Tarnagulla Tank, with minimal opportunity for chlorine decay during each fill.

Figure 8. The roof of the Tylden Tank showing a cut out in the roof material. Note the bird faeces nearby!

Following this change, a chlorine residual was detected at the inlet to the tank, however it was only about 0.3 mg/L total chlorine. At the time of leaving the treatment plant it was approximately 1-1.5mg/L. Clearly there was significant chlorine demand within the pipeline. As a result, the pipeline was scoured, along with the replacement of all air valves. Following this, chloramine residuals have been able to penetrate much of the distribution system downstream of the Tarnagulla Tank and there is no need to undertake direct chlorine dosing of the Tarnagulla Tank for a significant proportion of the year.

Since the *E. coli* detection at Tarnagulla Tank in October 2014, there has only been one further detection of *E. coli* within the Coliban Water systems, which has been a significant achievement.

These experiences in the management of *E. coli* risks highlight the importance of inspecting and managing assets to ensure a closed system is maintained. These experiences also underscore the value of the maintenance of chlorine or chloramine residuals, the importance of nitrification management, and other simple strategies that can be implemented to improve chlorine or chloramine residuals.

The Author

Andrew Telfer (agtelfer@gmail.com) was Water Quality Manager with Lendlease during the implementation of the actions described in this paper. Lendlease is the Operations and Maintenance contractor for Coliban Water.

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BIO-AUGMENTATION OF WASTEWATER TREATMENT PLANT TO REDUCE AMMONIA

By Ryan Wong, Engineer, City Of Tea Tree Gully, Adelaide

Project details

The Greenwith Wastewater Treatment Plant (WWTP) was commissioned in 2011 and handed over to Council to operate. The WWTP influent is sourced from two sewage pumps stations owned by Council. This is commonly referred to as 'sewer mining', where the council takes raw sewage from the sewer reticulation system and treats it to re-use level.

The WWTP uses a Sequence Batch Reactor process with the following processes: raw influent screening; primary aeration; secondary aeration tank; balance tank; sand filtration; ultra-filtration membrane; UV disinfection; and chlorine disinfection. Design flow is 1.2 megalitres per day.

The WWTP was experiencing treatment issues, including septicity at the Sewage Pumping Stations (SPS), poor nitrification and a high level of organics post-aeration, reducing tertiary treatment processes.

Trial of bio-augmentation product – For Earth Bio Plus®

For Earth Bio Plus is a liquid bacteria product that contains nitrifying and denitrifying bacteria.

Prior to dosing the WWTP with For Earth Bio Plus, four jar tests were performed, which gave very positive results – a reduction in ammonia by 99 per cent, and total nitrogen by 54 per cent.

Bio-augmentation trial

After the review of the jar testing, a three-month trial commenced. For Earth Bio Plus was dosed at both SPS that fed the WWTP.

Samples were taken at SP3 (inlet), SP7 (aeration tank) and SP11 (decant to balance tank) daily to monitor the quality of the treated effluent. The parameters being monitored were ammonia, total nitrogen, total phosphorous, pH and more.

Trial results

The treatment results over the three-month trial period where very similar to our jar testing, with a significant drop of ammonia at SP3, SP7 and SP11, which helped us reduce the usage of chlorine at the tertiary treatment. Both total nitrogen and total phosphorous have a noticeable decrease, as well. pH is more neutral at SP3 and it is less acidic throughout the class B treatment.

Conclusion

We continue bio-augmentation of our influent with For Earth Bio Pus with ongoing positive treatment results, reducing the use of chemicals for pH correction as well as disinfection. Bio-augmentation has improved the nitrification process without the requirement of additional aeration or tanks.

ATP MONITORING IN NETWORKS

Anthony Borg

Western Water supplies water to a population of nearly 157,000 across the towns of Melton, Sunbury, Bacchus Marsh, Gisborne and much of the Macedon Ranges near Melbourne. The network consists of approximately 2,020 km of pipes and approximately 20 water storages.

The Field Services team has a focus on water mains cleaning, which is critical to ensuring best possible water quality is maintained throughout the network. To help achieve this, several cleaning programs are used:

1. Routine flushing – turning on a hydrant to increase the flow and remove sediments from that hydrant. Flushing is our most cost-effective way to resolve water quality complaints.

2. Air Scouring – introducing a mixture of air and water to scour the pipes. This is our most used method for planned maintenance programs.

3. Ice Pigging – introducing an ice slurry to the water main to clean bio-films when air scouring is not effective (e.g. low pressure or low flow areas).

Over time, several processes have been developed that help track and respond to water quality issues and complaints. These processes include a water quality database, a procedure for repairs on water mains and a water quality monitoring system to measure the effectiveness of the water mains cleaning program.

Water quality monitoring is critical to understanding the network and acting on any issues. We measure the chlorine residual and turbidity and have recently started using a new test that measures ATP (Adenosine Triphosphate). ATP is a molecule associated with cellular energy in all living cells including bacteria and any other living microorganisms in water samples. When a specific enzyme is added to a water sample with ATP present, light is produced. The intensity of the light produced is then measured with an instrument called a luminometer. The more living microorganisms, the more light is measured. The test takes approximately 8 minutes to complete. All tests are performed on site, regardless of the weather (Figure 1).

Figure 1. Performing an ATP test in the field.

The enzyme is supplied in a freeze-dried format. After hydration, the enzyme must be stored in a refrigerator at 4 degrees for short-term, or minus 20 degrees for long-term storage. Each test costs $18 compared to $28 for an external laboratory test, which may take a few days to receive a result.

Checking ATP has proven to be an indispensable tool, alongside chlorine residuals and turbidity testing. The testing unit is stored in a 40L tough case which is perfect for field use (Figure 1) and can be operated using a mobile phone App that can be run on the operator's iPhone. This App is used during ATP testing to take measurements, store results and can send the data collected in the field to office based staff via email. The mobile App also logs the GPS location of the sample point, enabling tested areas to be quickly mapped.

Testing in the field is quite simple and involves the following steps.

- Turn on the App.
- Enter the current location.
- Enter where the sample came from e.g. recycled or potable water.
- Fill the sample bottle.
- Calibrate the enzyme strength by adding 100μL of enzyme and 2 drops of Ultra-check calibration standard into one of the test tubes.
- Mix and put the test tube in the meter and record the enzyme strength on the App. This step is necessary as the enzyme strength will deteriorate with time and temperature. The calibration process allows for the changing strength of the enzyme when measuring the light intensity and therefore how much ATP in the sample.
- Pour 50mL of sample water into the syringe fitted with one of the supplied syringe filters.
- Pass the sample through the filter.

Figure 2. An example of report generated from the ATP App.

- Remove the filter, remove the syringe plunger and fit the filter back onto syringe.
- Dispense 1mL of the lysing agent (to extract the ATP from any living cells) into the syringe, pass through the filter and into the dilution tube provided.
- Using the pipette, extract 100µL of liquid from the dilution tube and put it in a test tube.

QGA cATP Interpretation Guidelines

Application	Good Control (pg cATP/mL)	Preventive Action (pg cATP/mL)	Corrective Action (pg cATP/mL)
Potable & Sanitary Water	<1	1 to 10	>10

Table 1. The guidance table.

- Using the pipette, extract 100µL of enzyme and add to the sample in the test tube.
- Mix and put the test tube in the machine and press start on the App.
- The machine will do its cycle and the result will come through on the App.

The testing kit supplier provides a table as a guide on how to interpret the results of the ATP test (Table 1).

At Western Water, management responses have been developed for the different ATP levels. If the ATP result is <10 pg/mL no action is required; however if the ATP result is between 1 and 10 pg/mL, additional monitoring is carried out. Any area with a high result (>10 pg/mL) is actioned for flushing until the result is satisfactory.

As part of Western Water's network characterisation, we have found some areas of the network read slightly higher than others, while also maintaining a good chlorine residual. Based on the combined results of turbidity, chlorine, ATP and the historical experience of the network, we can better determine when to flush the network to resolve potential water quality issues.

Prior to testing for ATP, water samples have previously been sent to an external laboratory, resulting in long delay times of up to 5 days. The most significant benefit of the ATP check is the instant reading that allows immediate action by field staff to assist in the decision-making process for planned and unplanned works.

I have used ATP testing extensively during our planned water mains cleaning program and as a follow-up check for large water main breaks. The ATP machine was a necessity when we had a major break on the 300mm mains on Riddell Rd in Sunbury to measure the effectiveness of the recharging and flushing program.

Figure 2 is an example of how ATP testing is used as part of normal network management. The report generated from the App clearly shows the benefit of flushing.

The first sample at this location taken at 3.44 pm on November 29 had a high ATP value of 13.56 pg/mL. Flushing was started and another sample taken at 3.50 pm. The value was a bit lower, but not good enough, so flushing was continued. A third sample at 3.54 pm had a value less than 9.85 pg/mL but I still wasn't happy with it so I continued flushing. The next sample at 4.37 pm had a low value of 3.57 pg/mL. All good, time to move on to the next problem!

By completing these checks, we can identify areas in the network that require additional cleaning.

Personally, I find the work that we do is rewarding, knowing that we are playing a significant role in providing safe drinking water to our customers. It is both a pleasure and a privilege to be doing this work.

The Author

Anthony Borg (Anthony.Borg@westernwater.com.au) is Water Quality Field Services Network Technician with Western Water in Victoria.

THE SWARM BUOY – MONITORING WATER QUALITY IN REAL TIME

Many lakes and reservoirs are used in Australia for both recreational activities and raw water supply. Monitoring their water quality is therefore crucial to estimate the risks to human health. Yet, water quality monitoring programs are currently limited by access to remote locations and the frequency of sample collections.

The SWARM buoy addresses these issues through real-time monitoring in remote locations. The buoy is equipped with multiple sensors and transmits the data every hour so that water authorities can advise citizens and water treatment plants in real time when water quality is degrading.

Multiple parameters are measured in real-time: turbidity, electrical conductivity, temperature, current speed, depth, dissolved oxygen and organic matter.

The SWARM buoy has been developed to be robust and reliable. It also requires

minimal maintenance, as it produces its own energy thanks to a solar panel and windmill. The buoy is therefore ideal for remote locations.

In addition to collecting data, the SWARM system includes algorithms that continuously analyse the data to provide early warnings of different water quality events. For example, the buoy can be used to predict algal blooms and therefore allow water authorities to take action before it is too late. A water quality forecast can also be provided to water treatment plants so that plants operators can optimise the treatment processes.

To find out more about the deployment of SWARM buoys, contact Veolia on 03 5339 3580 or aquaservices@veolia.com.

JAR TEST TRAINING. IS IT GOOD ENOUGH?

Peter Mosse

Jar testing is the single most important method to determine the coagulant dose for the treatment of water. While there are instrumental methods such as Streaming Current Detectors (SCD) or the COMPASS system, the majority of WTPs in Australia rely on operators setting the best dose of coagulant.

There are numerous examples where jar testing has been critical to achieving optimum process performance and treated water quality in the face of extreme weather events and natural disasters. One example is ash and dirt laden runoff following events like bushfires, that can provide significant treatment challenges for operators. Another is extremes in raw water turbidity following heavy rainfall or flood events.

An article published in the June 2003 edition of *WaterWorks* detailed the massive number of jar tests that were carried out by operators in North East Victoria to manage water treatment following heavy rains after a bushfire event (Figure 1). With turbidity rapidly rising as high as 129,000 NTU and then falling off fairly quickly over two weeks, North East Water operators conducted 350 jar tests over the two week period.

After heavy rain in southern Queensland in 2008, the turbidity in the raw water reservoir increased to about 100 NTU (Figure 2). Due to the constancy of the raw water quality in the reservoir over decades, this amount of turbidity increase was unexpected by the operators. They were ill equipped to manage the event. One of the identified problems that contributed to the subsequent poor quality of treated water was the lack of preparedness of the operators to conduct a jar test. Indeed the jar testing equipment onsite had not been used for years. As a result, the filtered water turbidity exceeded the target set for the filters for several hours and protozoan pathogens were detected in the final treated water from the plant.

More recently, a water quality issue occurred in Central Victoria in December 2017, where the turbidity in the raw water sourced from a lake increased to 120 NTU and true colour to 280 Hz. Some 36 jar tests were carried out in rapid succession over one day to determine a coagulant dose that worked. Alum doses up to 130 mg/L had previously been used at the site. Eventually, the operators were able to determine that an alum dose of 240 mg/L was required to achieve an acceptable treated water quality.

Figure 1. Poor quality water being followed by terrible quality runoff after the 2003 Victorian forest fires.

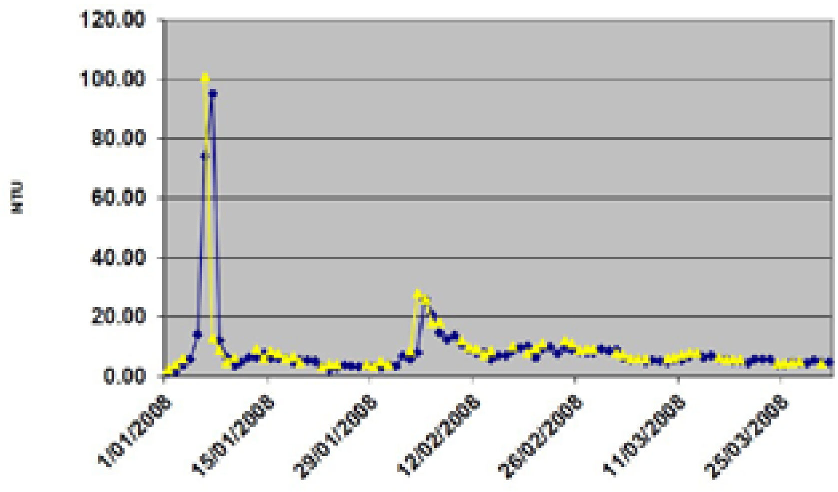


Figure 2. Raw water turbidity data after heavy rainfall in southern Queensland in 2008.

These are examples of the variability of raw water quality and implications for water treatment. WTP operators and technical support staff must be able to respond to changing conditions with confidence and speed. Jar testing is the main tool available to allow this. Therefore, all staff involved with operation of WTPs must be trained in this fundamental skill. Any Drinking Water Quality Management Plan should identify poor training as a risk and take formal, definite steps to ensure the training meets the needs of the operators and by extension, the consumers.

Figure 3. Operators undertaking jar test training. This type of training does not necessarily have to be undertaken in a laboratory.

There is a National Water Package Unit of Competence – NWPTRT015 Operate and Control Coagulation and Flocculation Processes. Under Elements and Performance Criteria in this unit the only entry is:

"1.4 Conduct jar tests and determine dosages".

There are also references to jar testing in the Assessment Requirements for this same Unit, but the wording is quite vague and by default leaves it up to individual Training Provider to interpret. As a result of the wording, it would be possible for the Training Provider to not include jar testing.

It is important that Water Utilities and those responsible for identifying training needs and procuring training services recognise the limitations of the current training system.

Firstly, depending on which organisation delivers the training, it appears possible to obtain a Certificate III in Water Treatment in Australia at present without conducting a jar test or indeed ever witnessing one.

The extent and quality of jar test training offered by Training Providers varies considerably.

Many operators have never carried out a jar test and admit to not knowing how to do one. Others advise that despite having had some training, they are not confident to do a jar test.

Specialist chemicals such as Powdered Activated Carbon (PAC) for removal of taste and odour and algal derived toxins, or potassium permanganate for removal of manganese are being dosed at many WTPs. This is without the operators being aware that jar testing can be applied to determine the dose of these chemicals rather than using guesswork.

We must provide our operators with the skills necessary to maintain effective water treatment and deliver safe drinking water in the face of changing weather and raw water quality.

The majority of Australian WTPs treat surface water that is subject to variation due to changing weather conditions and in particular, heavy rain. Most use alum as a coagulant but increasingly more complex coagulants such as poly aluminium chloride (PACl) or aluminium chlorohydrate (ACH) are being used. A very large percentage also dose polymer as a coagulation or flocculation aid. Increasing numbers of WTPs are also dosing PAC for control of taste and odour and algal toxins, and potassium permanganate, principally for manganese removal.

So what is needed?

Firstly, the assessment requirements in NWPTRT015 need to be reviewed and amended to make it a mandatory requirement that trainees undertake a range of jar tests before they can be awarded this unit of competence.

There are some fundamentals that any jar test training should include:

- Making up jar test solutions including different coagulants and polymers
- Basic alum jar tests
- Alum jar tests with pH adjustment
- Jar tests evaluating alternative coagulants, Alum, PACl, ACH and possibly ferric salts
- Polymer jar testing including assessment of different types of polymers to determine which is best and where and when it should be added
- PAC and potassium permanganate jar tests as required.

There should also be sufficient equipment to allow all trainees practical hands on experience. As a guide, there should be no more than 3 persons per jar test machine and preferably 2 persons (Figure 3).

Water Utilities need to carefully assess what is being offered and whether it meets the needs of their WTP operators and whether it adequately reduces the risk associated with changing raw water quality. Operational staff and risk management staff need to be involved in the training evaluation and procurement process.

Training Providers need to closely consider their offerings to ensure the needs of the industry and consumers are met.

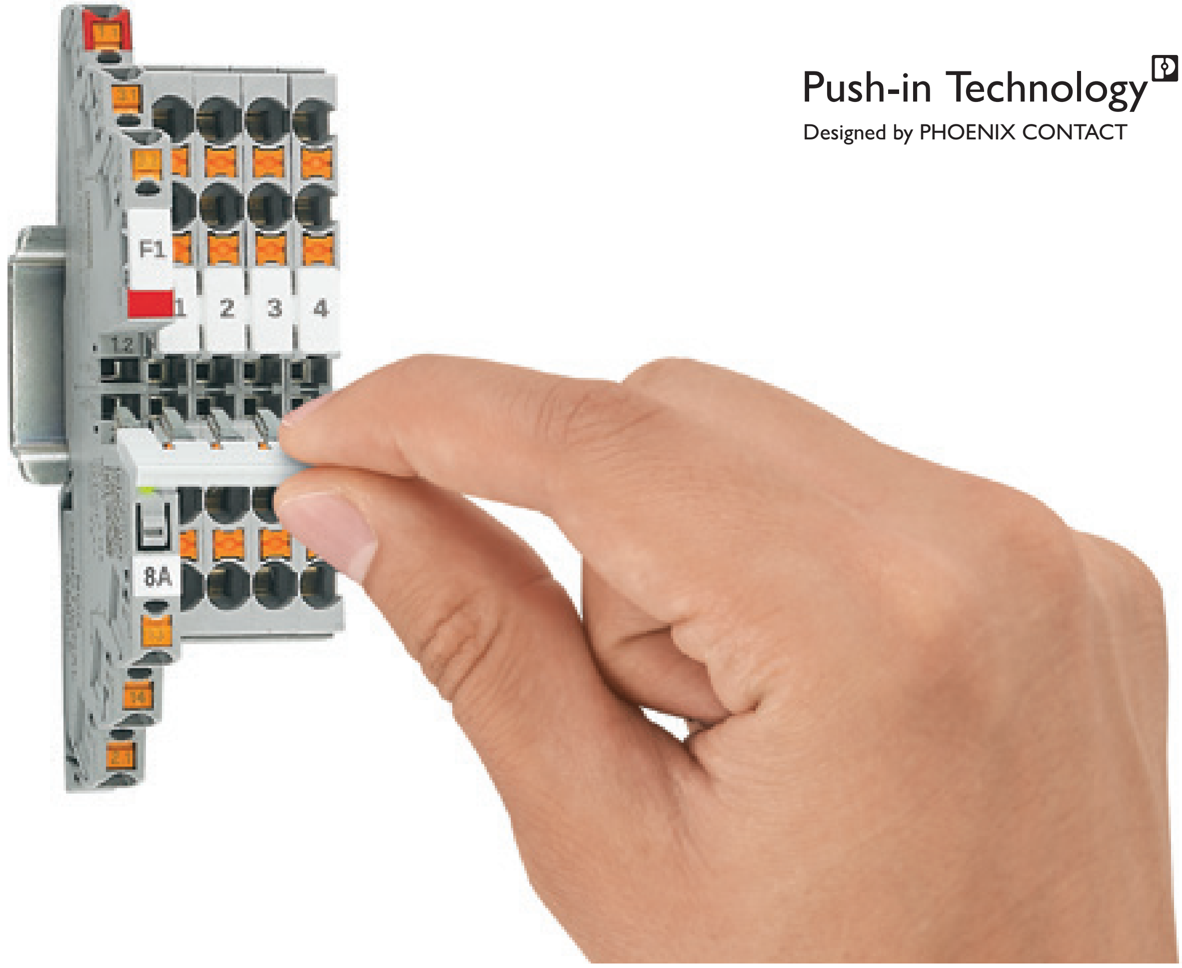
In the aftermath of both the Walkerton event in 2000 and the Havelock North event in 2016, poor or inadequate training was identified as a contributing cause. We need to move before Australia has a serious water quality event and a high level government enquiry identifies the same deficiencies.

But initial high quality training is only the first step. Skills newly acquired can be lost quite quickly. Regular practice is required to maintain the skills. Practice needs to be implemented as a formal requirement in the risk management process. Why not set up a mandatory monthly jar test requirement for all operators? And to increase the challenge and introduce a bit of fun, make up a bulkibox of "unknown" water. Get some water from a local creek or reservoir, add a few handfuls of dirt and perhaps a few tea bags, mix well and give a sample of the "unknown" water to all the operators. See what results they obtain from their jar tests and compare the results between the different operators.

This will ensure that on the occasion when water quality does change, they will have the confidence to undertake a jar test.

The Author

Peter Mosse (peter.mosse@gmail.com) is the principal of Hydrological, a water industry consultancy company.



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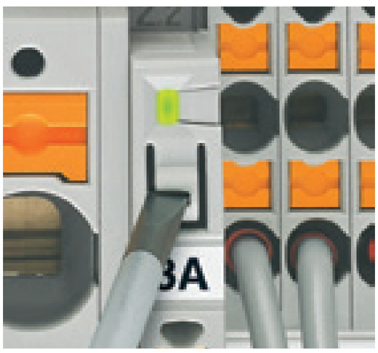

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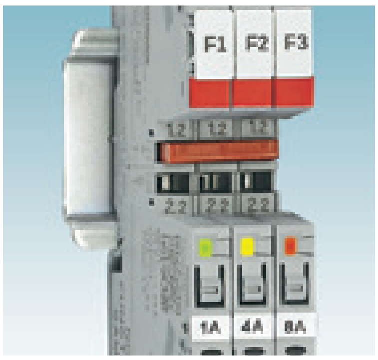

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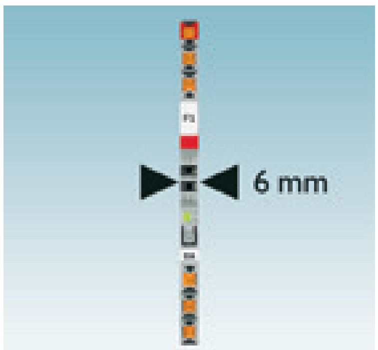

MORE SPACE IN THE CONTROL CABINET

PHOENIX CONTACT
INSPIRING INNOVATIONS

DENSO LAUNCHES NEW HEAT SHRINK SLEEVES IN AUSTRALIA AND NEW ZEALAND

Leaders in corrosion prevention and sealing technology, Denso Australia is this year celebrating its 50th year of operation in Australia. Denso's track record spans a number of water industry infrastructure projects, with its products widely used on assets ranging from pipelines and water treatment facilities to irrigation and potable water systems throughout Australia, New Zealand and Papua New Guinea.

Denso's new range of Heat Shrink Sleeves offers cutting-edge protection to steel pipelines.

With an eye on continuous research, development and improvement of their product range, and in partnership with Vogelsang, a German manufacturer, Denso Australia has introduced a unique range of sleeves suitable for both the water and gas markets. The new Heat Shrink Sleeves have undergone extensive testing in Europe to DIN EN 12068 and DIN 30672.

Features of the new sleeves include self-repair characteristics (butyl rubber-based adhesive), a thermal indicator, high mechanical stability and low water vapour permeability.

The new range of Heat Shrink Sleeves will be marketed in Australia as Premier Shrink Sleeves™.

With extensive European and Australasian case histories with major water and power operators, municipalities and gas asset owners in Germany, Austria, Lithuania, Croatia, Romania, Poland, Vietnam and Hong Kong, Denso recently engaged Deakin University to carry out testing on the new range of Premier Shrink Sleeves™ to the Australian standard AS 4882, which passed with resounding success.

Recently, Denso Australia supplied the Premier Shrink Sleeves™ on an APA Networks Pipeline installed by National Australian Pipelines in Melbourne, and a South Australian water project with the sleeves applied in Adelaide by Smart Fabrications.

The new Heat Shrink Sleeves are starting to generate a lot of interest within the pipeline industry and Denso looks forward to supplying a range of premium Heat Shrink Sleeves to various asset owners across a variety of industry sectors.

CLEANING UP COMMUNITIES

Flo-Max Australia Pty Ltd is a 100 per cent Australian-owned and -operated contracting organisation with an extensive background in pipeline and equipment cleaning and maintenance extending for more than 25 years. Flo-Max offers long-term solutions through the specialist cleaning services of pipeline pigging, air scouring and chemical cleaning, as well as facilities management through the operations and maintenance of pipelines and water supply systems.

Flo-Max has successfully cleaned several remote townships in Western Queensland. Works were completed over two months and incorporated the use of both air scouring and pipeline pigging. The Chinchilla township also benefited from the services of Flo-Max, having had their entire township cleaned by the air scouring method. Flo-Max has developed succinct procedures, and purposely built pigs, to assist with the cleaning of pipelines of any distance to remove soft slimes, silts and hard scales.

We are proud distributors of Knapp Polly Pigs and Australian-manufactured Bullseye Pumps. In addition to these distributorships, we also offer a cost-effective alternative for the supply of pig launchers and receivers with our own designed Standard Series of pigging traps.

For further information about our capabilities, visit our website at www.flomax.com.au or contact our head office on 07 4942 8544 or mackay@flomax.com.au.

BIOSOLIDS LOADING WEIGHT SYSTEM

Peter Uwland

The Problem

Waste Activated Sludge (WAS) from the Warrnambool IDEA STP is dewatered by two separate belt filter presses and fed to sludge cartage contractor bins (Figure 1).

The problem was that there was no way of determining when the bins were full with the correct weight of biosolids. Instead this relied on an operator being present on site, visually checking the bin volume and making an estimation based on loading time, experience and visual volume. There was no weighbridge onsite so the contractor was transporting loads to the nearest weighbridge some 15 kilometres away. With the many variables associated with biosolids (solids concentration, solids dryness, poly batching and wash water) it was challenging to get a consistent weight of biosolids into the bins. This had been an issue at the Warrnambool STP for over 25 years (the life of the current plant). There had simply never been a reliable way of determining the correct weight of biosolids loaded into the bins.

As a result, on occasion, the bins had been overfilled by several tonnes and on other occasions the bins were under weight. This meant either unsafe loads being transported, overspill or having to drop biosolids on the ground, or inefficiencies in transport costs from under filled bins. There were significant costs in down time and contractor and equipment hire. There was also a significant OHS issue with the operator accessing the top of bins for visual checks (Figure 2).

The requirement for the operator to be continually onsite resulted in high overtime costs with operators working after hours and on weekends which was impacting on the work life balance of the operators.

There were also environmental risks at the site with leaking bins (Figure 3).

When connecting the trailer bin for filling with biosolids, the contractor would typically hook up the truck's air supply for the bin trailer's air bag suspension. The trailer had a pressure gauge on the side. We started checking the pressure gauge against the weighbridge dockets and found that we could estimate when the bin was full, purely based on air pressure.

Figure 1. Sludge carting contractor bins ready for filling.

Figure 2. Accessing the top of the bin to see the level of the biosolids posed a safety issue.

Figure 3. An example of liquid leaking from one of the bins (left) and the contents of an overfilled trailer spilling onto the ground (right).

The Solution

Firstly, we connected a constant air supply to the trailer bins from our existing air compressors for the belt filter presses (Figure 4).

The blue air line supplies compressed air to the air bag suspension and the red air line supplies the pressurised air from the air bag suspension back to the pressure transducer/transmitter.

This helped the operator read the trailer's pressure gauge to determine how full the sludge bin was. We then installed a digital pressure transducer/transmitter connected to a second air hose off the trailer's air supply. We connected this pressure transducer/transmitter to our Citect and the SCADA team programmed the gauge pressure and controls. This then gave the operator a constant Citect reading on pressures and trends (Figures 5 and 6). It also allowed the trailer bins to swap duties when the pressure set-point was reached, or shut down the whole dewatering process either if both sludge bins were full, or if there was no bin present.

With the new control system, we were able to fill the bins to within 200 kilograms of the full 27 tonnes capacity. Prior to this it was easy to go several tonnes over or under the limit. This meant increased efficiency in ensuring every load going offsite to our drying facility was being optimised.

Another bonus of our new system was the ability to operate the belt filter presses outside normal working hours and have the confidence to fill the trailers and rely on the system shutting down. This proved extremely useful during the recent upgrades where the original 25-year-old belt press was decommissioned and replaced with a centrifuge. During that project there was a requirement to reduce our wasting of MLSS (Mixed Liquor Suspended Solids) from approximately 40 l/s to less than 20 l/s for several months due to the filter belt removal. The sludge bin pressure system allowed us to operate for extended times and weekends to maintain tank MLSS and sludge age.

The whole project cost less than $10,000 in goods, equipment, and labour yet delivers huge ongoing cost savings for Wannon Water.

The Author

Peter Uwland (peter.uwland@wannonwater.com.au) is the Treatment Operations Coordinator with Wannon Water in Western Victoria.

Figure 4. The bin trailer connected up to the air lines.

Figure 5. The bin trailer load "pressure" gauge.

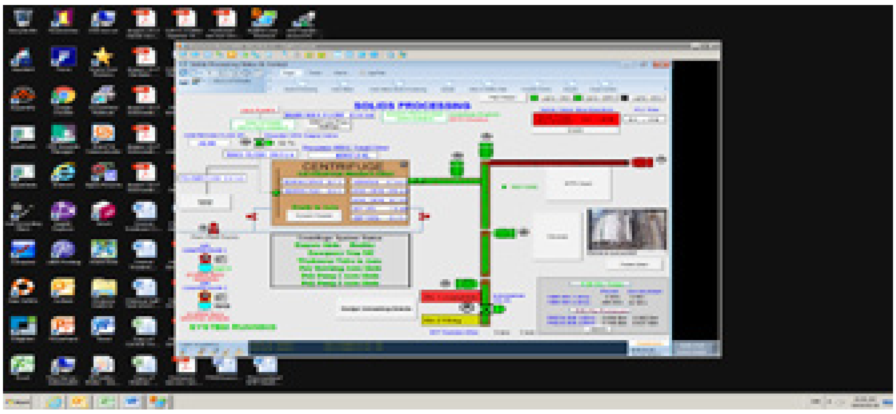

Figure 6. Part of the SCADA screen showing the trailer bin controls.

MEMBRANE MANAGEMENT FOR COST EFFECTIVE OPERATIONS

Colin Ellett, Konrad Mueller & Kathy Northcott

Veolia operates three WTPs under the AQUA 2000 contract with Coliban Water, to supply drinking water to Bendigo, Castlemaine and Kyneton. All three WTPs are advanced microfiltration (MF) plants with a combined capacity of around 150 ML/d. The three microfiltration plants have been fully operational since 2002 and since then the Bendigo team has collected a significant body of knowledge on membrane performance.

There are some basic principles of membrane monitoring and management that can increase the cost effectiveness of membrane operations. Proactive maintenance, monitoring and continuous improvement in membrane operations has enabled the team to be proactive regarding membrane ageing and fouling issues, as well as responsive to changes in operation or feedwater quality.

Understanding the Impact of Feedwater Quality

Membrane performance issues almost always relate back to feedwater quality. Hence it is important to understand the physical and chemical characteristics of feedwater, and how it relates to membrane performance. The following parameters are often a good starting point when considering potential impacts to membranes from feedwater quality issues:

- Source water type
- Temperature
- Oil and grease
- Chlorine
- Turbidity
- Organic content
- Inorganic content.

The nature of the source water to the membrane process has major implications for the operating philosophy and future membrane performance. Some operating considerations include:

- Surface reservoir sources generally have a longer backwash interval, whilst secondary effluent sources have the shortest.
- Secondary effluent Trans-Membrane Pressure (TMP) rise setpoints between backwashes are more conservative as there is higher risk of organics fouling, which can be difficult to manage through cleaning.

Water temperature range, the presence of oils and greases and chlorine (or more generally oxidants) concentration can all have a major impact on the long term condition and performance of membranes. Typical ranges for these parameters are:

- Temperature: 1 to 40 deg C, where lower temperature requires higher feed pressure.
- Oils & greases: Preferably zero ppm, but 1-2 ppm may be tolerated with additional cleaning.
- Chlorine/oxidants: highly dependant on the membrane material. Polyvinylidene fluoride (PVdF) membranes can withstand a concentration of 1mg/L chlorine for 750,000 hours (ppm-hours), whereas Polypropylene (PP) membranes can only withstand 100 ppm-hours.

Membrane suppliers may state that microfiltration/ultrafiltration (MF/UF) membranes are capable of operating with feedwater turbidities of up to 250 NTU. Whilst this may be feasible for short periods of time, such high turbidities cause high resistances, short filtration run times and large volumes of backwash water. Longer term operation at high turbidity causes serious issues with poor backwashing, solids build-up, pore-plugging and irreversible fouling resulting in shorter membrane life. As a general indication for municipal applications, typical feedwater turbidity should be less than 30 NTU. Otherwise further pretreatment processes should be considered.

There are two main pathways for organic fouling on membranes, presence of organics in feedwater, or the growth of biofilms. Biological fouling is caused by the growth of microorganisms which consume the organic matter in the feed water. Biofouling increases TMP and reduces membrane flux. Prevention can be achieved though regular backwashing and air scour. Build-up of biofilm can be removed with chlorine (oxidant resistant membranes only), or biocide.

Organic fouling occurs through adsorption onto the membrane surface. Major organic fouling can be prevented by reduction of organic content with coagulation and filtration or activated carbon before MF/UF. Removal can be achieved either by high pH (alkaline) or chlorine clean, depending on membrane material.

Inorganic fouling is caused by various predominantly metallic compounds (e.g. calcium, magnesium, iron) building up on the membrane surface. High alkalinity feedwater can increase fouling (i.e. carbonate scales). Excessive inorganic fouling can be prevented through various forms of pretreatment (oxidation / precipitation / filtration before UF). Removal can generally be achieved by a low pH (acidic) clean.

Membrane Performance Monitoring

The basic principal of membrane operation is to allow water to pass through whilst holding back particles based on their size or other physical characteristics. Membranes are not really designed to treat excessively turbid waters for extended periods, but are in fact intended to be a highly effective barrier to pathogens (bacteria and protozoa). The MF/UF filtration objective is to maintain a consistent flow across the membrane. The TMP increases with increasing filtered water volume, as a fouling layer forms. Build-up of surface fouling on MF/UF membranes is controlled by backwashing. Typically a combination of pressurisation followed by a quick pressure release and/or air scour and flushing.

Optimisation of membrane performance is achieved by careful monitoring and appropriate response to the following parameters:

- Membrane integrity
- Membrane TMP and/or resistance

- Recovery after backwash
- Recovery after chemical clean (Clean in Place (CIP) and Chemically Enhanced Backwash (CEB))
- Backwash troubleshooting.

Continuous online integrity monitoring, such as turbidity and/or particle counts are monitored to ensure membranes are providing adequate pathogen removal. The required level of treatment is set by water businesses as part of their Drinking Water Quality Management Plans (DWQMPs). Important treatment barriers such as MF/UF filtration will often be included as part of the Hazard Analysis and Critical Control Point (HACCP) assessment, where strict limits on turbidity and/or particles may be set as a Critical Control Point (CCP). Periodic membrane integrity testing, such as the pressure decay test (PDT) are also used to determine a log removal value (LRV) for the effectiveness of the membranes as a barrier to pathogens.

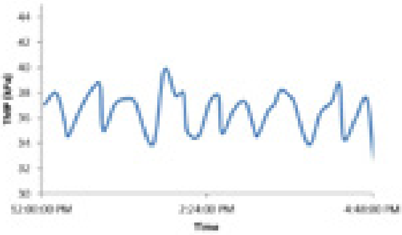

Figure 1. Change in TMP over a five-hour plant run for a pressurised MF system.

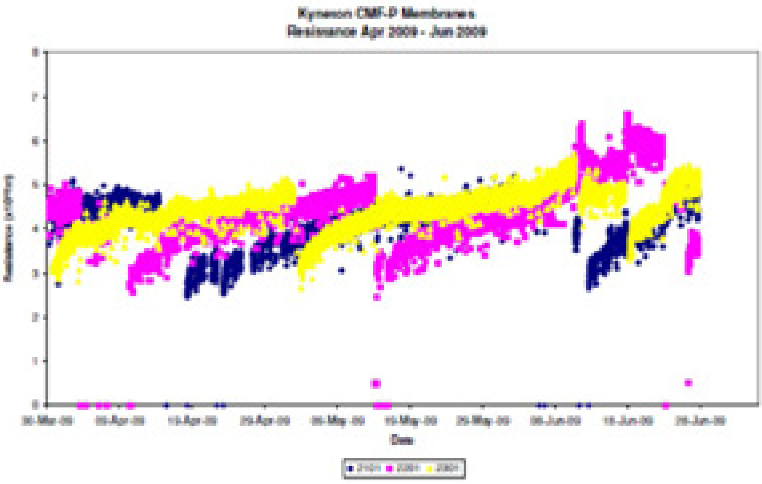

Figure 2. Resistance recovery after chemical CIP on a pressurised membrane system.

The other key membrane performance parameter is membrane TMP or membrane resistance. These parameters measure the extent of fouling on the membrane. Ideally in a well managed system, the TMP or resistance will recover after a backwash, with the acceptable backwash recovery generally specified by the membrane supplier. Figure 1 shows how the membrane TMP recovers after each backwash during a typical membrane plant run.

Similarly the TMP and resistance should recover substantially after a chemical clean-in-place (CIP). Figure 2 shows the recovery after an acid/caustic CIP for polypropylene membranes.

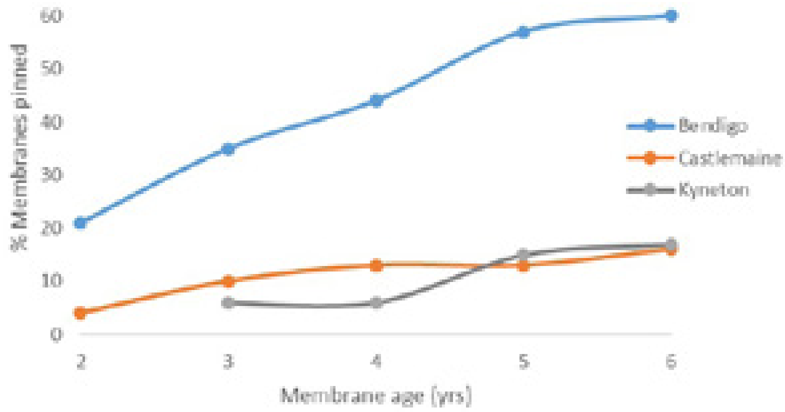

Figure 4. Membrane maintenance statistics (percentage membranes pinned) for the three Aqua2000 plants.

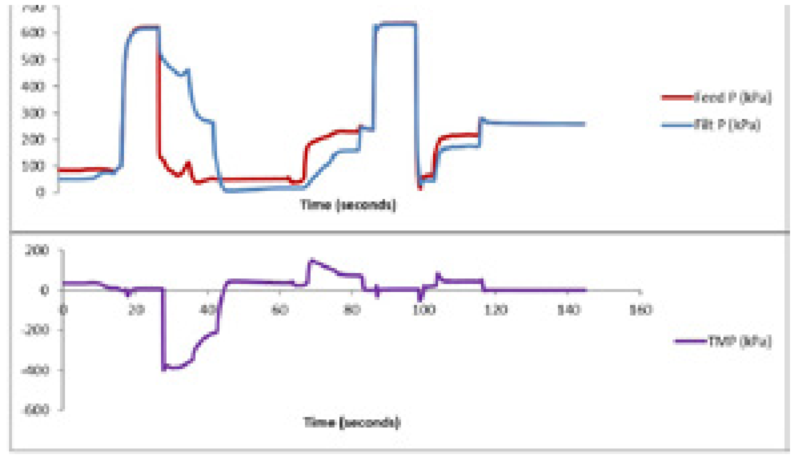

Figure 3. Example backwash snapshot for a pressurised membrane skid.

Troubleshooting problems with membrane backwash is a crucial part of monitoring membrane performance.

Problems with backwashing can be identified by the following:

- Poor TMP recovery after backwash
- Build-up of solids in membrane bundle (identified by visual inspection).
- Increase in resistance higher than normal
- Reduction in flux and/or permeability (ability for membrane to pass water).

If problems with backwashing are identified, options are to

- Review and adjust the backwash frequency
- Conduct a backwash snapshot to identify system problems.

Backwash snapshots are typically carried out by a professional technician. However, they can be a highly effective tool for identifying problems with valve operation, draining and pressurisation of housings, too much or too little air during scouring (see Figure 3). It is recommended that backwash snapshots be performed annually to identify issues with the membrane system.

Membrane Maintenance

Membrane testing and repair should be conducted on a routine basis to ensure good condition and performance of MF/UF membranes. Monitoring results of PDT tests and LRVs will help operators to determine if there is a problem with failing membrane integrity.

Conducting a sonic test or leak test, which pressurises the membrane so that only broken or damaged fibres will allow the air to escape, will allow the operator to inspect the membrane skids or cells, and identify and mark the location of faulty membranes on a test sheet. For pressurised membranes, sonic testing and in-situ bubble testing are often used to identify a leaking membrane. For submerged membranes, visual checks are undertaken to look for air bubbles from leaking membranes.

Some facilities will “lock-out” the offending membranes and conduct pinning at a later date. During pinning the offending membrane is placed in a test unit or, in the case of in-situ pinning, a test mode. Air is applied to the fibres which then shows up a stream of bubbles coming from a faulty fibre. The fibre is then sealed with a pin. If the damage is in more than one fibre (i.e. a small area) then a patch can sometimes be fitted. For ex-situ pinning, all o-rings are then checked, lubricated and the membrane is reinstalled. Another leak test is conducted to make sure that the right membrane was repaired.

The Importance of Good Record-keeping

Membrane maintenance activities are recorded in the membrane “Module-Map”. The database contains information on the frequency of membrane inspections, membrane pinning and patching, membrane replacement, dry membranes and damage to membranes.

The database can also be used to generate reports to investigate trends in maintenance and membrane performance. It is essential that all maintenance activities be recorded. This includes observations of wear and damage for replacement and warranty requirements and the number of pins and patches which can be used as an indication of need to replace membranes.

Suppliers often have recommendations for maximum acceptable number of pins. For example Norit recommend no more than 0.25% of fibres to be pinned in a 12 month period (which equate to around 30 lumens).

Membrane discards can also be used to indicate end of membrane life.

Figure 4 provides a comparison in the membrane pinning data for three different types of Memcor membranes.

- Bendigo – submerged PVdF membranes
- Castlemaine – high pressure PP membranes
- Kyneton – low pressure PVdF membranes.

This kind of data allows the team to prioritise maintenance activities and plan for future membrane changeouts.

The Authors

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SOIL SURFACE TENSION AND CHARGE BALANCE

A new tool to optimise irrigation and dust strategies

Established agriculture practices call for the use of gypsum or lime to help modify soils, particularly sodic clays, through an ion exchange mechanism to free the soil from exchangeable sodium, promote water infiltration and reduce dispersion tendency for greater friability. This proposition appears to have limitations, and the irrigation market is looking for alternative, faster-acting solutions.

Our hypothesis that polyether-modified siloxanes will enhance wetting tendency and assist in the movement of water through the soil profile, as well as the additional hypothesis that silicone quats will provide an avenue for ion exchange to displace sodium, are tested in field activity. It is noted that when these chemistries are used together, the effect of reduced surface tension and higher cationic charge provide a directional guide for water and electrolyte movement with significant implications for soil health, environmental considerations and cost issues arising out of irrigation processes.

Through the use of patented siloxane chemistries, field studies show that it is possible to increase or reduce the infiltration rate of water, and expel sodium from and through soil much more rapidly than either gypsum or lime.

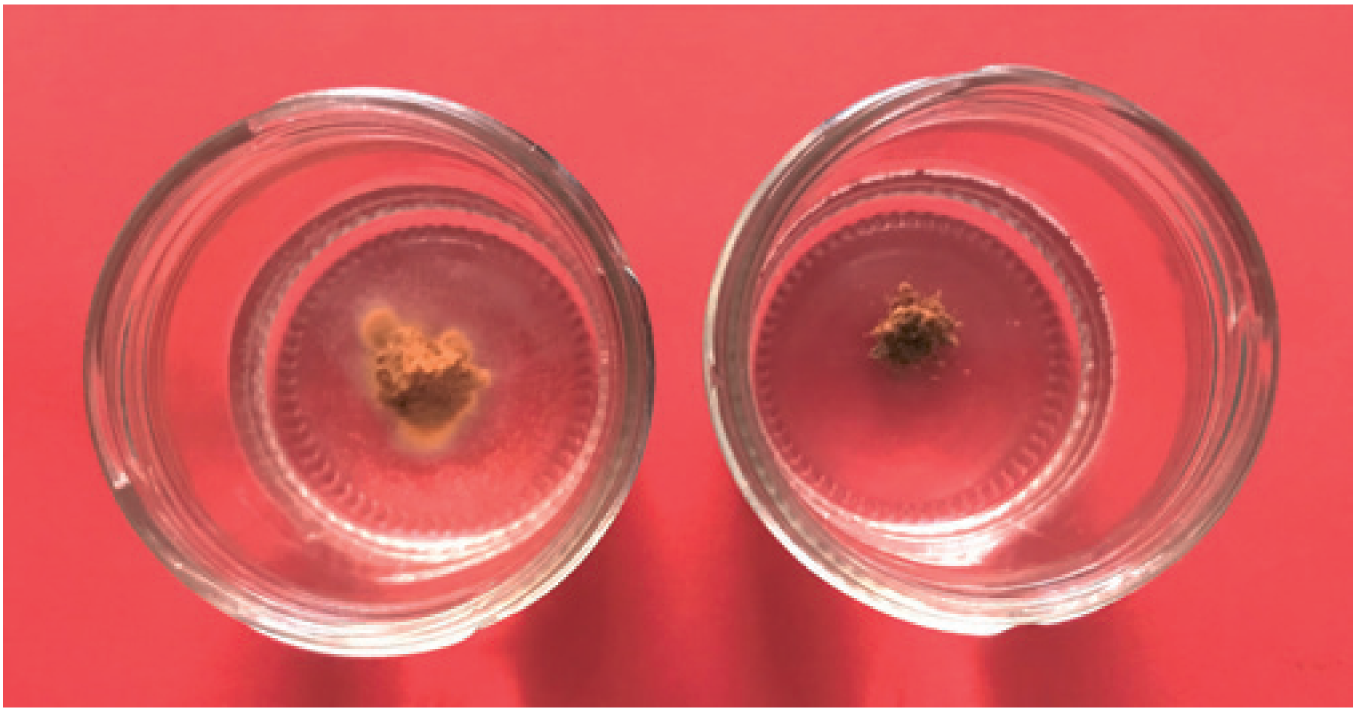
These products, called AQUA-SIL, are made in Germany from a new generation of inorganic polymers that act to change the behaviour of the soil in respect of water movement. They are liquids and are applied in high dilution through irrigation or planting water to the soil for the equivalent costs of what you may spend on lime or gypsum.

Whether your objective is higher soil friability, less stickiness, lower dampness on harvest or changes to water infiltration, it is time to think beyond gypsum and lime, and start thinking about surface tension and charge balance. Once you do that, a whole new dynamic of soil management opens up for you to optimise your chemical and irrigation programs, and reduce your overall cost.

If you really need increased calcium, then the use of lime or gypsum becomes much more effective with a greater flow of water through the soil. The other benefit is that, by increasing the flow of water through the soil, you are more likely to disperse and release retained nutrients much more efficiently.

In Australia, many of the agricultural soils are clays, sodic and at times hydrophobic, which contribute significant complexity and compromise the delivery of irrigation programs. Of all the functions that water serves in irrigation, none is more important than its mobility through these soils, and much effort has been expended to optimise and conserve water usage. AQUA-SIL is focused on the movement of water through the soil profile.

The benefit of these new products is that you can now overcome dispersion problems and achieve soil behaviour modification in a short space of time. Furthermore, the use of lime or gypsum becomes more efficient with AQUA-SIL-treated soils. By managing the flow of water through the soil, you are more likely



to disperse and release retained nutrients much more efficiently, giving you greater control of your chemical program, allowing you to reduce costs and strengthen your sustainability focus by reducing leaching behaviour through the soil.

If you want to know more, look out for us at the 2018 Irrigation Australia Conference and Exhibition (booth J14), the Hort Connections Exhibition Brisbane Convention Centre (18–20 June, booth 144/179), the Agritech Workshop demonstration, or our presentation on Friday 15 June 2018.

You can also email us at agriculture.australia@cht.com, or visit our website, www.cht.com/agriculture.trial-request.

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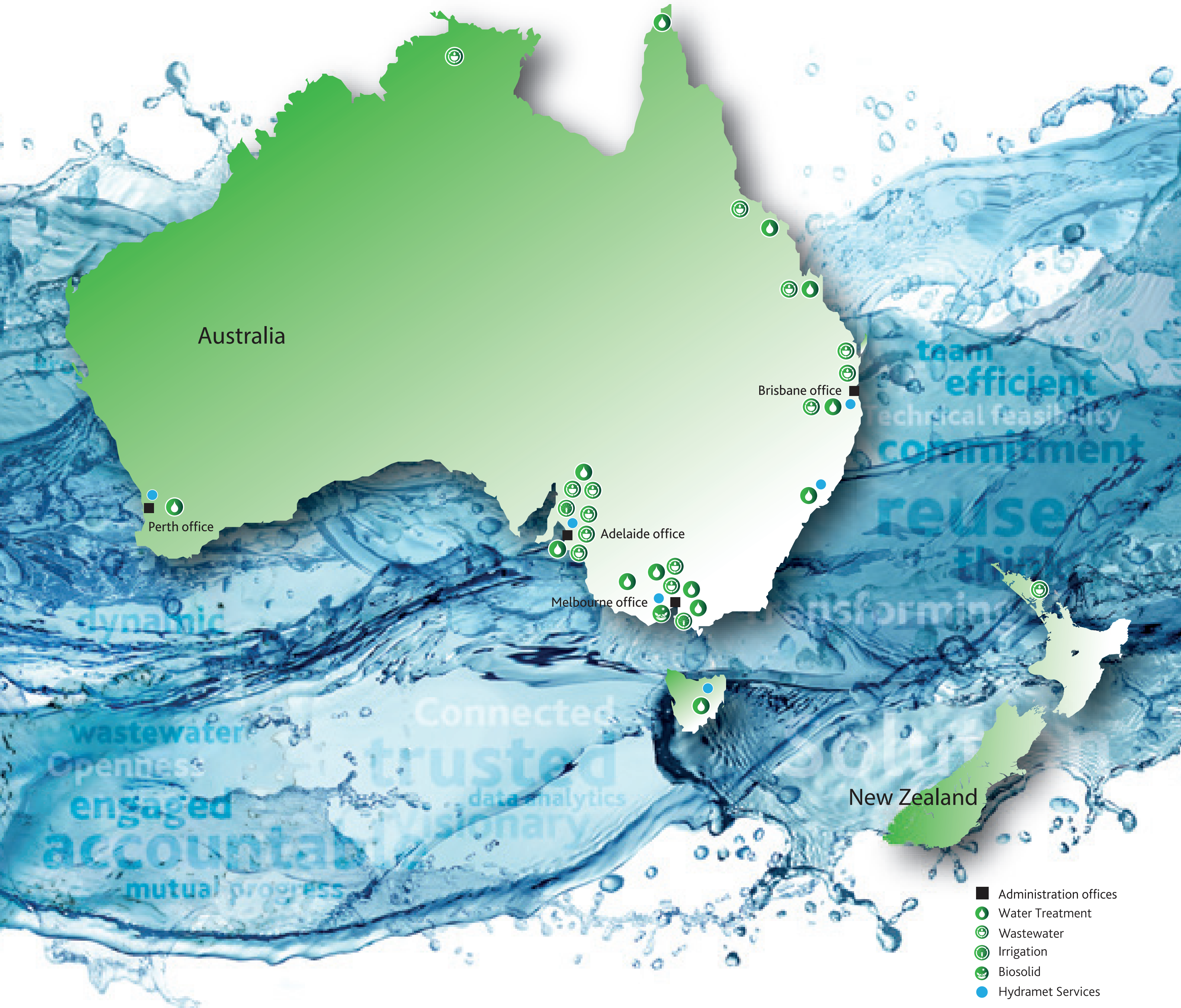

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