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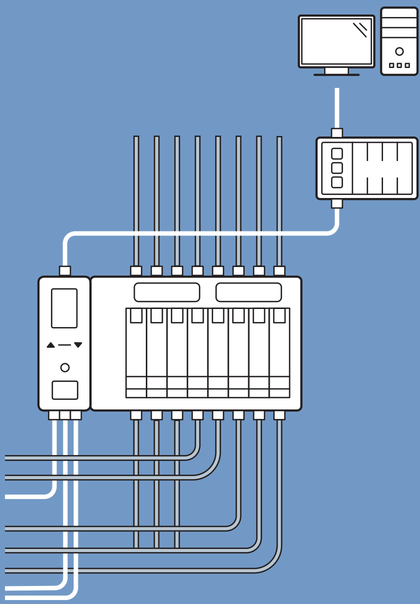

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WaterWorks
OFFICIAL JOURNAL OF THE WATER INDUSTRY OPERATORS ASSOCIATION OF AUSTRALIA

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Contributions Wanted

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

CONTENTS

OPERATING IN DIFFICULT TIMES

The resilience of the water industry, and in particular the skills of the operational staff have been tested in unprecedented ways in recent months. Many have been dealing with the impacts of drought; massive bushfires followed by water quality issues resulting from fire affected runoff; floods; and now we are all meeting the new challenges of COVID-19.

True to form, with the majority of the community in lockdown and working from home, operational staff are still out in the field on a daily basis, continuing to deliver high quality and safe water and wastewater services to our communities. That so few in the community even think about or recognise the fact that there is an army of operators keeping everything running around the clock, does not detract from the importance of your task and we applaud and appreciate your ongoing efforts.

Like many other businesses, the COVID-19 pandemic has had a major impact on WIOA and our operations. With the majority of WIOA's engagement with our members done through face-to-face events such as conferences, seminars and interest days, all these activities have needed to be suspended, hopefully only temporarily.

Unfortunately, WIOA had no choice but to cancel the 2020 New South Wales, Queensland and South Australian conferences and exhibitions. We have also rescheduled the 2020 Victorian Conference that was to be held in September to the last week of November to give the event the greatest chance of proceeding. As the country comes out of lockdown in the coming months, we will monitor the situation and keep our members informed.

In response to the social distancing restrictions and the cancellation of events, WIOA is now investigating the use of digital platforms to allow us to continue with our important role of collecting and sharing information in support of our members. We plan to continue to deliver our webinars along with other initiatives to increase engagement with our members and the broader water community.

We have created a page on the website that we are regularly updating which includes links to the latest information on the pandemic from a variety of trusted sources. We will continue liaising with other water industry peak bodies, including the various Water Directorates, to ensure that we can share appropriate information or provide any assistance when required.

Our congratulations are extended to Heidi Josipovic from Albury City Council who was recently re-elected as WIOA President for another year. Heidi is an integral part of WIOA's Diversity and Inclusion working group doing some great work to assist the association with initiatives to ensure that we have an inclusive culture that embraces diversity, celebrates our differences and encourages and supports participation. The group is focussing on new initiatives, activities and events to promote and celebrate diversity in our industry.

WIOA President Heidi Josipovic on International Women's Day – #IWD2020 #EachforEqual.

OUR COVER

Matthew Smith and Joel Hargreaves from Tamworth Regional Council's Environmental Laboratory collecting groundwater samples from Tamworth's Reuse Farm as part of regular environmental monitoring. The sampler can collect samples for depths up to around 40 m.

WIOA had planned to launch our new Certification web-based portal "Acuario" at the NSW conference but these plans were shelved due to the forced cancellation of the event. Developed with the assistance of funding support from the Australian Services Union (ASU), the new portal is making it much easier to record and maintain the data and Continuing Professional Development (CPD) activities of certified operators. The Acuario system is available for new applicants to register to be certified under the WIOA Certification Scheme, and we invite all certified operators and their employers to access the system at https://wioa.org.au/certification/.

Having appropriately trained and competent operators is vitally important for our industry. With the provision of face-to-face training not a viable option at present, we are aware that many training providers are currently converting some of their courses to a digital format. Technology is being used in innovative ways with cameras and real time monitoring options being developed and used as part of the training and competency assessment process. One positive from the pandemic is that utilising this type of technology will become an important tool in the future, particularly in supporting the training of operators in our regional and remote communities.

Now more than ever before, industry associations like WIOA will play a vital role in the ongoing support of our members and the water industry. We encourage all our members to communicate the benefits of participating with WIOA to your water industry colleagues and we look forward to your support at our coming events, both online and when we get to meet again in person.

Stay safe and well, and we hope to catch up with you all soon.

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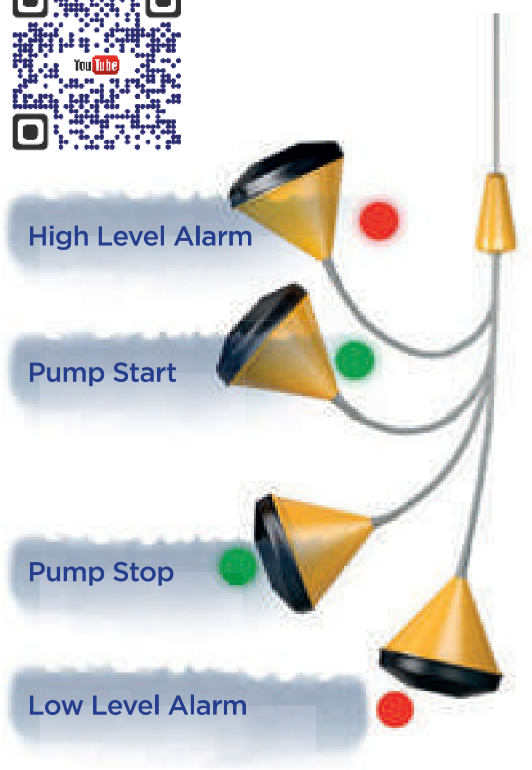

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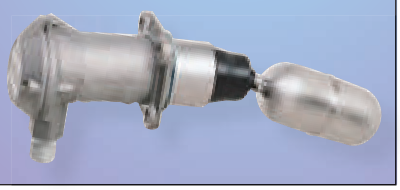

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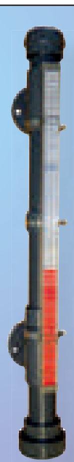

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COMMUNITY BENEFITS OF RECYCLED WATER

Winner of the Best Paper by an Operator at the 2019 WIOA Queensland Operations Conference

Andrew Watson and Shay White

Kingaroy is located approximately 200 km north west of Brisbane within the South Burnett region of Queensland and is administered by the South Burnett Regional Council. It is known as the peanut capital of Australia. The current population is approximately 12,500 people with 9,000 EP connected to the sewer system. The average rainfall for Kingaroy is 670 mm of which most falls between November and late January. June to September is typically a dry part of the year.

As an operator writing this paper, I believe that there should always be a priority with effluent "filter it, farm it and then discharge it – to the creek". Recycling wastewater is not a new idea, but with advancements in wastewater technology, the production of recycled water is now more achievable and stable. This puts less pressure on the natural water courses, aquifers and potable water supplies.

The Kingaroy WWTP (Figure 1) has the ability to produce Class A+ recycled water providing community benefit to the local sporting field, golf course, show grounds as well as on-site reuse. The local golf course and sporting fields take up to 690 kL and 330 kL of recycled effluent per day, respectively. The secondary effluent from the plant is of such quality that after disinfection and detention, it can be applied directly to the South Burnett Regional Council neighbouring 30 Ha farm. The effluent is applied using two fixed pivot irrigators to commercialise a resource and reduce the residual nutrient load that would otherwise end up in the catchment that provides Kingaroy's water supply. Considering the ADWF to the WWTP is around 1.8 ML/d, it is easy to have at least half of the effluent diverted to good use. Since the irrigators have come online, the plant has had days where the reuse of the effluent is up to 85%, with the overall goal being zero discharge by reusing everything coming in during dry conditions and where demand is high. With popularity growing in the use of recycled water, it is nearly a full-time job to monitor demand and supply from our plant.

How the Process Works

The Kingaroy WWTP uses the Nereda® process which was developed by DELFT University in the Netherlands. Conditions are manipulated within the aerobic bioreactor to encourage the activated sludge biomass to form granules. These granules are responsible for the biological removal of phosphorus and nitrogen. Another benefit is the granules have an outstanding settling capability compared to traditional activated sludge floc. The Kingaroy system works through a balance tank that feeds one reactor at a time whilst the other reactor is in operation or reaction. Another major benefit of the process is the small plant footprint, at most, half the size of a conventional oxidation ditch treatment plant, resulting in significantly reduced capital expenditure.

The influent received by the WWTP is mainly domestic apart from some septage. The treatment process is summarised in Figure 2. The influent enters the WWTP for primary treatment, passing through screens and grit removal infrastructure. The screened influent is held in the balance tank until fed into the reactor for secondary treatment. After secondary treatment is complete, the effluent is passed through a secondary clarifier and filter feed tank where it is stored for the start of Class A+ reuse. If the filter feed tank is full, the effluent will be chlorinated and diverted to detention lagoons where it passes through earthed and walled baffling for a minimum 25 days. The result is a Class C product suitable for use on the farm or discharged to Kingaroy Creek via a measurement flume.

Figure 1. Kingaroy WWTP 2019.

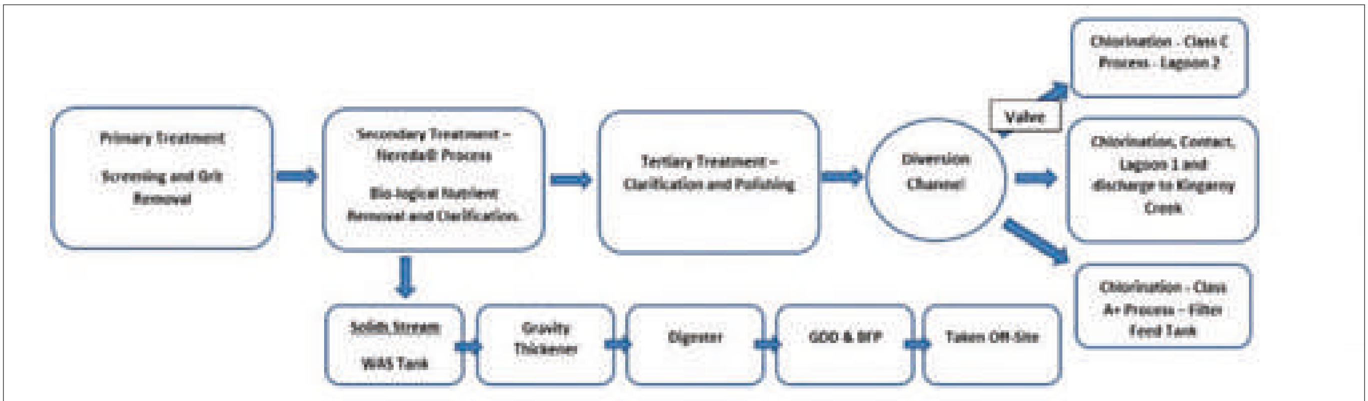

Figure 2. Liquid and solid stream process flow diagram.

The quality of the treated effluent is stable year round (Figure 3) with only minor rises in Total Nitrogen (TN) in the colder months.

With stable effluent we can reliably supply Class A+ and Class C effluent to our irrigation customers (Figure 4).

Producing Class A+ Recycled Water

To meet the Queensland Government's Water Recycling Guidelines and produce Class A+ effluent, the secondary effluent passes through three barriers: filtration and dual disinfection comprising UV light and sodium hypochlorite.

The recycled water system consists of a filter feed tank that is kept full by the means of a splitter box to enable flow to any of the three destinations of the final effluent. Duty standby submersible pumps deliver effluent to the pressure filters (Figure 5).

Alum is dosed in line to coagulate the effluent prior to entering the filters. The two inline pressure filters are capable of 25 L/s.

The effluent passes through the 3 stage filter media to achieve a final turbidity of less than 1 NTU. The next phase is UV disinfection through dual in-pipe UV reactors. This is followed by sodium hypochlorite dosing with a contact time of at least 30 minutes before passing into a holding tank for delivery to customers, or to be used onsite. Pump stations are onsite to supply customers that have a requirement for the Class A+ effluent. Each consumer has a storage that can communicate with SCADA to ensure we are aware of when they require water and the total volume pumped to each site.

Each pressure filter is serviced by air scour and backwash pumps. Instrumentation (we call it the Wet Rack) consists of 3 ultra-turbidity analysers so the operator can monitor both filters simultaneously and the effluent in the reactor at the time of discharge. The rack also contains a transmissivity analyser that determines dosages for the UV reactors. The chlorination monitoring provides real time dosing and alarms for SCADA. All instruments are monitored by SCADA and this provides a failsafe if the instruments fail or recycled water goes out of specification. Maintenance is relatively simple; routine cleaning, calibration and inspections to ensure the plant delivers a good and safe product to our customers.

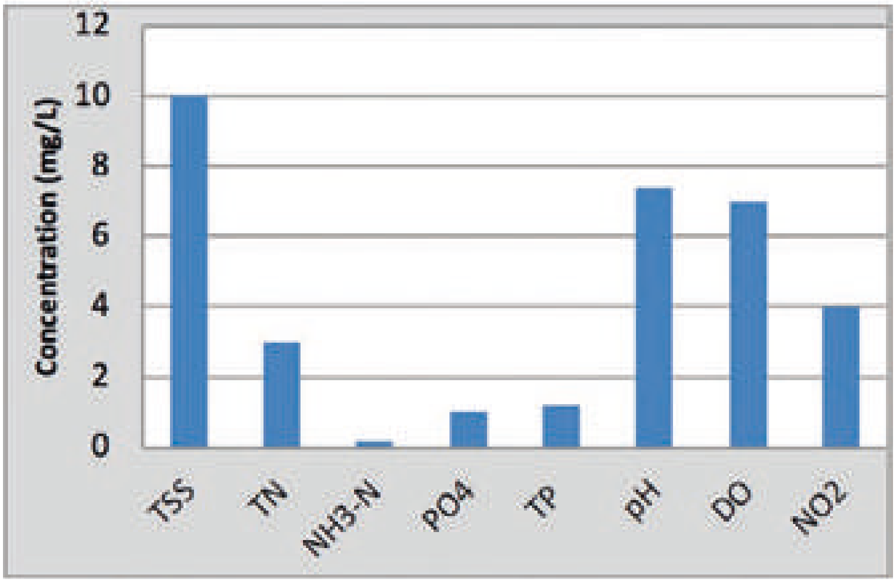

Figure 3. Typical effluent quality results for 2017–2019.

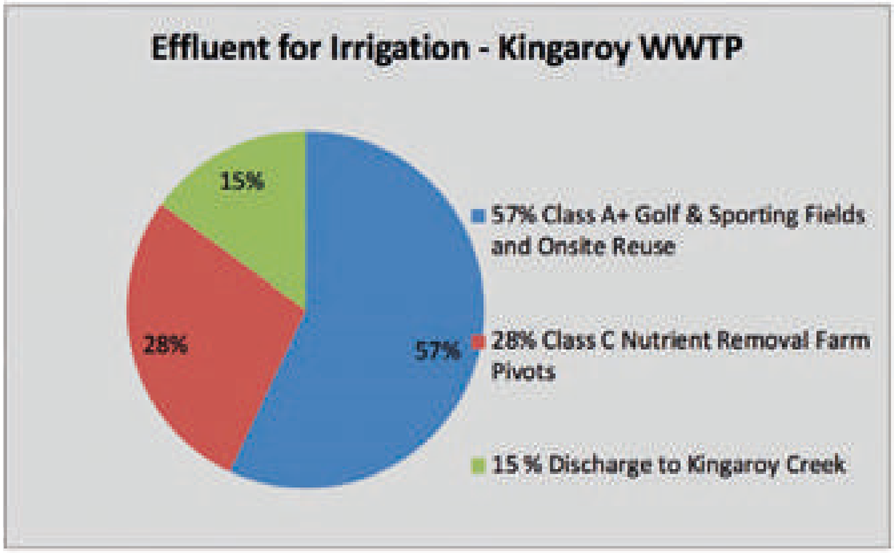

Figure 4. Distribution of daily effluent release in 2019.

Using Class C Recycled Water

The wastewater farm was last used in the 1970s with a small team of workers who ploughed, planted and baled Rhodes grass. But as time went by, the detention time in the lagoon system could not be achieved due to failures within the lagoons, so the farm was no longer utilised.

Before the farm could be used again, the lagoons had to be desludged and the baffles repaired.

The paddock was then burned during a safe, but hot part of the year to achieve an intense fire to remove a large quantity of vegetation and regrowth. The paddock was deep chisel ripped to loosen up hard pan areas to allow for unobstructed root growth, to promote higher water shedding and penetration, and to allow addition of lime or gypsum to further condition the soil if required. All nutrients can be taken deep into the soil without run off and any nutrients in remaining effluent will be irrigated over the land and taken deep into the soil instead of entering the watercourse.

Two pivot irrigators were installed and commissioned. The lagoons were also re-commissioned and started to fill.

Rhodes grass was selected because of its ability to grow in a wide variety of soils, including nutrient poor soil, and its tolerance to drought, frost and salinity. Rhodes grass becomes the dominant species and out competes weeds, and will regrow without seeding. It can be cut and baled, and is a very good source of fodder for cattle during drought times.

The secondary effluent from the WWTP is of such quality that following a minimum 25 days storage in detention lagoons, it can be applied directly to the South Burnett Regional Council neighbouring farm. The system was commissioned in late 2018.

Figure 5. Pressure filters at the WWTP.

Council expects the harvested Rhodes grass to be a good source of income and assist further nutrient removal within the local ecosystem.

Working for the South Burnett Regional Council, Water and Wastewater Section, operating and maintaining one of the newest wastewater installations in Queensland, driving through town and seeing children playing on the fields that without recycled water would be dust bowls with prickles makes the extra effort in maintaining, monitoring, sampling and testing of the recycled water worth the effort 10 times over.

Seeing the benefits to the town's sporting recreational areas, possibly being able to feed a few hungry cows on round bales grown on the farm and reducing the amount of nutrients into the creek is a definite fringe benefit of my job.

The Authors

Andrew Watson (awatson@southburnett.qld.gov.au) is a Senior Plant Operator with South Burnett Regional Council, **Shay White** is a Process Engineer with Aquatec Maxcon.

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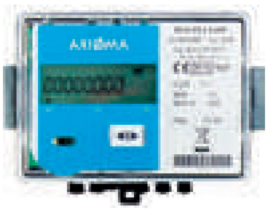
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ELECTROCUTION RISKS WORKING ON WATER SERVICES

Winner of the Hepburn Prize for Best Paper Overall and Best Paper by an Operator at the 2019 WIOA Victorian Operations Conference

Craig Piazza

Even though I am a licenced electrician it was never front of mind for me, and likely many other Water Network Operators, that anyone could be electrocuted while working on a water service. It was only after one of North East Water's water network operators took me to a property that had electrical current flowing through the water service that I realised that the risk of electrocution was possible.

The issue of electrocution when changing meters is real and there is sufficient evidence to suggest it is a high risk with high consequence. Water network operators understand they need to apply earth straps when changing meters; however, I'm not convinced everybody understands how a water network operator can receive an electrical shock and, in some cases, a fatal one.

This paper will explain how the electrical network is connected to water services, how the electrical infrastructure can fail and energise the water network, why this failure goes unnoticed until it's too late, and what steps water network operators can take to protect themselves from electrocution.

How Water and Electrical Networks Are Connected

Connections between water and electricity networks exist in houses that were built before the 1980s as it was a requirement to connect the copper main earth wire to the copper water service. This effectively makes the water service part of the earthing circuit. Every circuit has an earth that provides an uninterrupted path for current to flow in a fault condition, keeping everything we touch at earth voltage, which is 0 volts. This earth comes back to the main switchboard and is connected to the main earth bar (Figure 1). This earth bar is connected to the main neutral bar and the main earth wire which is connected to the copper water service in older houses, or to an earth stake.

Electrical earth wiring is there to remove the risk of electrocution when electrical equipment fails. There is a risk of electrocution when an active electrical wire comes into contact with something that is conductive, for example the frame of a toaster. The earth wire provides a direct path for the electrical current to flow back to the switchboard where it will trip the circuit breaker or blow the fuse that protects the circuit. If the earth wasn't there, the frame of the toaster would have 240 volts on it. There is never any electricity on the earth circuit unless something has failed.

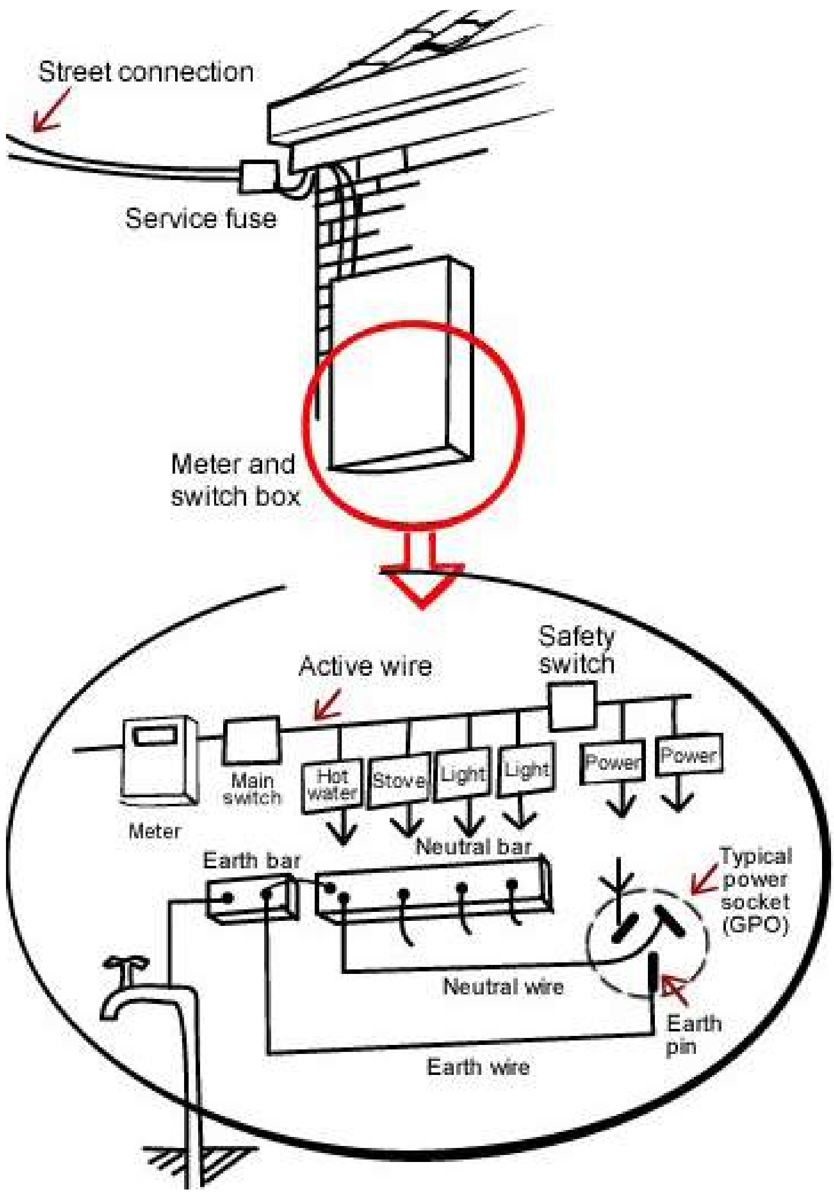

Figure 1. Interconnections between the water and electrical systems.

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Electrical Failure

If the active supply cable to a house fails, there is no electricity supplied to the house. The home owner would know if this happened, because nothing would work.

If the neutral supply cable fails, there is a possibility that the main earth will take its place and act as the neutral. Remember from Figure 1 that the main neutral and main earth are connected in the switchboard. The lights will be a bit dimmer and the home owner might think that was strange, but wouldn't know there was a fault because everything electrical still works.

When the main earth is acting as the neutral, and a water network operator cuts the water service or removes the water meter, they are in danger of being electrocuted. The water network operator is breaking the electrical circuit, just like switches, circuit breakers and fuses do. When the water service is disconnected and a main neutral fault is present, up to 240 volts will instantly be on the house side of the water service depending on the ground condition. This is why bonding straps, devices such as Plumb Guards and insulated gloves are used to stop the electrical circuit from being broken and protect the water network operators.

The same risks of electrocution apply when working on metallic water mains; however, it is less likely to be fatal. A difference in pipe size and the way in which electricity affects our bodies are the reason for this. Our muscles operate from electrical pulses from our brain. If we're being electrocuted, our brain doesn't have any control over our muscles anymore. In a limb like our arm, every muscle contracts. The muscles that close our hands are stronger than the muscles that open them so our hands will close tight. A 20 mm water service pipe is a perfect fit inside someone's hand and as a result the water network operator's hand or hands will become tightly closed around the water service and they won't be able to let go. In contrast, if the water network operator is holding onto both sides of the break in the mains service the electrical current will flow up one arm, across their chest and heart and down their other arm. As a water network operator's hands aren't big enough to fit around a 100 mm or larger water main they will get an electric shock from the main; however, they won't keep holding onto the main so their exposure will be shorter.

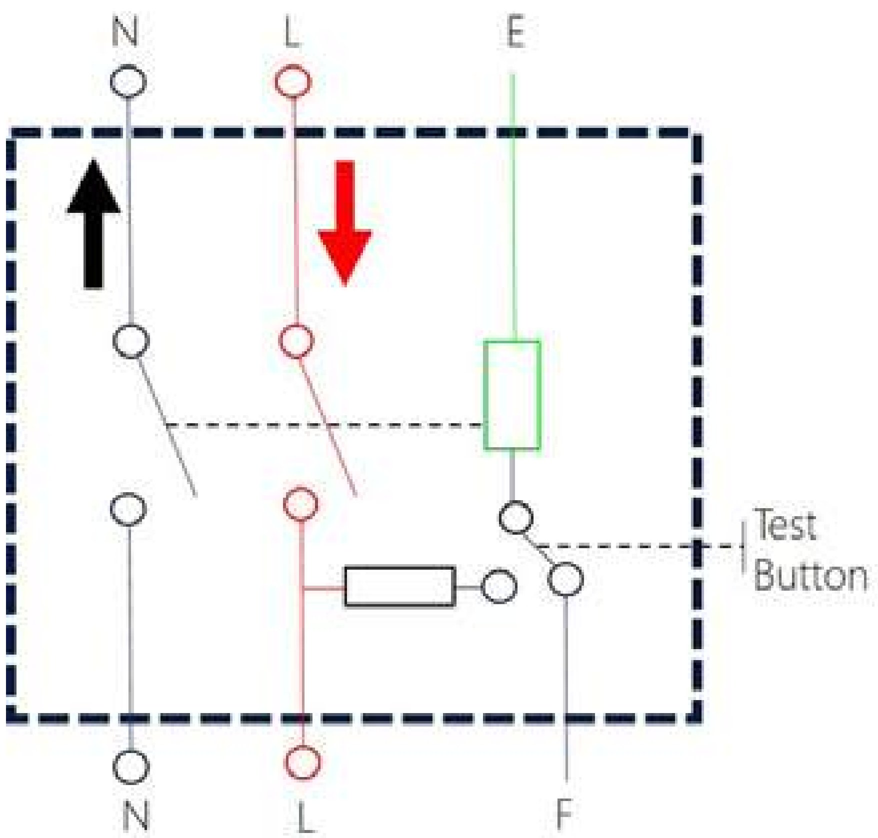

Figure 2. Diagram of an Earth Leakage Circuit Breaker (ELCB).

What To Do If Someone Is Electrocuted

Unfortunately things do sometimes go wrong. If you witness someone being electrocuted, do not try to pull them away. This can result in you also being electrocuted and not being able to remove yourself. Try to locate the source of the electricity and switch it off. Turn off the main switch in the house meter panel or pull out the main fuses in the panels that have an electrical industry tag on them. If this doesn't work and they're still being electrocuted kick them in the wrist as hard as you can. This will:

- Force their hand off the pipe, so they are no longer being electrocuted.
- Prevent you from electrocution because your work boots are insulated (this is why we kick instead of hit).
- Make you feel better for all the paperwork they just created for you!

If someone is being electrocuted in the home, turn the power point, light switch or circuit breaker off.

Getting a licenced electrician to upgrade the protection on your electrical circuits to Earth Leakage Circuit Breakers (ELCBs) will mean this never happens to your family. ELCBs are also known as Residual Current Devices (RCDs). When electrical current flows, it creates a magnetic field. The more current, the bigger the magnetic field. So when current flows through the active side (L) of an ELCB, the same current (magnetic field) must be on the negative line (N) of the ELCB or it'll trip (Figure 2).

The current flowing one way must equal the current flowing the other, therefore protecting anyone inside the house. Unfortunately for water network operators, the current has already passed back through the ELCB before the main earth connection, therefore water services are not protected by ELCBs.

Take Precautions

The single biggest danger of electricity is that you can't see it. Add to that the fact that electrocution isn't typically front of mind for water network operators, makes this risk even greater. I've got no doubt that many water network operators have worked on water services with electricity flowing through them, but have been unaware of it. This will happen more and more in the future as the ageing electrical network fails.

Almost 30 years ago, on my first day as an apprentice electrician, my very first lesson was to treat everything as live. If you don't need to touch something, don't. If you don't touch it, it won't touch you. This philosophy has so far worked for me.

If water network operators don't need to touch the service then they won't be electrocuted from it. Insulated gloves, insulated tools and bonding straps will help to reduce the risk. Work with your thumb and pointer finger and have the other three fingers already curled up so you don't have your five fingers around the service if something goes wrong.

I encourage you to:

- follow your employer's procedures
- use correct PPE (Figure 3)
- use bonding straps (Figure 3)
- prepare your work area to ensure good earthing practices (Figure 3)
- take 5
- mentor and educate
- call it out if you see others not following procedures.

Figure 3. Correct safety practices in use to reduce electrocution risks. The red clamps are the bonding strap and the black clamps are for the Plumb Guard. The other black clamp is attached to the water pipe near the operator's left hand.

The Author

Craig Piazza (CPiazza@newater.com.au) is an Industrial Control Systems Technician with North East Water in Victoria. Craig is also a licenced electrician.

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IMPROVING COMMUNICATION WITH VHF ETHERNET

Winner of the Best Paper Overall at the 2019 WIOA NSW Operations Conference

Alex McCaffrey

Long Flat Water Treatment Plant (WTP) (Figure 1) is located a 50 km drive west of Wauchope in the beautiful Hastings River valley. The WTP services a community of 250 people and has a capacity of 100 kL/day utilising microfiltration followed by sodium hypochlorite for primary disinfection. The WTP is unmanned and fully controlled via our SCADA system. Instruments on site include 5 turbidity, 2 chlorine, 3 pH, 8 tank levels, 7 flow meters and many other analogue and digital sensors used to control the plant.

Currently only a limited amount of SCADA data is available remotely from the plant (Figure 2).

The Water Process Team asked to be able to access all available data from the WTP on SCADA to assist them in monitoring and operating this remote plant. Their request was for their centralised reporting database to have direct access to the raw data for onward reporting on process compliance. Having a central single version combined with automated reporting was the vision, but our remote SCADA and Telemetry network was at its input/output (I/O) capacity. Using Elpro Remote Telemetry Units (RTUs) and SCADA-C software, we were limited by the RTU frame type. The WTP RTU could only transfer 128 digitals inputs, 128 digital outputs, 24 analogue inputs, 8 analogue outputs and 4 pulsed inputs.

Figure 1. The Long Flat WTP.

Figure 2. Current information available from the Long Flat WTP.

This meant that some important data couldn't be collected via the RTU to our SCADA system and, in turn, would not be available to the Water Process Team and could not be easily saved and made available for reporting requirements.

Long Flat WTP has been a long standing communications problem for Port Macquarie-Hastings Council. The remote site has always struggled to have reliable data communications. The radio repeater at a distance of 20 km from the WTP is not overly troubling but a 200 m high mountain range in the radio path, makes it difficult to maintain reliable, robust radio signal and reliable comms (Figure 3).

The Water section of Council has budgeted to replace the existing SCADA software in 2021 and anything we planned for Long Flat WTP to deliver the Water Operators request must integrate with the planned, but not designed, SCADA upgrade.

The main challenge was to improve the radio data speed and capacity, enabling transmission from the plant to the new SCADA system without using third party providers e.g. NBN, mobile phone/data providers or installing new communications towers and multiple radio links.

Methods of transferring communication data have been rapidly changing over many years, but all methods have some limitations that influence their reliability, including:

- availability to the area
- physical obstructions
- distance between sites
- required data.

Four options were considered:

1. Microwave links are by far the fastest wireless communication. Speeds in excess of 370 Mbps to 575 Mbps are commonly achieved. Microwave requires unobstructed line of sight to link and pass data.
2. Investigate existing, new and improved radio technologies.
   - UHF 450 MHz radios can link and transfer limited data over this distance and terrain. UHF signal does not require absolute line of sight but the speed and reliable data transfer is reduced as obstruction and distance increase.
   - VHF 150 MHz has speed and signal reliability and is least impacted by distance and obstruction of all the radio types we considered. 150 MHz VHF does have speed and data bandwidth limitations, but new modulation techniques are overcoming these limitations.
   - 900 MHz spread spectrum radio will deliver the required speed and bandwidth, but not in this situation where the distance and terrain would prevent reliability of this link.
3. VPN/NBN
   - VPN/NBN will deliver speed and data bandwidth but connection to third party providers reduced network security from possible outside attacks, needing managed routers to limit and control this risk. This option also attracts monthly rental charges. The involvement of a third party provider reduces our control of outages, in particular, response and outage repair times.
4. Expand the current system capabilities
   - The current Elpro Radio wasn't suitable to meet the future SCADA requirements as it couldn't pass Ethernet traffic. As Council's current PLC platform is Omron and is mostly communicating on the sites via Ethernet, we decided the new radio link must also communicate via Ethernet.

Desktop Investigations

Our current network using 450 MHz worked but delivered minimal data transfer. The investigation commenced with a desktop radio path survey using the Nearmaps elevation profile feature (Figure 3). It showed that the radio path is obstructed by a 200 m high mountain range in the middle of the 20 km distance. The mountain eliminates any chance of a microwave link being used to cover this distance, even with a tower added to each end.

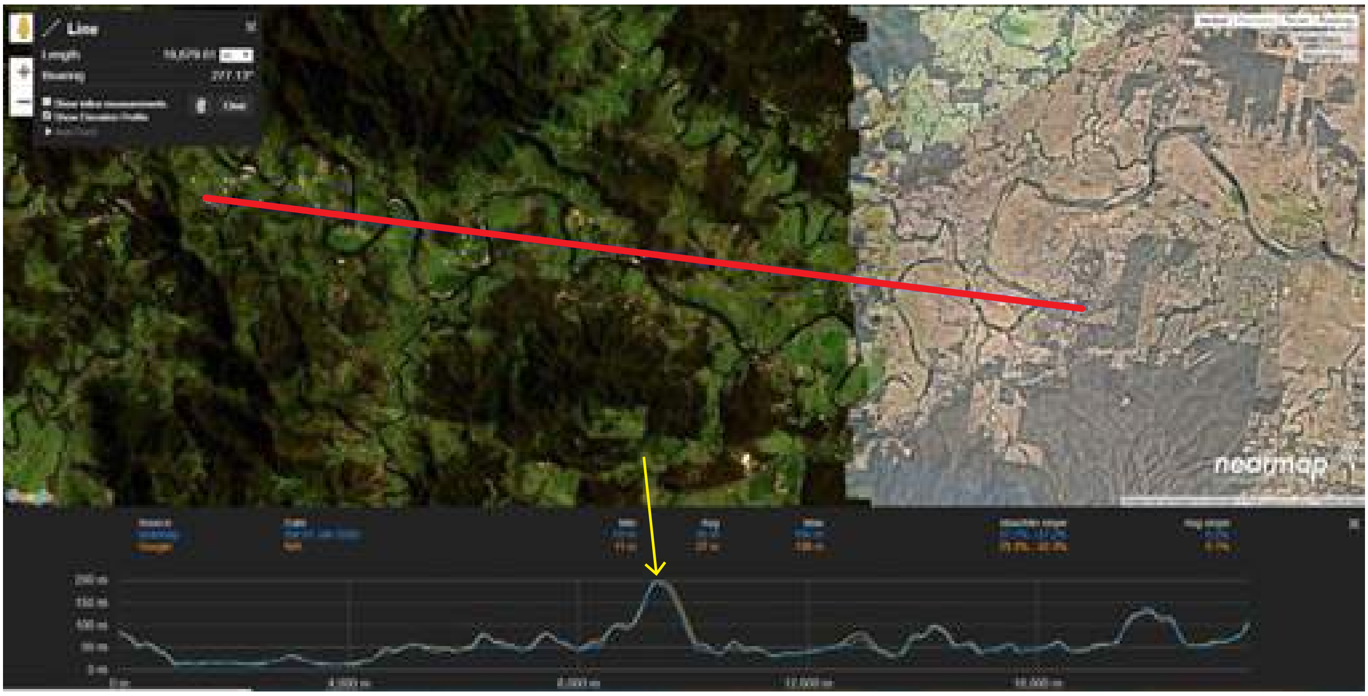

Figure 3. Signal path from Wauchope to Long Flat. The problem mountain range is shown with an arrow.

The existing link was on 450 MHz and has a RSSI (Received Signal Strength Indicator) of around -90 dBm. We searched the market for a radio technology that could provide higher speeds over this distance. We found that the recent VHF and UHF radio technology, which utilises Quadrature Amplitude Modulation (QAM), could deliver increased speeds and data bandwidth. UHF and VHF radios utilising 16 QAM are capable of 80 kbit/s when using a 25 kHz channel or 160kbit/s when using a 50 kHz channel.

QAM utilises both amplitude and phase components, to provide a form of modulation that offers high levels of spectrum usage efficiency. In simple terms, it's able to hide the data in more places over one transmission, making it more efficient in carrying a larger amount of data.

Dealing with I/O Limitations

We could have simply added another Elpro processor to carry the data but that would leave us with no DNP3 capability for the future, and we would be left with the same radio signal issues. Doing this would have involved the same amount of work as changing and upgrading the system.

DNP3 is a set of communications protocols used between components in process automation systems developed for communications between various types of data acquisition and control equipment. Its main use is in utilities such as electricity and water supply. The primary benefits are the back fill of data and network bandwidth control. This is achieved by time stamping each bit of data, saving the data at the RTU until the next communication and then the SCADA back filling the data for seamless trending. This provides faster sampling time with less radio traffic and seamless data following communication fail restoration.

Increased speeds and conversion to Ethernet means we are able to run the WTP on an Ethernet network, giving us limitless I/O and almost instant data feed into our SCADA system. This also provides headroom to be able to program and diagnose faults, or change PLC code live over the network, eliminating the need to travel to connect to the PLC to respond to a fault.

Omron PLCs can provide more I/O than we will ever need, at a higher resolution than the Elpro cards. Omron PLCs that had all the I/O fed into them were already used on site, so we needed to utilise them to pass the data.

The benefits that come with Ethernet communication includes signal stability and consistency, signal and (to an extent) network security, and scalability to wide area networks. Ethernet communication will permit our staff to connect to the Long Flat WTP site PLCs from their office in Port Macquarie for interrogation and fault finding. Council contractors will also have remote access to the same PLC code.

After exploring all options, it was clear the VHF radio link was the best option for our needs. We also required a 50 kHz channel and a radio that is capable of at least 16 QAM. We are currently trialling two radios that meet our requirements.

The preliminary onsite testing is achieving a signal level of -80 dBm and a signal-to-noise ratio of 25 dB using a 3 dBd 3 element Yagi yielding 16 QAM, achieving reliable data speeds of 160 Kbit/s. 160 Kbit/s should deliver reliable DNP3 communication and, with some SCADA development will meet the expectations of the Water Operators and Process Engineer. The SCADA will access the site PLC to display and record all data and control that is available on site.

What Has Happened Since

The radio network has now been expanded to include Comboyne WTP and Cowarra off-creek storage dam. Comboyne WTP is a twin to Long Flat WTP and is located 26.5 km south-west of our Wauchope repeater. The radio path to Comboyne is unobstructed unlike the path to the Long Flat WTP (Figure 4).

We have been able to implement the same set-up as Long Flat WTP. Testing shows that this signal will improve with the installation of a new mast on site.

Figure 4. Signal path from Wauchope to Comboyne WTP.

Similarly, Cowarra dam is only a stone's throw away in comparison at only 8.5 km south-east from the repeater and a simple signal path.

The Ethernet filtering smarts of the radio we have chosen are not just limited to one network, so Council is now working on integrating our sewer and water networks into one. We have installed another base in Port Macquarie at our repeater site Transit Hill. This is currently servicing Telegraph Point WTP which is similar to Long Flat and Comboyne WTPs and located 22 km north-east of Port Macquarie.

This radio base is also serving multiple sewage pump stations around Port Macquarie. Reliable communications had been troublesome with these sites but are no longer a problem due to the penetrating properties of the VHF.

DNP3 Integration

DNP3 is being integrated into the sewer network where the new VHF radio is used.

This has greatly improved our remote fault finding. The data-sampling rate for the well level is 0.5% variation or every 50 milliseconds. The data can be sampled at a high rate and only reports when needed and/or when an unsolicited event happens i.e., a mains outage or pump fault. This means that there is a large reduction in airtime occupied by the radio. In the past we were only able to sample the data when the PLC was requested for data so a snapshot of data was taken every minute at best. If the radio didn't respond then that data was lost. Figure 5 shows an example of where data has been lost due to loss of comms.

Figure 6 shows a smooth continuous trend as the data is backfilled for every 50 milliseconds, not based upon what is happening at the site, at the time it was polled. In the event of a comms failure, the data will continue to collect on site and then backfill when communications are restored. This gives a much more comprehensive picture of what is happening on site.

The Author

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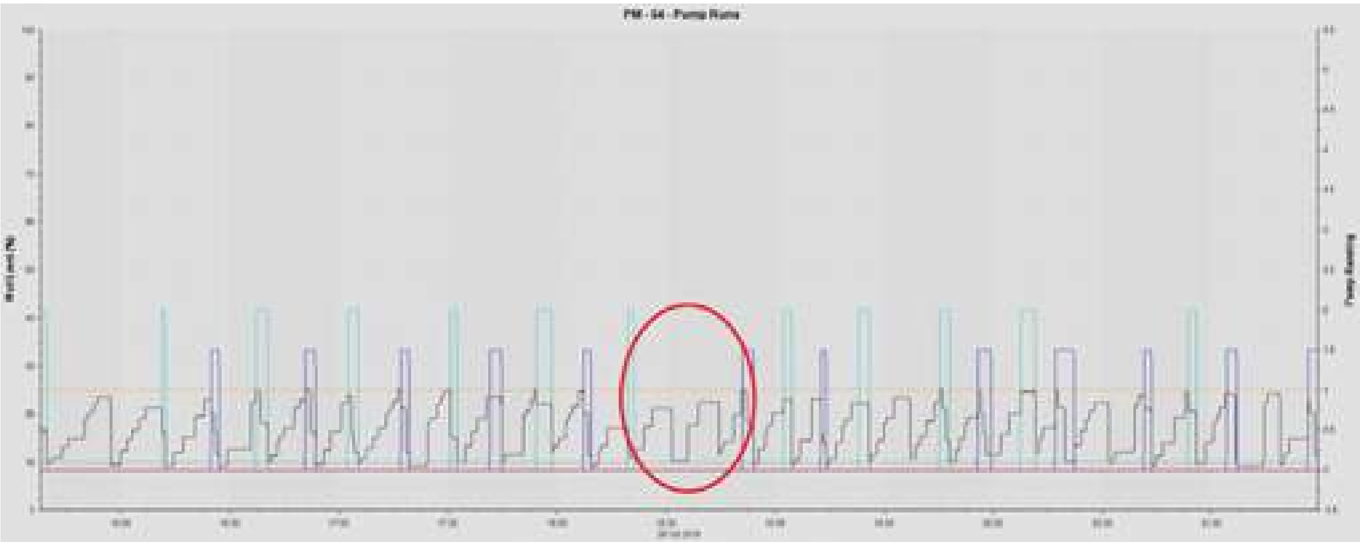

Figure 5. Sewerage pump station trend before DNP3 showing where two pump runs have been missed.

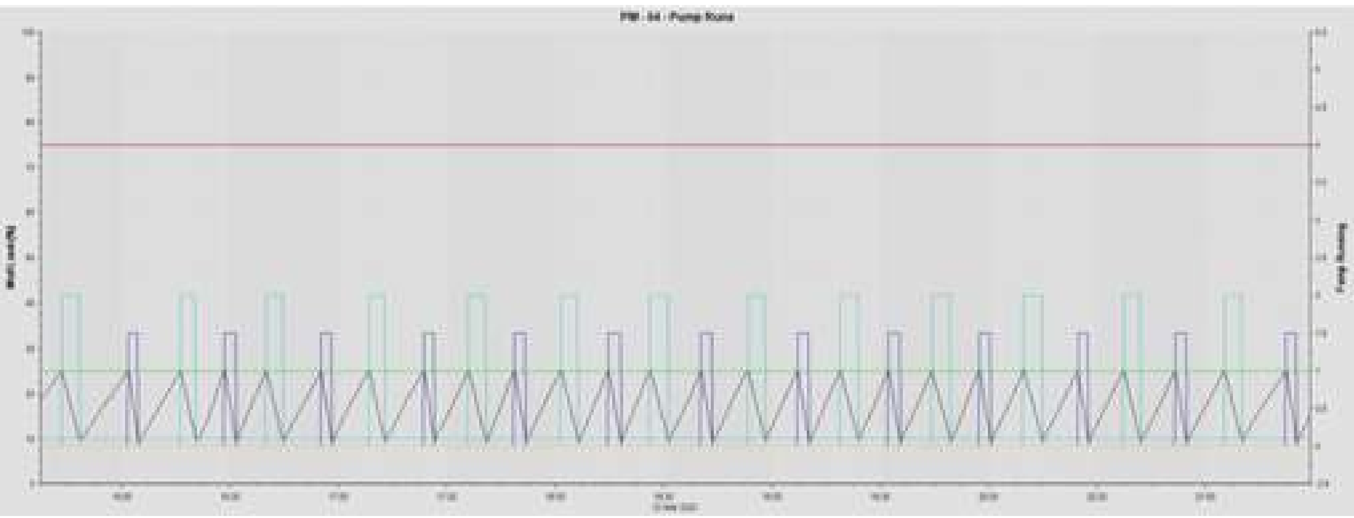

Figure 6. Sewerage pump station graph after DNP3.

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DON'T JUST ASK FOR IT, BUSINESS CASE IT

Jamie Rossato

North East Water (NEW) in Victoria started a journey to upskill its operational staff to identify projects and areas within operations to create order, reduce waste, gain efficiencies and cost savings, and improve OHS.

The Lean program is a Certificate IV qualification in Competitive Systems and Practices, which was delivered to all of our operational staff. The program was presented each fortnight for 2 hours over an 18 month period. The training provided NEW Operators with the skills to recognise areas for waste reduction, efficiency gains, customer service, and reduced operational costs. More importantly, it is about maintaining a safe and healthy working environment and having all employees committed to continuous improvement in all areas of safety awareness and application.

Throughout the course, modules with set questions to prompt us to work through every scenario for each project were completed in order to put business cases forward. The course was very hands on, and the facilitator worked closely with us throughout the program. The facilitator asked what we wanted to improve in the business, and via the steps of the program we worked through each idea to determine the efficiencies and benefits of incorporating it.

The Lean program has many components, however the module we focused on was the 5S and safety module. This module is based on the following 5 steps.

1. **Sort** – Remove all unnecessary items from the area, which made our work area safer, healthier, cleaner, brighter and clear of clutter.
2. **Set** – An appropriate place for every item. We organised all our equipment and gave it a set place and to allow ease of reordering when stock was low. Productivity increases when it's easier to find things.
3. **Shine** – Clean and inspect all areas and items within the work place. We brought items that were stored outside and put them inside the depot. The team ensured the workplace was always kept organised and clean. This lead to more cost savings as there was less chance of product damage and/or contamination.
4. **Standardise** – Set up standard ways of doing things. We set out rosters for cleaning and reordering stock. This ensured no task was ever neglected, and it promoted a more enjoyable work place.
5. **Sustain** – Monitor the other four steps, so our good habits are kept up.

Other modules in Lean included:

- Reduce waste – This covered saving on travel time, down time, over stocking spares, old spares and not utilising employees.
- Mistake proofing – This taught us how to remove errors by changing processes. We have developed a lot of new check sheets, to eliminate errors.
- Environmental sustainability – This focused on changes in the work place to minimise environmental harm, particularly with management of chemicals.
- Problem solving – This module emphasised the importance of finding the root cause of a problem, and determining a solution.

The question posed to us on the first day was "As a team right now, what is the number one challenge to your operational efficiency?"

Our response was that we had outgrown our current depot. It was small, cluttered and very disorganised, mainly due to the lack of floor space and storage. Our spare parts inventory and plant equipment was not organised and spares were spread over four different sites.

We applied the steps of the 5S and Safety and the learning from the other modules to determine our highest priority project that we believed would provide the best efficiency gains, OHS improvements and cost savings for NEW and then develop a business case. The highest priority project was the need for a new centralised depot.

Development of a Business Case for a New Depot

Stage One. Identify the Problem

NEW started with a small depot in Myrtleford, and four other sites across the region where we stored all of our equipment, pipes and fittings. These sites included the Myrtleford decommissioned UV plant, Myrtleford WWTP, Myrtleford WTP, and a small depot in Bright. These storage spaces were spread out and we had no idea of what spares (pipes and fittings), and other equipment was available or where it was. Sometimes we would make 2–3 trips a day to the different depots, clocking up numerous hours of wasted travel time. The depots were also very small and the equipment that was in them was crammed in and buried in the mounds of spares and equipment making it very difficult to find and keep track of.

Our original main depot in Myrtleford was very small and all our machinery (that would fit) was unsafely packed in and disorganised, leaving very little room for walk ways, so operators had to often jump over equipment to manoeuvre within the depot (Figure 1).


Figure 1. The original Myrtleford depot.

From the program and stepping through the 5S and safety steps we identified all the issues and associated costs with the existing depots. The main issues highlighted were the OHS issues associated with the over packed buildings, the unorganised spares inventory spread between four isolated sites, the travel time between the sites to obtain the required pipes and fittings for repairs and maintenance, the cost of renting the land for our Bright Depot and the cost of renting the existing Myrtleford Depot. As a team we discussed all the different aspects of the project and filled out many pages of butcher's paper to expand, unpack and discuss our ideas, to identify the actual cost saving and efficiencies this project could bring.

Stage Two. Identify Savings

As a group we determined all the potential cost savings, efficiencies, OHS benefits and any other benefits we could identify from having a centralised depot.

Table 1 summarises the list of the efficiencies we determined and the calculated savings from stepping through the modules and working closely with the facilitator.

Other benefits included:

- Larger work space, which is open to promote team dynamics and ergonomics.
- Meeting space, so meetings could be held at the Myrtleford depot to eliminate unnecessary travel to Wodonga (Head Office) for meetings. This would also be a benefit to the other nearby alpine teams (Beechworth, Wangaratta and Mt Beauty).
- Training space. With the new depot we would have a dedicated meeting room to hold training sessions.
- Rent for the Bright depot. We leased the land at the Bright depot site and owned the transportable house. With this project we sold the house and now don't have the added cost of rent for the Bright Depot site.
- All staff now start at the new Myrtleford centralised depot to organise daily tasks and operational priorities.

Stage Three. Our Recommendation to Management of What We Wanted

Our recommendation to management was to lease a larger site so that all our equipment, pipes and fittings could be stored under one roof. The projected savings are summarised in Table 2.

Table 1. Summary of estimated savings by changes to practices.

Item	Explanation	Savings/yr
Travel time	We calculated that on average we were travelling 5 times per a week between the 5 depots/sites. On average these trips would take 15 minutes. 15 minutes' x 10 trips per week x 52 weeks in a year at $70/ hr	$9,100
Upkeep of Sites	If we had a centralised depot we would no longer require the space in the old Myrtleford UV plant and could hand this land back to the Alpine Shire and we would no longer incur the maintenance costs.	$10,000
Inventory Control	Inventory was unable to be controlled in the current sites and there was no control over what was in stock and what fittings were needed. This resulted in double ups of many fittings and on the other hand not having adequate pipes and fittings for urgent repairs and maintenance. This was estimated to be costing NEW approximately $6,000/annum in over charges due to higher costs from local supply.	$6,000
Site Rental	Rent for old depot in Bright	$6,500
Site Rental	Rental on a site that would no longer be required.	$25,000
	TOTAL POTENTIAL ESTIMATED SAVING	$56,600

Table 2. Summary of estimated savings from new depot.

Action	Info	Cost Old Depot	Cost New Depot
Travel between depots	10 trips per week, average 15 minutes per trip at $70/hr	$9,100 p/a	$0
Upkeep of Depot Sites	Maintenance of the other sites we could now decommission –lawn mowing, rent, electricity etc	$10,000	$0
Inventory Control	Control stock levels, no double ups, pipes and fittings available when required, purchasing in bulk to save	$6,000	$0
Rent on old Depot (Myrtleford)	Rent for old depot	$25,000	$0
Rent on old Depot (Bright)	Rent for old depot	$6,500	$0
Rent on new Depot (Myrtleford)	Rent for new depot	$0	$46,616 p/a
Total cost		$56,600 p/a	$46,616 p/a
Total saving			$9,984 p/a

Cost of the new site = **$46,616/annum**

Construction of a new internal office in the new depot = **$60,000 (one off payment)**

Potential savings from section 3.2 = **$56,000/annum**

Return on investment = **6 years**

Additional Benefits

Water supply

Improvement of overall water "up time" of 1% due to efficiencies of obtaining, equipment, pipes and fittings quicker with less travel time. Improvement in "Water off time" on a mains break of 5% due to efficiencies of obtaining equipment, pipes and fittings quicker with less travel time.

Safety

OHS at the new depot was improved by having a turning space to park all the heavy machinery in forward meaning no dangerous trailer reversing is required.

- There is room for walkways so staff are not required to step over equipment, reducing the risk of trips and falls.
- Pipes and fittings are stored on properly constructed racks to prevent risks to staff if they fall.
- Clutter on the floor was eliminated.

A separate lunch room, meeting room, mud room and office minimises the potential for the transfer of biological hazards from working on sewer systems.

We gathered all the information and had all the facts and figures supporting our business case before we presented to the Board to seek additional funding to pay for the new depot lease. By collecting all the facts and figures first, the proposal was well received and the project was approved.

In 2018 we moved into our new depot, three times the size of our previous depot (Figure 2). We have finished building our office space within our new depot, complete with a separate lunch and meeting room, six desk areas, and a new bathroom and showering facilities.

All our pipes and fittings are now organised, covered (water and sewer spares are separated for hygiene measures) and under the same roof. We are now able to conduct regular stocktakes and order equipment, pipes and fittings when required. We have held numerous meetings in our new depot as well as several training sessions. We have even catered for a new hygiene course NEW is rolling out for all staff, complete with a simulation water main to provide a hands on training apparatus for staff.

By having the space to set up a new workshop and store room in a safe orderly manner, it was easy to keep track of inventory and subsequently reduce large amounts of excess materials in all forms. These practices offset the higher lease payment and we still made a saving.

Business Case for Other Equipment

We have also used the learnings we gained from the Lean program and applied them to recognising other problem areas and going through the steps we learnt to analyse the benefits, cost savings and efficiencies from new ideas. Two examples are provided below.

Mobile service truck

We have set up our service truck to be a mobile depot. We always had a service truck; however, the Lean program taught us how to organise our inventory better, and to label things for ease of finding to save time and also highlight when pipes and fittings are low so we could reorder. This ensured we always have everything we needed for a job. This has saved travel time to jobs as well as minimised the time it takes us to respond and repair during call outs.

Purchasing new equipment

Recently we had a troublesome pump station that would block due to heavy ragging at least fortnightly with the majority of blockages being on the weekend. The pump station was a single pump well, and if it overflowed could result in environmental harm.

Two operators were required to respond and unblock the pump resulting in hefty call out cost and an impact on operator work/life balance. We identified there was a new pump on the market that was designed to automatically sense a blockage and reverse the pump to clean itself and pass the debris. After we gathered all the costs associated with the call outs for this station, the OHS around picking up the pump, and the environmental concerns, we put a business case forward to purchase this new technology. The new pump has now been running for 18 months and never suffered a blockage. From our analysis of the pump operation, the pump has automatically reversed 29 times to clear blockages, which has eliminated 29 potential call outs, paying for itself in less than a year.

Conclusion

The Lean program has been a real eye opener to me, my team and the operational staff at NEW. Prior to the course we had plenty of ideas that could be beneficial to NEW and could result in cost savings and could make operations more efficient. The course has taught us how to get rid of the "could" and replace it with "it will".

The biggest thing that I have found after doing this course is my team come to me, not asking for things but presenting me with a business case with all the evidence, facts and figures to demonstrate the efficiencies that will be gained from seeing a particular project through. This has resulted in better team dynamics as less ideas are being dismissed and more were followed, and problem areas were fixed with full justification.

The Author

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Figure 2. The new centralised depot and a bird's eye view for size comparison between the old and new depots.

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MANGANESE REMOVAL AT COROWA

Winner of the Best Paper by an Operator at the 2019 WIOA NSW Operations Conference

Shawn Charlton and Martin Woodhead

Prior to 2002, the Corowa water supply was unfiltered. Raw water was pumped from the Murray River and disinfected using chlorine gas then transferred to the town water supply reservoirs and from there into the distribution system. In 2002, the Corowa Water Treatment Plant (Figure 1) was constructed, but unexpectedly the Council started to receive an increased amount of "dirty water" complaints. Customers were reporting black or dark brown water, with the majority of the complaints being generated in the spring and summer months. Council quickly discovered that a manganese biofilm was growing on the inside of the reticulation pipework and this biofilm was dislodged during times of high water use, causing the discoloured water. An annual water mains air scouring project was introduced resulting in dirty water complaints falling to an acceptable level.

Manganese levels in the Corowa raw water supply range from 0.03 – 0.06 mg/L. Peaks of up to 0.3 mg/L do occur during times of high catchment run off. These peaks are expected 3 to 4 times a year and generally last for no longer than 1 week.

According to the Australian Drinking Water Guidelines 2011 (ADWG), manganese concentrations of 0.02 mg/L will form a biofilm or black coating on the inside of pipes and this can dislodge as a black slime. At these concentrations, some nuisance microorganisms can concentrate the manganese, which can give rise to taste, odour and turbidity problems in distribution systems. This is why a discretionary target of 0.01 mg/L is a suggested for treated water. At a concentration of 0.01 mg/L, manganese generally does not accumulate in distribution systems, while concentrations of 0.02 mg/L can lead to aesthetic water quality issues.

Historically, an average manganese concentration of 0.02 mg/L has been found in Corowa's distribution system. This result would explain the high number of dirty water complaints from the residents of Corowa.

Figure 1. An aerial view of the Corowa WTP.

To reduce the concentration to below the discretionary target of 0.01 mg/L, soluble manganese in the source water must be transformed into insoluble manganese prior to the filtration process. If this can be achieved, then the insoluble manganese should be removed using existing treatment processes.

A trial was undertaken to determine if manganese concentrations less than 0.01 mg/L could be achieved without large process changes, capital or operations costs. The trial sought to oxidise the soluble manganese prior to filtration using sodium hypochlorite which was already available at the treatment plant. The sodium hypochlorite dosage was set so that 0.2 mg/L of free chlorine residual was present at the outlet of the filter.

The trial ran from January 2017 to May 2017. This period was selected to best maintain steady raw water quality conditions, including manganese levels.

Four treatment methods were selected:

1. Sodium hypochlorite was injected into the raw water rising main up stream of the aluminium sulphate injection point. This would in theory oxidise any soluble manganese present in the raw water and this now insoluble manganese would behave in a similar way to other suspended solids and be removed during DAF floatation.
2. Sodium hypochlorite was injected into the raw water rising main up stream of the aluminium sulphate injection point. Powered Activated Carbon was also added to adsorb organic molecules in the raw water, which would reduce the generation of disinfection by-products (DBP).
3. Sodium hypochlorite was injected into the raw water rising main up stream of the aluminium chlorohydrate injection point. Powered Activated Carbon was added to adsorb organic molecules in the raw water, which would reduce the generation of DPB. The change in primary coagulant from aluminium sulphate to aluminium chlorohydrate would allow the coagulated water pH to be maintained at a pH >7.5, which would aid the oxidation process.

4. Sodium hypochlorite was injected into the entry of the DAFF filter below the float. This in theory, would oxidise any soluble manganese to insoluble manganese, which will then be removed during the filtration process. The injection of sodium hypochlorite under the float should limit the generation of DBPs due to the majority of organic material already being removed during the floatation process. Removing the majority of the solids prior to the injection of sodium hypochlorite should also reduce the amount of chemical needed to achieve the same rate of manganese oxidation. The change in primary coagulant from aluminium sulphate to aluminium chlorohydrate would allow the coagulated water pH to be maintained at a pH >7.5, which would aid the oxidation process.

Each trial was run for 3 weeks, with the first week being considered as the optimisation phase with no water quality data analysed. During the second and third weeks, daily sampling and testing was conducted using the sampling program shown in Table 1.

Chemical dosing rates for all chemicals used at the treatment plant, excluding sodium fluoride were recorded and analysed to produce chemical usage costs.

Five criteria were selected to assess each treatment method:

1. Filtered water manganese concentration.
2. Chemical usage cost.
3. Disinfection by-product (DBP) generation.
4. Filtered water turbidity.
5. Clear water stability measured as the Calcium Carbonate Precipitation Potential (CCPP).

Table 1. Trial sampling program.

Sample	Frequency
Filtered water outlet manganese	Daily (NATA Accredited)
Filtered water outlet free chlorine	Daily
Final water chloroacetic acids	Once during week 3 (NATA Accredited)
Final water trihalomethanes	Once during week 3 (NATA Accredited)
Final water stability	Once during week 3 (NATA Accredited)

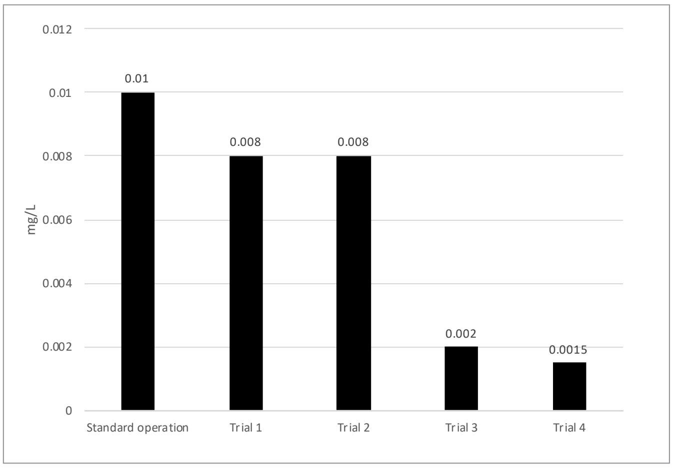


Figure 2. Filtered water manganese concentration.

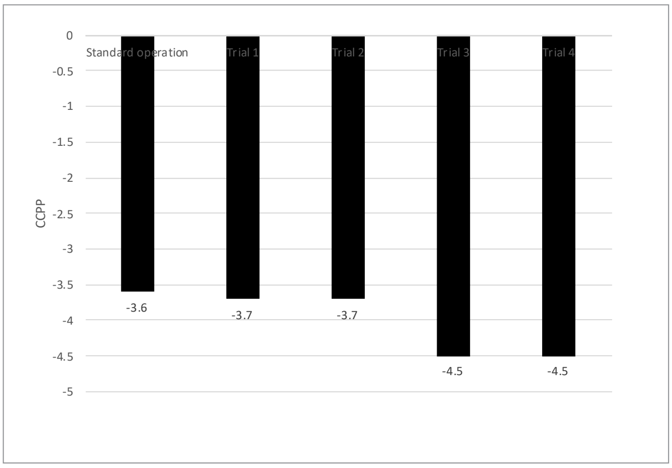


Figure 3. Final water stability.

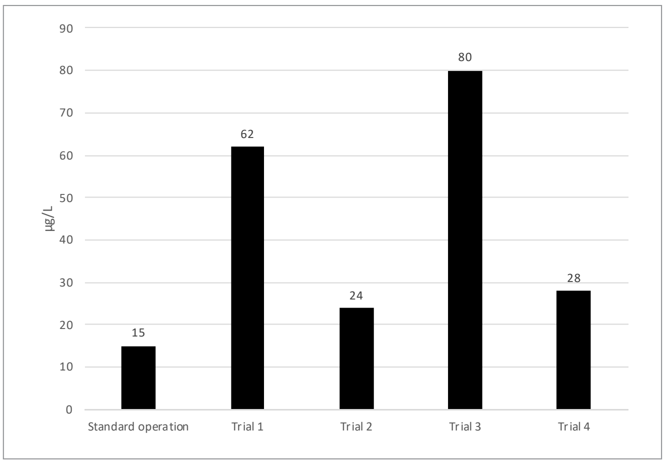


Figure 4. Final water DBPs.

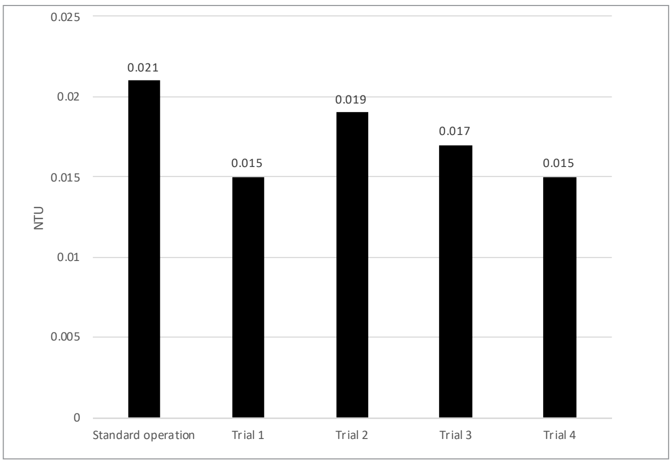


Figure 5. Filtered water turbidity. These turbidity values are an average of the online turbidity meters on the outlets of the filters.

Each of these variables were not evenly weighted with greatest consideration given to filtered water turbidity and DBP generation. The successful removal of manganese was not to come at a compromise to public health.

Results

Figures 2 to 5 show the results for filtered water turbidity and manganese, and final water stability and DBPs for each of the trials.

The results show that all the methods used had some success in the further removal of manganese during the treatment process, with the greatest removal rates being achieved when aluminium chlorohydrate was used as the primary coagulant (Trials 3 and 4).

Water stability did not alter significantly during Trials 1 and 2. There was a noticeable decrease in stability during Trials 3 and 4.

The generation of DBPs increased under all trial conditions. The largest increases were recorded during Trials 1 and 3. Only slight increases were detected during Trials 2 and 4. Under all trial conditions the ADWG health-based target of 250 µg/L was not exceeded.

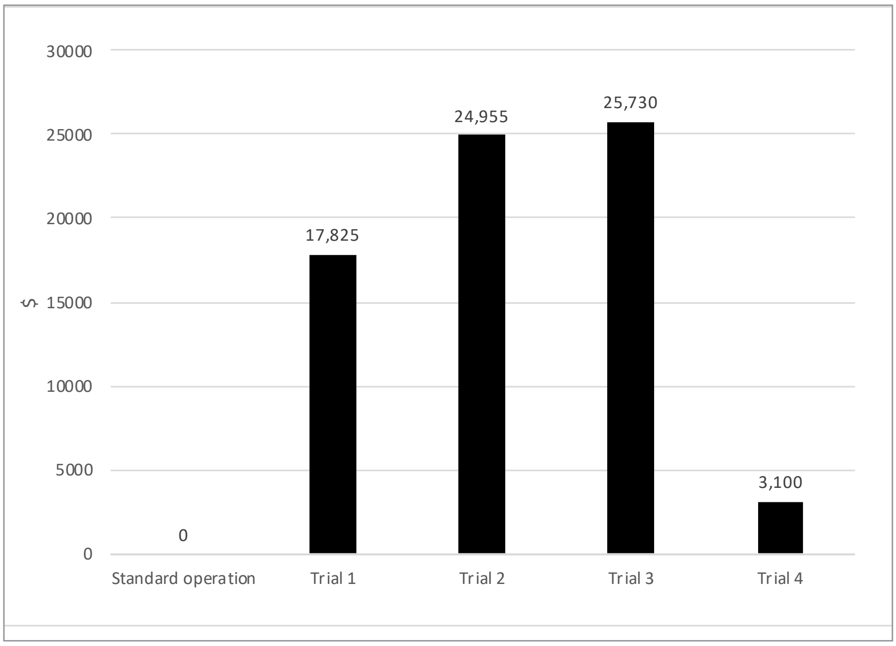
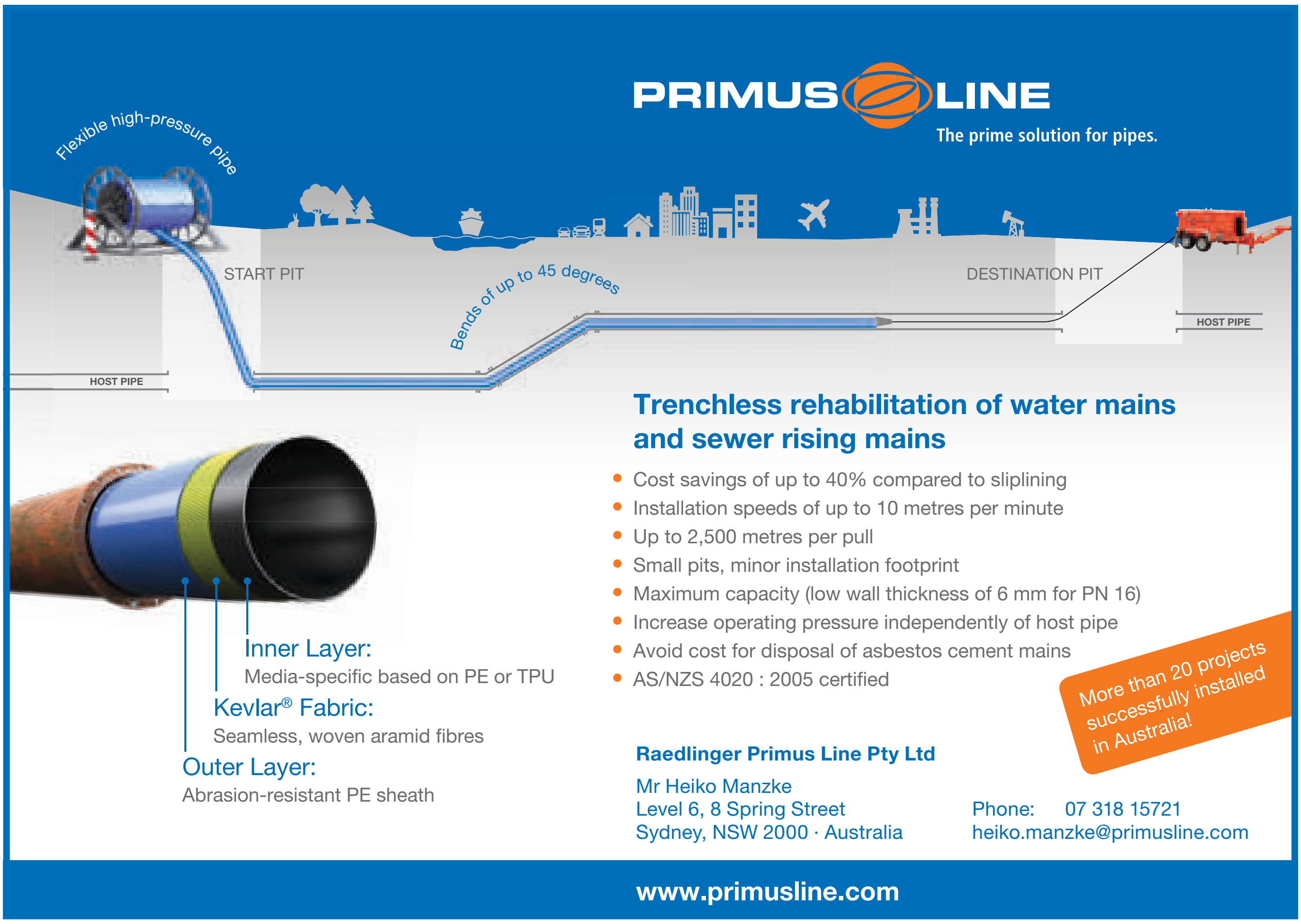


Figure 6. Yearly additional chemical costs above standard operation.

Trials 1 and 4 showed the lowest recorded average filtered water turbidity of 0.015 NTU.

Figure 6 shows the additional cost above the normal operating cost for one year for each of the chemical treatments used in the trials.

An increase in chemical costs was recorded for all trials, ranging from $3,100 to $25,730.



The largest increase in chemical costs can be attributed to pre sodium hypochlorite dosing. The cost of pre-chlorine dosing was identical except for Trial 4, which recorded a significantly lower usage and therefore cost. The change of primary coagulant from aluminium sulphate to aluminium chlorohydrate also saw a slight increase in cost, although this cost increase was partially offset by a decrease in the cost of the existing lime dosing.

Conclusions

Due to the poor manganese removal rates of Trials 1 and 2 these methods of removal were not considered viable. Trials 3 and 4 showed the greatest potential for the removal of manganese from the system with both trials producing average filtered water manganese concentrations of below <0.002 mg/L. Taking into consideration the annual chemical cost and the generation of DBPs of these two trials, it was concluded that the most efficient method of removing manganese from the system was Trial number 4 with ACH dosing and sodium hypochlorite injected into the entry of the DAFF filter below the float. Trial 4 did see a decrease in water stability due to a lowering of the required hydrated lime dosage caused by the change in primary coagulant. This result, although concerning, was not deemed significant enough to discount other positive results of the trial.

As a result of the success of Trial number 4, new ACH and pre sodium hypochlorite dosing systems were installed at the Corowa WTP in the 17/18 financial year. The work included:

- Installation of a new 5000 L aluminium chlorohydrate chemical storage tank and chemical dosing system.
- A new pre sodium hypochlorite dosing system and associated delivery pipework.
- Augmentation of the pre hydrated lime dosing system and associated delivery pipework.
- Installation of inline filtered water pH and free chlorine monitoring.
- PLC and SCADA design and programming.

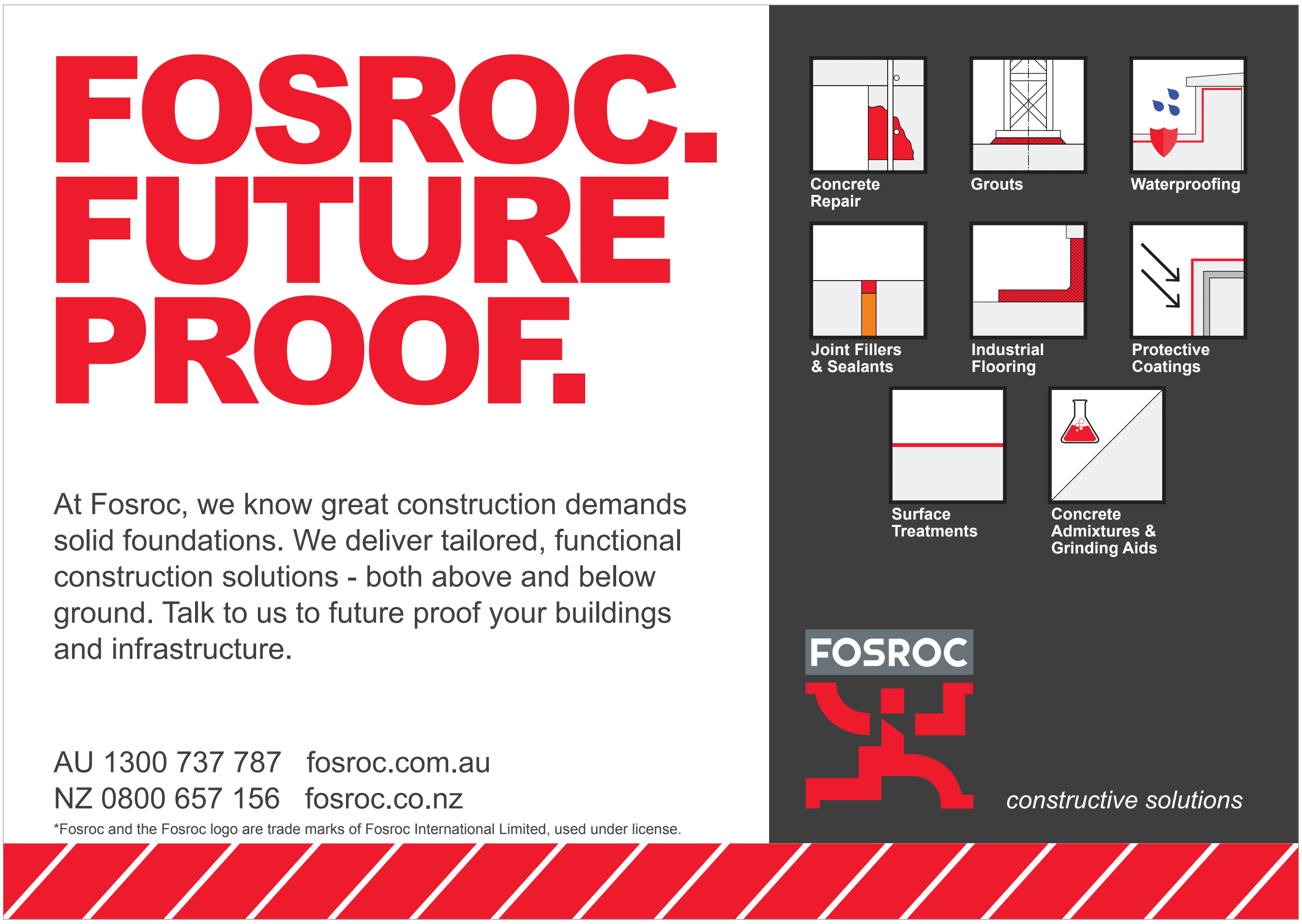
The capital cost of these installations was $90,000.

It is expected that the additional chemical cost of implementing the changed dosing systems will be $3,100 annually, which is well below the current $40,000 annual cost of air scouring. It is expected that some kind of water mains cleaning program will still be required in Corowa, but with average manganese concentrations below 0.01 mg/L from the treatment plant, it is plausible to expect the cleaning program could be extended out to be a 4 or 5 year event. With the final system installation costing $90,000 and a $3,100 additional annual chemical cost, it is expected that financial pay back for the system will be within 2 to 3 years.

The Authors

Shawn Charlton, (ShCharlton@alburycity.nsw.gov.au) is a *Water & Sewerage Specialist*, and **Martin Woodhead**, is *Team Leader Water Treatment*, with Federation Council in southern NSW.

Shawn has left Federation Council and is now working for Albury City as the *Supervisor of water filtration and pumping.*



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FIRE AND WATER

Bruce Murray and Ryan Melville

Following on from the recent extensive bushfires, a number of water authorities have been concerned about the impact of the degraded catchments on water quality. The biggest impacts are likely to be on rivers and dams where catchments have been badly burnt (Figure 1) and are susceptible to contaminants being washed in after significant rainfall events.

Following a fire event, huge amounts of ash, burnt material and eroded soil can be washed into waterways (Figures 2 and 3). Significant rainfall following bushfires are also likely to increase the mobility of pathogens from septic and sewage systems and animal agriculture into aquatic environments. Without adequate management and treatment these will affect the quality and safety of drinking water.

Impact on Water Quality

Fires, particularly in deforested catchments and riparian zones, alter the structure, behaviour and erosion of soil, typically resulting in high volumes of ash, sediment and debris being washed into waterways during subsequent rainfall events (Figure 2). These contaminants typically lead to the following changes.

Elevated turbidity and particulates.

Elevated colour and organics which may result in increased concentrations of disinfection by-products, for example trihalomethanes (THMs) and chloroacetic acids (CAAs) after disinfection.

Elevated nutrients from ash and other contaminants. Ash is high in both carbon and nutrients. Phosphorus presents a particular concern as elevated concentrations can lead to favourable conditions for growth of blue-green algae (BGA).

Increased level of pathogens in the raw water from run off impacted by sources of human sewage, such as sewage pump stations and sewer overflows and failing septic systems. Run off will also transport pathogens from animal sources, including from agricultural activity, animal carcasses within the catchment area and livestock able to enter the catchment area and access waterways due to depleted fencing.

BGA blooms and propagation of other algal species, which will likely result in increased concentrations of taste and odour compounds and potential toxins, and can degrade the performance of clarifiers and filters.

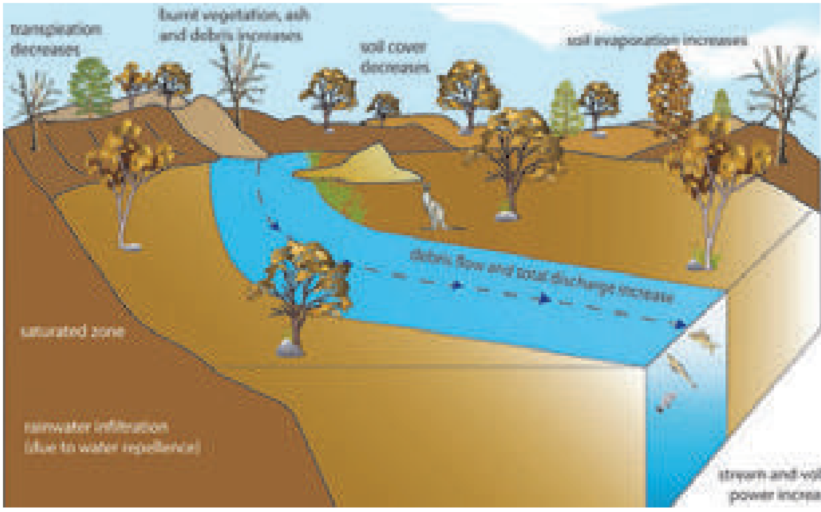

Figure 2. Some of the changes resulting from fire in a catchment.[1]

Figure 1. The aftermath of wildfire.

Figure 3. Poor quality water in a small waterway adjacent to burnt land.[2]

Reduced Dissolved Oxygen (DO) concentrations can result in an increased concentration of soluble iron and manganese in the water body from reducing conditions in bottom sediments. Nutrients can also be released from bottom sediments. Fish kills may also occur depending on the severity of DO reduction.

After a bushfire has subsided and ideally before the onset of significant rain, immediate actions to protect water catchments should be taken. While there will be catchment specific issues to consider, the following staged recommendations are suggested as priorities.

Immediate Actions

1. Assess the condition of existing water supply infrastructure, including any remote monitoring and telemetry and repair or replace where required.
2. Review the frequency and scope of catchment and raw water monitoring and inspections to ensure that changes in key indicators of water quality are not being missed.
3. Review WTP capabilities:
   a. Determine the limits of what raw water quality your WTPs can reliably treat while still achieving ADWG targets.
   b. Consider reducing plant flow rates and increase operating times to achieve longer contact times for improved treatment where necessary.
4. Optimise WTPs to deal with increased solids, organic and pathogen loads as well as potential filter clogging algae, taste, odour and toxicity issues. It is likely that doses for coagulant, polymer, powdered activated carbon (PAC) and chlorine will go up significantly to cope with the increased loading.
   a. Check the revised chemical dosing requirements through regular jar testing and adjust as the raw water conditions change.
   b. Enhanced coagulation (lower pH at high coagulant doses) may be considered for removal of organics.
   c. PAC dosing rates and contact time should be reviewed to combat colour, algal toxins and tastes and odours.
   d. Ensure an adequate supply of chemicals is available and maintained considering increased dosing.
   e. Management of the wastewater system (e.g. from clarifier blowdowns and filter backwash streams).
      i. Wastewater and solids production will increase.
      ii. Recycle streams may require additional monitoring to identify potential concentration of contaminants by recirculation. Recovery targets may need to be reduced if recycling contaminants is likely.
5. Operate dam destratification systems as often as possible in conjunction with appropriate DO monitoring to determine effectiveness.
6. Implement extraction point protection strategies, for example installation of floating booms (Figure 4) to protect from debris and ash.
7. Protect catchments by repairing fences or other barriers, especially those to exclude livestock.
8. Rehabilitate riparian zones to limit soil erosion and prevent contamination of waterways. This could be through the following possible regeneration practices.
   a. Spray on vegetation and grasses in strategic areas.
   b. Pinning down protective fabrics on exposed areas.
   c. Planting native shrubs and trees.
   d. Identify areas within the catchment where flows into the waterbody are more likely and implement strategies to control flow direction and volume, such as constructing physical buffers or barriers, for example silt fences, swales, gabion walls, sandbags and even repurposing fallen trees and branches to form barriers.

It should be noted that these holdback strategies can also conserve water by slowing down run off.

9. Assess potential sources of chemical, or pathogen contamination from fire affected areas.
   a. Stores of fuel, fertilisers and pesticides (personal and industrial volumes) may have been spilled during fires.
   b. Septic, sewer or stormwater systems may have been compromised.
   c. Confirm details of any firefighting chemicals or salt water used in the area and assess the risk. Most firefighting foams are now biodegradable and are low toxicity.

Short to Medium Term Actions

Investigate in situ water treatment in the reservoir, such as destratification systems, that help mitigate the impact of incoming poor quality water. It may also be possible to modify extraction infrastructure and processes to improve the selective withdrawal of better quality water from the reservoirs by avoiding extracting from areas of poor quality. This could be achieved by varying the offtake depth or relocating extraction pumps to unaffected areas of the reservoir or potentially installing riverside bores. If such flexibility is not available, consider installing fixed or floating booms (Figure 4) around extraction points to act as a physical barrier.

Other actions include:

1. Establish trigger levels for the management of water supply sources, for example algal counts and turbidity. These trigger levels would inform actions and protocols to be taken under various water quality scenarios. A BGA management plan is recommended.
2. Undertake seasonal hydrodynamic and DO modelling of the storages to monitor for changes in profile.
3. Implement community awareness and engagement programs.
   a. Advise landowners on potential benefits that could be realised through protecting the catchment that lies adjacent to or through their property, for example water retention and erosion prevention.
   b. Provide assistance in implementing catchment protection measures, for example constructing swales or sediment containment structures.

Figure 4. Installation of a boom in a fire affected reservoir.

c. Advise consumers using tank water to clean ash and contaminants off catchment sites and provide a first flush system. Clean and flush tanks and pipes as necessary. Refer also to https://www.health.nsw.gov.au/environment/water/Pages/rainwater-bushfires.aspx

Long-term Actions

1. Continue rehabilitation of the natural environment and maintaining control lines and access tracks.
2. Complete studies to gain a better understanding of the potential for algal blooms, factors influencing chlorine demands and decay and the potential for the formation of THMs and chloroacetic acids.
3. Consider increased water storage and reuse opportunities.
4. Undertake scoping assessments to review the robustness of the current WTPs performance in terms of changing climatic variables and its associated water quality issues.

According to Water Quality Australia (https://www.waterquality.gov.au/issues/bushfires), *"Depending on the severity of the fire, freshwater catchments are usually naturally regenerated to pre-fire conditions within five to twenty years. Aquatic ecosystems are remarkably resilient and often recover quickly if there is connectivity between affected and unaffected habitats."*

Assistance for the funding of works may be available via state and federal government grants and programs.

You can also contact your local Public Health Unit with any questions about the safety of drinking water, including communicating risks with the public.

Additional Sources of Information

- https://www.waterquality.gov.au/issues/bushfires
- https://ewater.org.au/bushfire/background_impactquality.shtml
- https://www.environment.act.gov.au/cpr/conservation_and_ecological_communities/aquatic_species_and_riparian_zone_conservation_strategy

Photo Acknowledgements

1. Image courtesy of the Department of Agriculture, Water and the Environment, Canberra, ACT, Australia (2020), 'Bushfires and Water Quality,' Available at: https://www.waterquality.gov.au/issues/bushfires

2. Image courtesy of Irene Dowdy: idphoto.com.au

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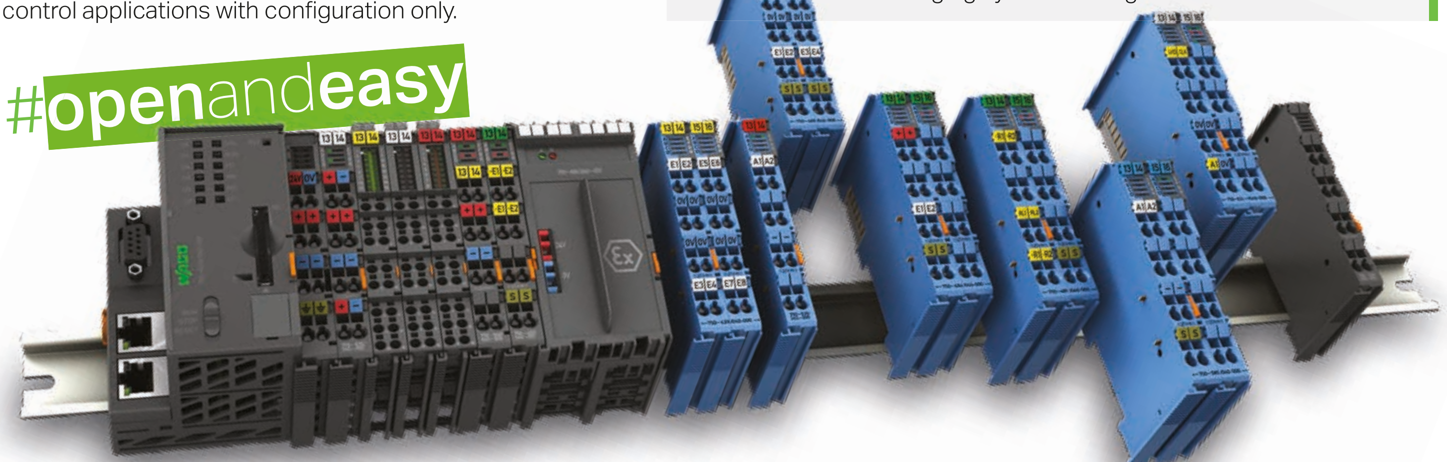

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MACARTHUR WFP INLET VALVE REPLACEMENT

Matthew Benstead

The Macarthur Water Filtration Plant (WFP) is a 265 ML/d direct filtration plant. It operates 24 hours per day, 365 days per year as it is the sole supply of drinking water to approximately 300,000 customers in Sydney's outer south west area of Campbelltown and Narellan. Raw water is supplied to the Macarthur WFP from any of the four dams within the local catchment area. The water goes through two stages of pumping which lift the water approximately 200 m in overall height from the Cataract River to the 2 x 5 ML raw water storage tanks. From the raw water tanks the water then begins its gravitational flow through the filtration plant and onward journey to the Sydney Water delivery network. The water descends around 140 m over a 15 km pipeline before Sydney Water take control of the water into their network delivery system for distribution to homes and businesses.

While the plant relies heavily on gravity for water movement, there are a range of moving parts, pumps, valves and equipment that are integral to the plant's operation. These all require maintenance or replacement at some point in their life.

The raw water inlet control valve (Figure 1) was identified as a single point of failure with no alternative option or strategy in place if the valve were to fail without notice. The valve is critical to the operation of the plant. In normal operation, the valve opens and closes automatically to allow raw water to enter the filtration plant via gravitational flow.

In 2014, the valve was approximately 20 years old, it was not a mass manufactured item, and therefore not something that was easily replaced. The valve itself was manufactured by GEC Alsthom Australia, it is sized with an 800 mm nominal bore internal control cone. The upstream inlet flange is a diameter of 1060 mm and the downstream outlet flange is 1910 mm. To drive the 800 mm disc there is an attached hydraulic motor and 3 hydraulic cylinders. The entire unit weighs approximately 4500 kg and is more accurately described by the manufacturer as an "In Line Regulator", but more affectionately known as a "GKILR 800".

We reviewed the maintenance history that had occurred to date and found there had been little maintenance undertaken other than visual inspections as the valve had operated almost faultlessly until now. It was decided the first thing we needed to know (other than the potential risk of failure) was the condition of the valve and the control system. The process controller team had also noticed that the flow controller output was not completely repeatable on flow changes made via the control valve.

A new flow meter as well as a new linear displacement transducer were purchased and installed on the control valve, the latter to provide valve position output feedback. A hydraulic specialist was engaged to undertake an assessment of the hydraulic drive unit for the valve where it was found there was a large gap between the cylinder rod to valve plate adjustment. This explained the lag in the system when required to operate in one direction and then the other; which is the core function of a flow control valve.

Figure 1. The Raw Water Inlet Flow Control Valve (GKILR 800). The two curved red lines indicate the flange faces of the existing GKILR and the space the new/engineered solution had to fit into.

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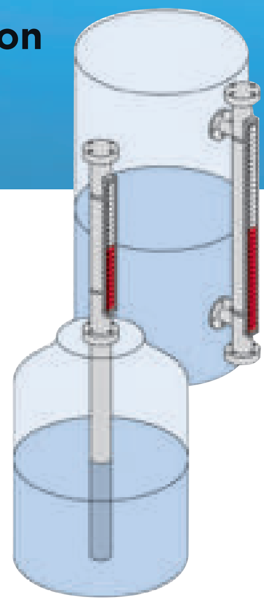

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As plant operation is 24/7 we could not afford to take the plant offline for any significant amount of time. As a single source supplier to Sydney Water's network, Macarthur WFP cannot be shut down for days or weeks to remove, repair and re-install the GKILR. Macarthur WFP has 30 ML of treated water storage on site, and the minimum contractual flow of the plant is 50 ML/d. Sydney Water only have enough water in their reservoirs within the entire network to supply for approximately 24–36 hours at "normal" demand.

With a straight "like for like" valve replacement being seen as the preferred option, we attempted to source an identical replacement but unfortunately, discovered this was no longer possible as production of the GKILR 800 had ceased. So the next consideration was to source a valve with a similar style of operation. Our investigations found a Plunger Style valve that might suit this purpose, however, after some time invested into this and a quoted price of approximately A$125,000, we realised this was going to be an expensive exercise and we required more expertise than our experience on site had the capability to manage.

We also considered installing the "new" valve in a bypass style arrangement as this would provide the redundancy we sought for risk mitigation.

During 2016 and the early part of 2017, a three part process was adopted as an agreed solution.

1. Develop a valve arrangement that could be used temporarily.
2. Remove the GKILR and install the temporary valve and get the plant running. This needed to be completed within a 16–20-hour window.
3. Overhaul of the GKILR.
4. Reinstall the GKILR and retain the temporary valve as a future spare.

This solution centred around the use of a double flanged, 750-30A butterfly valve with a webbed disc which provides improved flow control as the water transitions across the valve in comparison to a standard flat-disc type valve.

With a valve now selected and approved by the engineers, the next part of the solution delivery was for the engineering contractor to develop two spool pieces that could accurately match the upstream and downstream flange dimensions and bolt patterns and then all fit within the 1800 mm distance between flanges of the upstream and downstream faces (Figures 1 and 2). This was successfully achieved, however an increase in flow noise was identified as a side effect of this option, which would require pre and post temporary valve installation noise surveys to be undertaken. Change out from the GKILR 800 to the temporary valve was planned to be undertaken within sixteen hours and another four hours allowed for plant shutdown and start up; a maximum total of 20 hours downtime.

Remote control of the valve via the plant operation software was also required and obtained by selection of an appropriately sized gearbox and electronic actuator. This was probably the easy part of the process once the valve and spool piece designs were complete.

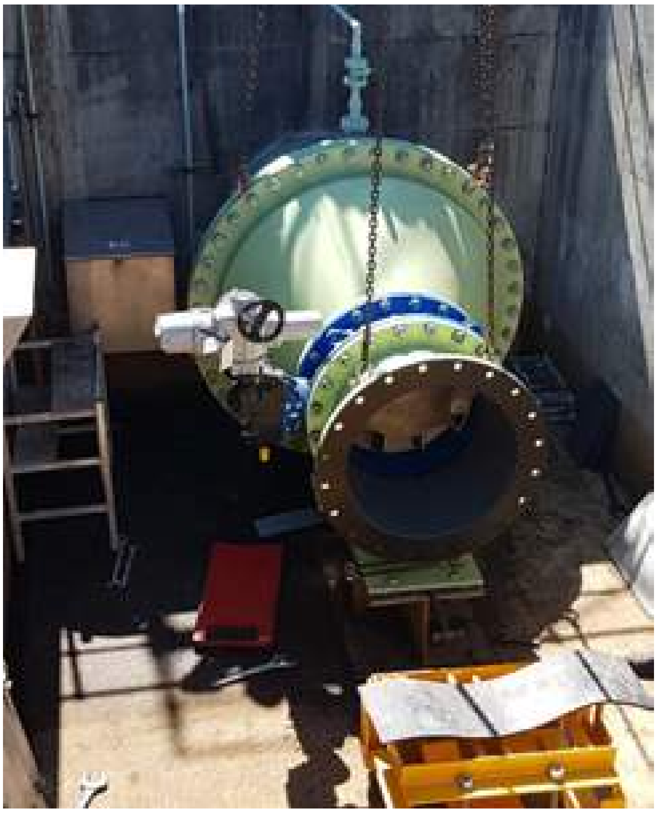


Figure 2. The photo on the left shows the newly developed solution sitting on the delivery stand (and what will be the future storage stand for the temporary valve once removed after the GKILR is re-installed). The photo shows the smaller inlet (1060 mm) flange, the new valve (blue) with gearbox (black) and Rotork actuator (grey) mounted, and also shows the downstream (1910 mm) flange that was engineered to replace the original bell shape of the GKILR. The photo on the right shows the solution being installed in place of the GKILR.

Delivering the Solution

Many would think that once you have agreed on a solution, the rest is easy, however this was probably the most complex stage of the process. Delivering the solution required the planning, coordination and management of all stakeholders for a seamless execution of the plan.

This step had the potential for unforeseen risks and problems to develop which could impact the client (Sydney Water) and the supply network. Ultimately it is the client who takes the biggest risk in this situation because if their network runs out of water, it's their customers who make the complaint.

After multiple risk assessment reviews and planning sessions, an implementation strategy was devised and planned. This plan incorporated aspects such as the controlled shutdown and start-up of the filtration plant, lockout isolations of the process, PLC changes and post installation testing of the valve, the required trade labour in the preparation for installation and on the day, cranes and dogman for the delivery of the temporary valve to site and installation as well as removal of the GKILR 800 back to the engineering workshop for overhaul.

I am pleased to say, that on September 19th, 2018, the plan was executed safely and almost faultlessly. Figure 3 shows the temporary valve in position at the plant.

The overhaul of the GKILR has been a long, slow and tedious process, however it is almost complete. Delays occurred for a number reasons, but predominantly due to changes in personnel, budget constraints and the commencement of the Macarthur WFP upgrade project changing our focus slightly. The upgrade project meant that the valve would not be easily re-installed with so much construction work going on around the location of the valve. Also, given the success of the engineered "temporary" valve in place at present, a strategic decision was made to take our time with the overhaul, get it right and not attempt re-installation until the upgrade construction works are completed towards the end of 2020.

The re-installation of the GKILR is now likely to occur in mid 2021 and will be stored on site at Macarthur WFP until then, once the valve is completely finished and returned to site.

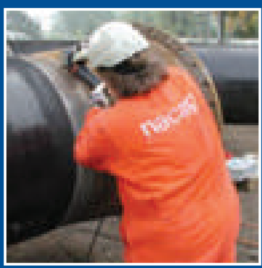
The overhaul involved initially stripping the 25 year old valve into parts and each part painstakingly assessed for what was required to be repaired or replaced to get it back to an "as new" condition. Like a vintage motor vehicle, trying to maintain something where parts are no longer available is not an easy task, so re-establishing worn metal surfaces and finding lathe's and milling machines capable of machining parts this size has also presented many challenges, but nonetheless has ultimately been successful with the final re-assembly almost complete. The valve is scheduled to be back on site at Macarthur WFP by mid 2020 and will be installed and brought back into service mid 2021. The temporary valve will then be mothballed and kept on site. This ensures we have achieved the primary goal that kicked all this off, a working GKILR, and a spare for what was seen as a single point of failure risk to the water supply of 300,000 customers in Sydney's south-western suburbs.

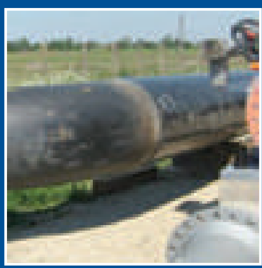
The Author

Matthew Benstead (mbenstead@TRILITY.com.au) is the Maintenance Coordinator with TRILITY, the operator of the Macarthur Water Filtration Plant.

Figure 3. The temporary valve 'in position' and operating successfully.







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Case study: Facultative sanitary wastewater lagoon

A wastewater lagoon system in Syracuse, New York needed to be upgraded. The lagoons had been aerated with two 3.7-kilowatt surface aerators – one per lagoon. They accepted the wastewater from 115 mobile home units in suburban Syracuse.

Problem

Over time, a sludge blanket developed at lagoon corners and along its banks. It became so well established that zones of sludge were not being treated and hydrogen sulphide odours returned. Numerous odour complaints were received. Maintenance also posed a safety risk for operators.

Solution

A Venturi Aerator (VA) system was installed, consisting of:

- one VA-100 for the polishing lagoon
- one VA-250 for the primary lagoon
- one 11-kilowatt Gorman-Rupp T4 self-priming pump to power both aerator units.

The results

The kinetic energy of the VA was able to spin the 'entire' sludge blanket with the following effects.

- Within a day, hydrogen sulphide odours were eliminated.
- Within a week, the blackened, anoxic waters changed to light brown in colouration (indicative of active aerobic digestive activity).
- Within two weeks, the sludge build-up in the lagoon was completely decimated.

Safety risks were greatly reduced, and operators have easy access to equipment for maintenance.

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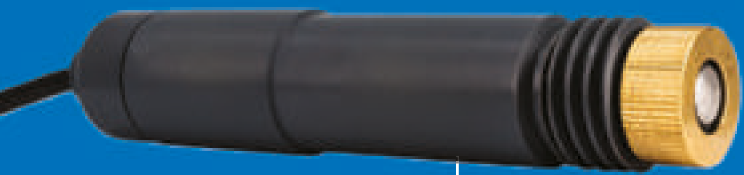
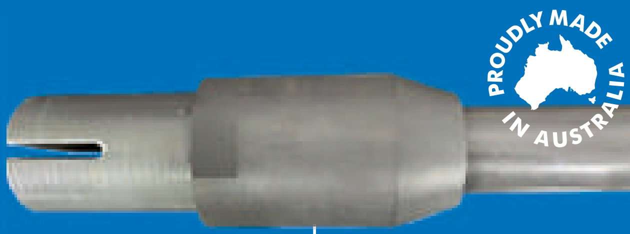
Secure & reliable technology for total water management

- High accuracy & reliable process measurement
- SCADA & Cyber Security solutions
- Using IIoT solutions to manage ageing infrastructure
- Integration of Operations & IT environments
- Secure hosted operations

Australian Made Wastewater DO & TSS Sensors for the World



RWT G95A
Galvanic Dissolved Oxygen Sensor



RWT S73D
Submersible MLSS Sensor

Following up on the success of its Australian designed and manufactured **Dissolved Oxygen Sensor**, Royce Water Technologies has added the **S73D Online Total Suspended Solids Sensor** to its range of Online Instruments.

Designed and manufactured by Royce in Australia for Australian conditions, the S73D measures from 50mg/l to 20,000mg/l Total Suspended Solids accurately and reliably. Built-in Jet Cleaning maintains clear measurement and reduces maintenance.

The S73D can be retrofitted to the hundreds of Royce Water RWT75 Instruments currently measuring Dissolved Oxygen and pH in Wastewater Treatment Plants throughout Australia.

MXD 75
Multi-function Analyser

BXD17
Single Input Controller

ACCURATE / RELIABLE / BUILT-IN JETCLEAN / EASY RETROFIT / ECONOMICAL

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