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CASE STUDY: HAVELOCK NORTH, NEW ZEALAND – WATERBORNE DISEASE OUTBREAK

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ABSTRACT

In August 2016 the town of Havelock North, New Zealand, witnessed the worst recorded waterborne disease outbreak in the country's history. The incident occurred after a period of heavy rain involving a groundwater source that was believed to be secure. The outbreak resulted in more than 5,500 individuals becoming ill from *Campylobacter jejuni*. More than 40 individuals were hospitalised, and 3 deaths have been attributed to the outbreak.

The management of the water supply system and responsibilities for public health protection in the region are complex and the initial media response and blaming for the outbreak resulted in confusion amongst the residents. Conclusions from multiple investigations showed that sheep manure from a farm located close to the drinking water supply caused the outbreak.

In September 2016, an independent inquiry was established into the incident. Stage 1 of the inquiry sought firstly to clarify responsibilities, establish the cause of the incident, the facts of the outbreak and how it was managed, and then to consider this in the context of what should have happened, what should have been known and if any fault or systematic failures could be identified. Stage 1 of the inquiry has concluded with a report published in May 2017.

Stage 1 of the Inquiry attributed failings to all parties who had duties to protect the safety of the drinking water supply and found there had been significant failures in the assessment of risk. The report also suggests that a more collaborative relationship between the District Council and Regional Council may have prevented the outbreak.

Stage 2 of the inquiry identified several changes required to legislation and drinking water management in New Zealand, including a recommendation that all drinking water supplies be treated, and that New Zealand adopt a similar risk management approach as described in the Australian Drinking Water Guidelines, particularly a set of Guiding Principles for water supply management.

1.0 INTRODUCTION

Information for this paper is drawn from multiple web sites listed in the Appendix and the evidence presented at the Government Inquiry into North Havelock Drinking Water www.dia.govt.nz/Government-Inquiry-into-Havelock-North-Drinking-Water

Havelock North is a town of approximately 14,000 people on the East Coast of the North Island of New Zealand. It is part of the tourist area of Hawke's Bay and within the urban area of Hastings District which has a population of more than 75,000. It is a wine growing and farming region with approximately 800mm annual rainfall.

The drinking water supply for Havelock North comprises groundwater from three bores in the Brookvale borefield that draws water from the Te Mata aquifer (Figure 1). According to the Drinking Water Standards for New Zealand, the water supply is considered "secure".

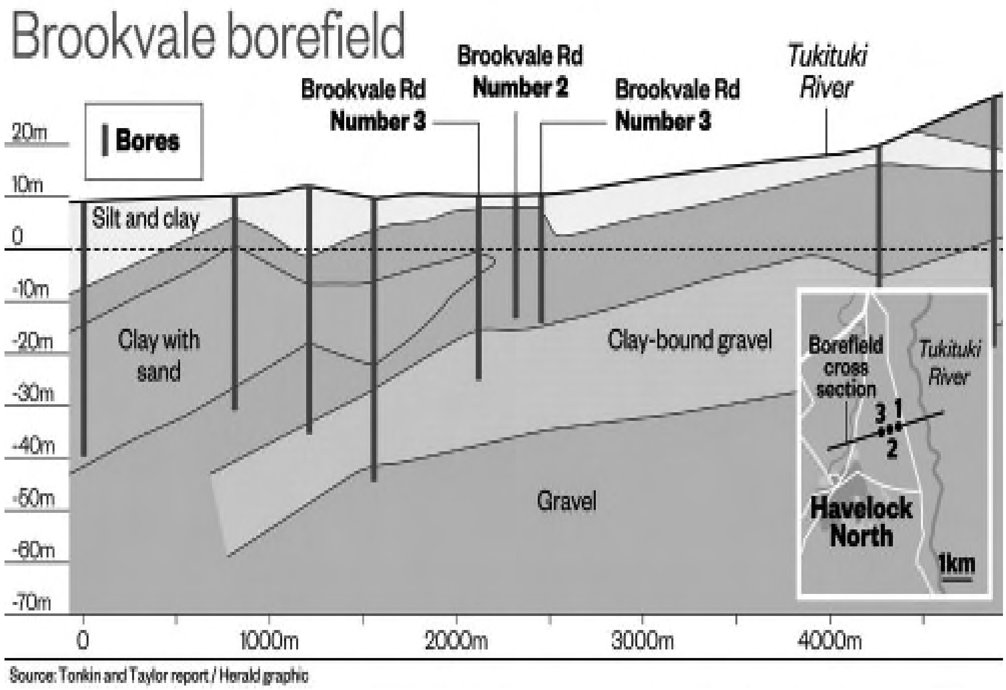
Of the three bores, one is 17 years old and two are 30 years old. The water was supplied to consumers fluoridated but not chlorinated, with *E. coli* monitoring undertaken every 2 days. The bores are operated by the Hastings District Council and it has been reported that one of the bores was shut down in 2015 due to detection of *E. coli*.

The waterborne disease outbreak occurred over a two week period in August 2016. New Zealand has about 50 waterborne outbreaks associated with drinking water per year with the Havelock North event representing the largest recorded outbreak. Recorded outbreaks are generally small, with an average of about 8 people affected.

The Brookvale borefield that was the centre of the 2016 incident had previously been implicated in a waterborne disease outbreak. In July 1998, 80 individuals were sickened from *Campylobacter* and Bore 2 was implicated.

The 2016 outbreak has been linked to heavy rain on Friday 5 August, which inundated paddocks and filled a pond in proximity to Bore 1. This contaminated water then entered the aquifer. During the rain event, there was significant local flooding and power failures. Routine *E. coli* testing was all clear from samples analysed on Tuesday 9 August, but presumptive *E. coli* was reported in water samples on Friday 12 August – received at 10:30am. The Hastings district council Mayor was notified on that same afternoon and a decision to chlorinate was made at 3pm. A boil water advisory was issued at 6pm on Friday 12 August.

Additional monitoring detected *E. coli* in Bores 1 and 2 on Saturday 13 August and over the weekend *Campylobacter* was confirmed as the cause of the outbreak. By the time the agent for the outbreak had been identified, dozens of individuals had been hospitalised and several thousand had experienced gastroenteritis. As early as Thursday 11 August, local schools were noticing absences, with up to 120 students reporting as being ill.



<u>Figure 1:</u> ***Brookvale Borefield***

1.1 Water Utility Response

The Hastings District Council quickly moved to chlorinate the affected water supply and provided tankers of drinking water from nearby Hastings. In an unrelated incident, one of the tankers returned a presumptive positive result for *E. coli*. This resulted in the Hastings water supply having to be chlorinated and boiled as well. The boil water order was lifted on 3 December, but chlorination was to remain in place for 3 months. A UV treatment system as now been commissioned for the borefield.

A detailed investigation of the borefield and potential sources of contamination was undertaken after the outbreak. Media speculation and finger pointing at first suggested a local mushroom farm was responsible, then ingress from the Tuki River. Dye tracer tests carried out in 2017 at a small dam the "Mangateretere Pond" situated approximately 90m from Bore 1 identified the pond water as impacting the bore. *E. coli* and *Campylobacter* were detected in the pond and the outbreak genotype detected in sheep nearby.

1.2 Community Costs

As of January 2017, the costs to the community were approximately $2.7M as follows. These costs do not include compensation from individuals or the final outcomes from the Government inquiry.

- Clinical supplies - $31,000
- Hydration management - $18,000
- Administration and communication expenses - $28,000
- Lab expenses - $8000
- Legal expenses - $270,000
- Surveys - $36,000
- Staff sickness - $216,000
- Staff cover and costs - $330,000 - (e.g. covers public health, SMO cover, ED and ICU expenses)
- Government Inquiry - $637,000 (Jan 2017)

1.3 Regulatory Framework

New Zealand's *Health Act 1956* is the primary legislation for the safety of drinking water supplies and is supported by *Guidelines for Drinking-water Quality Management for New Zealand* and *Drinking-water Standards for New Zealand 2005 (revised 2008).* The framework establishes a role for drinking water assessors to ensure compliance of water suppliers with the legislation and standards and monitor implementation of their water safety plans. Drinking water suppliers include district councils and communities.

Water suppliers may gain access to water sources managed by regional councils through a resource consent permit issued under the *Resource Management Act 1991*. Regional councils can apply conditions on a consent.

In this case, the water supplier was the district council who had a resource consent permit from the regional council for extraction from the aquifer.

1.4 Government Inquiry

On 12 September 2016, New Zealand's Attorney General announced the establishment of an independent inquiry into Havelock North Drinking Water Supply contamination incident. Stage 1 of the inquiry has concluded with a report published in May 2017. However, the inquiry continues, and Stage 2 takes on a much broader focus including the scope and efficacy of the regulatory framework.

Stage 1 of the inquiry sought firstly to clarify responsibilities, establish the cause of the incident, the facts of the outbreak and how it was managed and then to consider this in the context of what should have happened, what should have been known and if any fault or systematic failures could be identified. Stage 2 of the inquiry was focussed on identifying changes to regulations and drinking water management systems to ensure no other outbreaks occur.

2.0 DISCUSSION

The Stage 1 Inquiry report, released in May 2017, confirmed that the cause of the outbreak was *campylobacter* from sheep faeces being washed into a pond because of heavy rain which then infiltrated the aquifer and potentially flooded the bore chambers.

The Inquiry proceeded to attribute failings to both persons and organisations involved in the safety of the drinking water supplies including a consultancy operating as a technical adviser. This analysis recognised the importance of a multi-barrier approach and the multiple organisations involved in implementing this.

The Stage 2 Inquiry report was released in December 2017 and focussed on legal and regulatory changes and changes required for drinking water management. The summary of the outcomes of Stage 1 and Stage 2 reports are summarised below.

2.1 Drinking Water Regulation

The District Council's Water Safety Plans were required to be approved, and their implementation monitored, by a drinking water assessor. Water safety plans remain in force for a maximum of 5 years. The district council had an approved Water Safety Plan (2015) at the time of the outbreak, however the adequacy of the plan and its implementation was found to be insufficient by the Inquiry.

The inquiry found that the drinking water assessor's approach was not forceful enough both in applying the drinking water standards and ensuring the district council met its responsibilities of its water safety plan and emergency response plan. The drinking water assessor had knowledge of significant information missing from the plan including a previous outbreak and a large number of *E. coli* detections in the system. The contingency planning by the district council was known to be lacking and various requests had been made to the district council over previous years to request one be developed and implemented.

The stage 2 report recommended the setting up of a dedicated drinking water regulator, and comments that there is no adequate or effective enforcement of the current statutory obligations on water suppliers.

Also recommended is a review of the NZS 4411 (Environmental Standard for drilling of soil and rock) and a requirement to review Water Safety Plans and review the Drinking Water Standards of New Zealand.

2.2 Quality of Risk Assessments

The Havelock North drinking water supply had been the cause of a campylobacter outbreak in 1998. The district council had repeatedly detected *E. coli* in the Havelock North system as well as an adjacent water supply drawing from the same aquifer. This information was known to the district council but had not been shared with the regional council.

The district council relied on the security of the source and the regional council was responsible for managing risks to the aquifer. Information sharing may have provided the regional council the opportunity to reassess the risks to drinking water safety regarding the aquifer. Regardless, the Inquiry found the regional council's knowledge and awareness of aquifer contamination risks to be below the required standard.

The Inquiry stated "it appears nothing was learned from the July 1998 outbreak. The District Council, as the water supplier, did not take the 1998 outbreak seriously enough and implement enduring, systemic changes. Memory of the earlier outbreak simply faded."

The district council did not record the 1998 outbreak in its risk assessment. The Inquiry said that the risk rating assigned for the consequence of contamination "substantially underrated the impact of a waterborne contamination incident on the community." The district council had engaged a technical advisor to assess bore head security but did not provide a copy of the water safety plan.

The regional council, the district council and the district council's technical advisors each had roles in the assessment of risks to the drinking water supply and the inquiry found that in varied ways all three parties failed to adequately assess these risks.

2.3 Cross-agency Collaboration

To manage the risks to the safety of the drinking water supply, the district council and regional council needed to have a collaborative and cooperative relationship. The Inquiry found that this was not the case for the Havelock North supply and that a better relationship with meaningful collaboration between the two agencies may have resulted in a different outcome.

The district council's water safety plan identified the need to work with the regional council, however this had not been implemented. Notably the regional council remained unaware of the significant number of *E. coli* detections by the district council which could have prompted further investigation on source security.

The Stage 2 report recommends mandated collaboration between agencies.

2.4 Contingency Planning

The Inquiry found that the district council had no emergency response plan to deal with an event such as the Havelock North outbreak. There was no contingency plan, draft boil water notices or communications plans prepared though the water safety plan referred to these and the drinking water assessors had requested their preparation on various occasions.

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Thanks to Emma Carden from the Victorian Department of Health and Human Services for input into the results of the Stage 1 enquiry. Parts of this paper was first presented as a joint presentation at the WIOA Victorian conference in Bendigo in September 2017.

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MEMBRANE OPERATION AND MAINTENANCE, PMHC WTP'S

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MEMBRANE OPERATION AND MAINTENANCE, PMHC WTP'S

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ABSTRACT

This paper is a summary of the Port Macquarie Hastings Council (PMHC) implementation and continued use of membrane filtration. PMHC uses membrane filtration for the purposes of potable water treatment with additional membrane filtration plants at sewage treatment plants and a reclaim water facility.

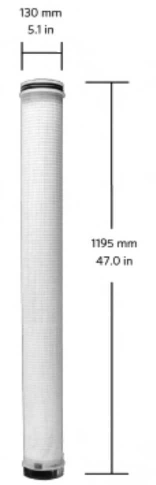
There are several necessary monitoring and maintenance procedures regarding the proper operation of a membrane filtration plant including, but not limited to, simple observations, parameter adjustment, recovery cleaning, membrane repair and even membrane replacement.

Several membrane replacement projects have been undertaken in recent years with a variety of challenges posed from plant to plant. Though the concept of membrane filtration is simple, no two filtration plants are the same and there is always a new challenge yet to be uncovered.

1.0 INTRODUCTION

Ultrafiltration (UF) is defined as a membrane separation process using membranes with a pore size of approximately 0.002-0.1 microns and a feed water operating pressure of approximately 200 to 700 kPa. UF removes materials such as sand, clays, algae, silt, Giardia lamblia and Cryptosporidium cysts and all microbiological species. Although UF is not an absolute barrier to viruses, when used in combination with disinfection, it can effectively control these microorganisms in water.

Port Macquarie Hastings Council has 4 ultrafiltration membrane plants for potable water, 1 reclaimed water plant with ultrafiltration and reverse osmosis, and 2 sewage treatment plants with membrane filtration. The membranes used within the PMHC water treatment plants are the MEMCOR S10N hollow fibre, submerged ultrafiltration membranes with nominal pore size and membrane area of 0.04 micron and 23.1 m^3, respectively. A photograph of these membranes modules is shown in figure 1.



<u>Figure 1:</u> ***MEMCOR S10N Membranes***

Using low-pressure UF membrane processes provide many advantages compared to conventional clarification and disinfection, including:

- Reduced chemical requirements (i.e. no need for coagulants, flocculants)
- Constant quality of the treated water in terms of microbial and particle removal
- Reduced footprint
- Simple automation
- Size-exclusion filtration as opposed to media depth filtration.

This paper will focus on the potable and reclaimed water membrane filtration plants and outline how they operate as well as how they are maintained. Additionally, membrane replacement along with the pros/cons/pitfalls of membranes will be discussed. This paper will also touch on how things have changed over the past 10 years and the areas that require more investigation to gain the most out of membrane filtration in the future.

2.0 DISCUSSION

Membrane filtration is one of the best filtration process available. The PMHC potable and reclaimed water treatment plants that use membrane filtration include:

- <u>Wauchope Water Treatment Plant</u> – This is an ultrafiltration plant supplying treated water to the Wauchope reticulation, comprising 224 membrane modules allowing for a maximum filtrate flow rate of 93 L/s and a total plant capacity of 8 ML/day. The source water is extracted from the Koree Island Pumping Stations before being dosed with lime, carbon dioxide, fluoride and chlorine.
- <u>Comboyne Water Treatment Plant</u> – This is an ultrafiltration plant that supplies treated water to the Comboyne reticulation (population 500), comprising of 24 membrane modules allowing for a maximum filtrate flow rate of 6 L/s and a total plant capacity of 864 kL/day The source water for the plant is extracted directly from the Thone River and due to the river's high manganese and iron levels, the water is pre-dosed with sodium hypochlorite as an oxidant to remove these from the water and protect the membranes.
- <u>Long Flat Water Treatment Plant</u> – This is an ultrafiltration plant that supplies treated water to the Long Flat reticulation (population 400), comprising of 12 membrane modules allowing for a maximum filtrate flow rate of 4.5 L/s and a total plant capacity of 432 kL/day. This plant has direct river extraction, strainers to protect the membranes and chemical dosing.
- <u>Telegraph Point Water Treatment Plant</u> – This is an ultrafiltration plant that supplies treated water to the Telegraph Point reticulation (population 1000), comprising of 40 membrane modules allowing for a maximum filtrate flow rate of 10.5 L/s and a total plant capacity of 1440 kL/day. This plant has direct river extraction, strainers to protect the membranes and chemical dosing.
- <u>Port Macquarie Reclaimed Water Treatment Plant</u> – As part of PMHC's Reclaimed Water Scheme, this treatment plant currently treats 15% of the effluent from the Port Macquarie Sewage Treatment plant. The effluent enters the plant and is disinfected by chloramination and UV disinfection. The sewage is then subjected to ultrafiltration (pore size 0.04 micron) followed by reverse osmosis membranes (pore size 0.0001 micron) which removes bacteria, viruses and salts. This level of membrane filtration produces 'Six Star' water which is used within our dual reticulation system. The reclaimed water plant was updated in 2017, increasing capacity from 1 ML to 2 ML per day. This involved doubling the membrane modules to 128 and implementing a second reverse osmosis train.

Table 1: ***Summary of the Water Treatment Plant Capacities***

	No of Trains	Total Plant Capacity	Max Flow Rate	Membrane Surface area	No. of modules
Wauchope	1	8 ML/d	93 L/s	23.1sqm	224
Telegraph Point	1	1440 kL/d	10.5 L/s	23.1sqm	40
Comboyne	1	864 kL/d	6 L/s	23.1sqm	24
Long Flat	1	432 kL/d	4.5	23.1sqm	12
Port Macquarie Reclaimed	2	2 ML/d	40 L/s	23.1sqm	128

2.1 Operation

Water filtration is simple in concept, in that water is passed through a physical barrier to remove unwanted contaminants. Membrane filtration is the same except that, unlike other methods of water filtration, there is no pre-treatment necessary.

The operation of a membrane filtration plant starts with source water monitoring. While there is often little that needs to be adjusted due to changes in the source water there are limits to what the plant can handle, and these limits will differ between different membrane types.

During operation some indicators of note are the Trans-Membrane Pressure (TMP) and the membrane resistance. These two figures will indicate the amount of fouling on the membranes which will in turn indicate necessary maintenance (see Section 2.2).

It is also necessary to monitor critical control points to ensure the plant is operating as within the desired limits in terms of parameters such as turbidity, pH and chlorine.

2.2 Maintenance

As well as the standard maintenance that comes with the operation of any plant (pumps, pipes, valves, seals, etc), membrane filtration plants require some additional fouling removal due to the higher log removal.

The maintenance backwash in a membrane filtration plant consists of two parts, membrane agitation using air and reversing the water flow to dislodge as much particulate matter as possible. The backwash water is then drained away and the cell refilled to resume operation. The intervals between backwashes is usually between 10 and 40 minutes and can be adjusted to accommodate differences in source water or membrane deterioration.

Membranes also require a chemical Clean in Place (CIP) to remove metals and organics that cannot be removed with a backwash. This will consist of two cleans, the first one being acid (usually Citric acid) to remove metals and the second being sodium hypochlorite to remove organics and biological fouling. Both cleans will go through a process of soaking and recirculating the chemical to ensure that the clean is effective.

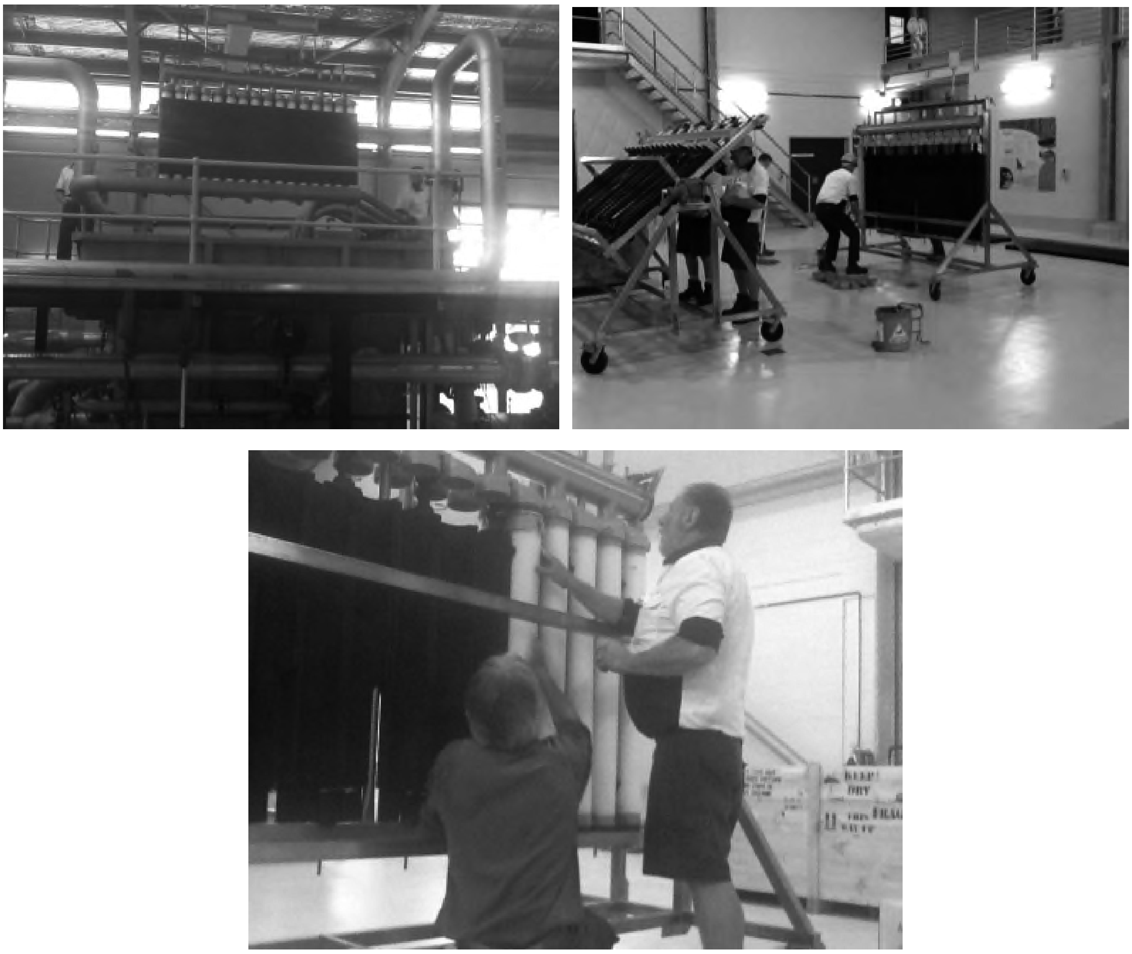
Another maintenance process used in membrane filtration plants is a Pressure Decay Test (PDT). This test involves the membranes being pressurised to a desired pressure using air and held for a set duration. This will give a pressure decay rate within the membranes and indicates the integrity of the membranes. Usually it is a select few membrane strands that are compromised, and they can be isolated through a simple process called pinning. Extremely high-pressure decay rates may indicate the membranes need replacing.

2.3 Membrane Replacement

After approximately 10 years of use, membranes may need to be replaced. Some common signs of aging membranes include:

- Inability to meet design flows
- Increase in cleaning frequency
- High levels of fibre failure
- Reduction in the permeability of the membranes
- Membrane autopsies indicating structural changes and increase in weight (membrane fouling)
- Consistently high TMP and membrane resistance

All 4 potable membrane filtration plants and the reclaimed water plant have had new membranes installed (all ultrafiltration). The process is very simple and took no longer than a day for each plant. The membrane replacement process is shown in Figure 2.



<u>Figure 2:</u> ***Photographs showing the Membrane Replacement Process***

2.4 Pros, Cons and Pitfalls

The pros of membrane filtration are in the final product and the ability of the membranes to handle large swings in source water quality with very little adjustment. Most modern membrane filtration plants should be producing water with <0.1 NTU turbidity. This is not dependant on any pre-dosing and can be expected even when the source water makes a turn for the worse. In addition to the higher final standard there is a significant reduction in chemical usage resulting in long term savings.

The cons of membrane filtration are higher initial capital cost, high replacement cost and under qualification. The cost of a new membrane filtration plant is no small number and hard to justify, especially if there is a complaint treatment plane already in operation. On top of this, the replacement of the membranes is also expensive however at current rates they should be lasting at least 10 years. This makes budgeting for them difficult.

Potentially the largest pitfall to membrane filtration (like most things) is education/neglect. Although today's membranes should last 10+ years their life span will be significantly reduced if managed incorrectly. Membrane filtration is relatively new by most standards and as a result there are few experts on the matter and not a lot of information available. And as a result, we have had to learn through continuous improvement initiatives (e.g. Training and Optimisation).

2.5 The Future

The future of membrane filtration is fouling removal. While we do have processes in place to remove some of the most common fouling there are some things that get missed. And each site will be different from the last and so specialised and tailored maintenance regimes will become standard.

There will also be an increase in automation as online instrumentation becomes more reliable. This will mean that operators will be doing more verification checks and data analysis to optimise operation.

3.0 CONCLUSION

Membrane filtration is an extremely effective method for the removal of particulates, microorganisms and natural organic matter from water which can impact its colour, taste, odour and it's potential to form disinfection by-products. The operation and maintenance of membrane filtration is relatively simple however the capital costs involved can be the deterrent. As advancements are made in membrane production and module design, capital and operating costs will continue to decline, making the process of membrane filtration more and more attractive.

4.0 ACKNOWLEDGEMENTS

Many thanks to Alan Butler (Water and Sewer Process Engineer) and Danny Roberts (Operator in Charge) for their involvement and assistance in developing this paper.

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WATER DIVINING WITH SCIENCE
(PALLAMALLAWA HYDROGEOLOGICAL STUDY)

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WATER DIVINING WITH SCIENCE (PALLAMALLAWA HYDROGEOLOGICAL STUDY)

Alex Norman, *Assistant Technical Officer,* Moree Plains Shire Council

ABSTRACT

Pallamallawa is a small town located about 30 km’s from Moree. It has two town supply bores, one of which was failing. Moree Plains Shire Council (MPSC) decided to drill a replacement bore to ensure water security for the town. Department of Primary Industries Water Division instructed MPSC to conduct a hydrogeological study of the surrounding area to assess the new bores impact on the aquifer and surrounding bores. MPSC engaged Geo9 to perform this study through a seismoelectric and electrotelluric geophysical survey. This survey involves the strategic placing of electrodes on a grid pattern in the area surrounding the proposed bore location and around existing bores. Metal plates are struck on the ground, sending seismic P-waves into the subsurface. Interaction of seismic energy with the mineral-water interface produces an electric field, which is recorded at the surface with a digital recorder. Digital signal processing of allows 3D maps of hydraulic conductivity and water quality to be produced from these recordings. The resulting map reveals a palaeochannel network, and the interpretation of the groundwater system and the interconnectivity between existing bores. With this data MPSC was able to target a new location for a bore that would not affect existing water supply bores.

1.0 INTRODUCTION

Moree Plains Shire Council (MPSC) supplies potable water for a small town, Pallamallawa, located about 30 km’s east of Moree. The potable water supply consists of a duty/standby bore arrangement which pumps to a cooling tower from which it is treated and pumped to a reservoir. In June of 2016, during a clean and inspection of the bores, it was noted that there was serious concern for the integrity of the Bore No. 2 as can be seen in Table 1. The report from the cleaning contractor identified multiple points in the casing and screen that were corroded, several holes were identified and sections where the gravel packing vas visible, as can be seen in Figures 1 and 2. The recommendation from the contractor was that the bore was in a poor condition and was subject to potential imminent failure above both screens.

Figures 1 & 2: ***Photos of Pallamallawa Bore No. 2 Condition***

Due to the age and condition of the bore MPSC decided to commission a replacement bore. Department of Industry Water Division advised MPSC that a hydrogeological assessment would need to be completed outlining the effects of the bore on the existing aquifer and how it would affect neighbouring bores within 200 m.

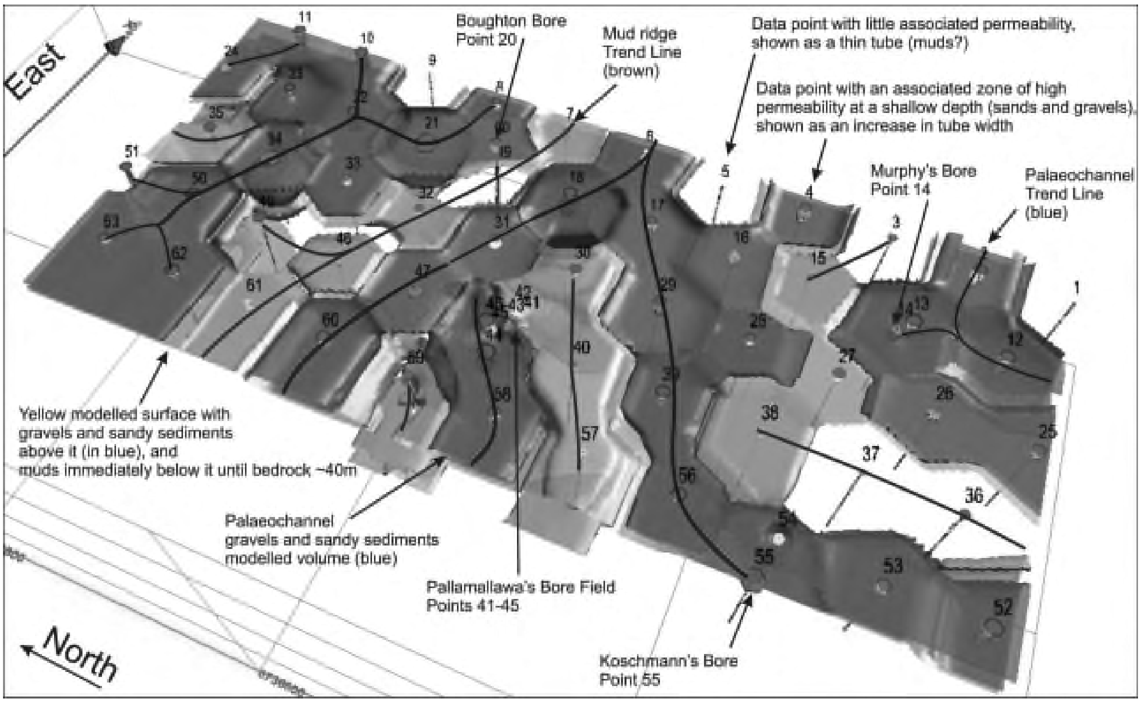
Table 1: ***Notes on Observations from CCTV Inspection and Acoustic Televiewer for Pallamallawa Bore No. 2***

No.	Depth	Significant Observation	Comment
1	Surface to 14.2m	Casing look corroded above water table and iron stained	Corrosion signs of pitted casing is evident
2	15.1m	White precipitate and pitted corroded casing visible	
3	16.1m	Hole in casing and badly pitted casing visible. Possible gravel pack visible	Serious concern for bore integrity
4	17.3m	Badly corroded casing visible	
5	18.4 to 20m	Significant hole in casing just above screen with gravel pack visible	Serious Concern for Bore Integrity Heat Affected Zone of weld is where corrosion is significant
6	20.2 to 24.7m	Screen in good condition with gravel pack visible for 95% of the bore. A few growth of Iron still present as screen was not brushed due to fragile nature of bore.	Chemical cleaning and bailing and surging was successful with 95% of bore screen open.
7	24.7	Bottom of Screen has an Iron build up at weld ring	
8	24.7 to 28.8m	Casing with some Iron build up still present improved from original video	Note Original inspection could not get past 27.8 metres as bottom screen blocked and not visible.
9	26.9m	Round hole clearly visible with 2 or 3 gravel pack pieces visible estimate about 6mm diameter	Serious Concern for Bore Integrity
10	28.9m	Hole in casing just above screen with gravel pack visible	Could be due to poor workmanship weld exacerbated by corrosion.
11	28.9 to 30.4m	Screen in good condition no Iron precipitate visible. Sand and debris in bottom of bore at 30.4 metres.	Work Summary Report say screen 28 to 31 metres. Driller advises bore bottom is at 30.5 metres can feel steel bottom.

2.0 DISCUSSION

Moree Plains Shire Council engaged Geo9, based on recommendations from a contractor Council had used previously, to complete a hydrogeological study for a replacement town water supply bore in Pallamallawa.

The report utilised a seismoelectric and electrotelluric survey, which mapped the aquifer between the council bore field and three neighbouring bores as seen in Figure 3, in conjunction with local and regional geological, geophysical and hydrogeological features.



<u>Figure 3:</u> ***3D Map of Aquifer - Looking North-East Across the Survey Site***

To map the aquifer, Geo9 completed 63-point surveys in the area surrounding the proposed bore site. This involved setting up a sensor at each survey site and then striking a metal plate near that sensor. The seismoelectric survey records the electromagnetic signal caused by the motion between minerals and fluids. This can be related to the relative movement of the matrix and water and the strength of electrical attraction between the mineral and the fluid. Further processing of the recorded signal produces a 3D electrotelluric survey, which measures geo-magnetically induced electrical currents flowing through geological formations in the subsurface. The survey is used to delineate lithological structures at depths and can provide calibration information to the seismoelectric survey.

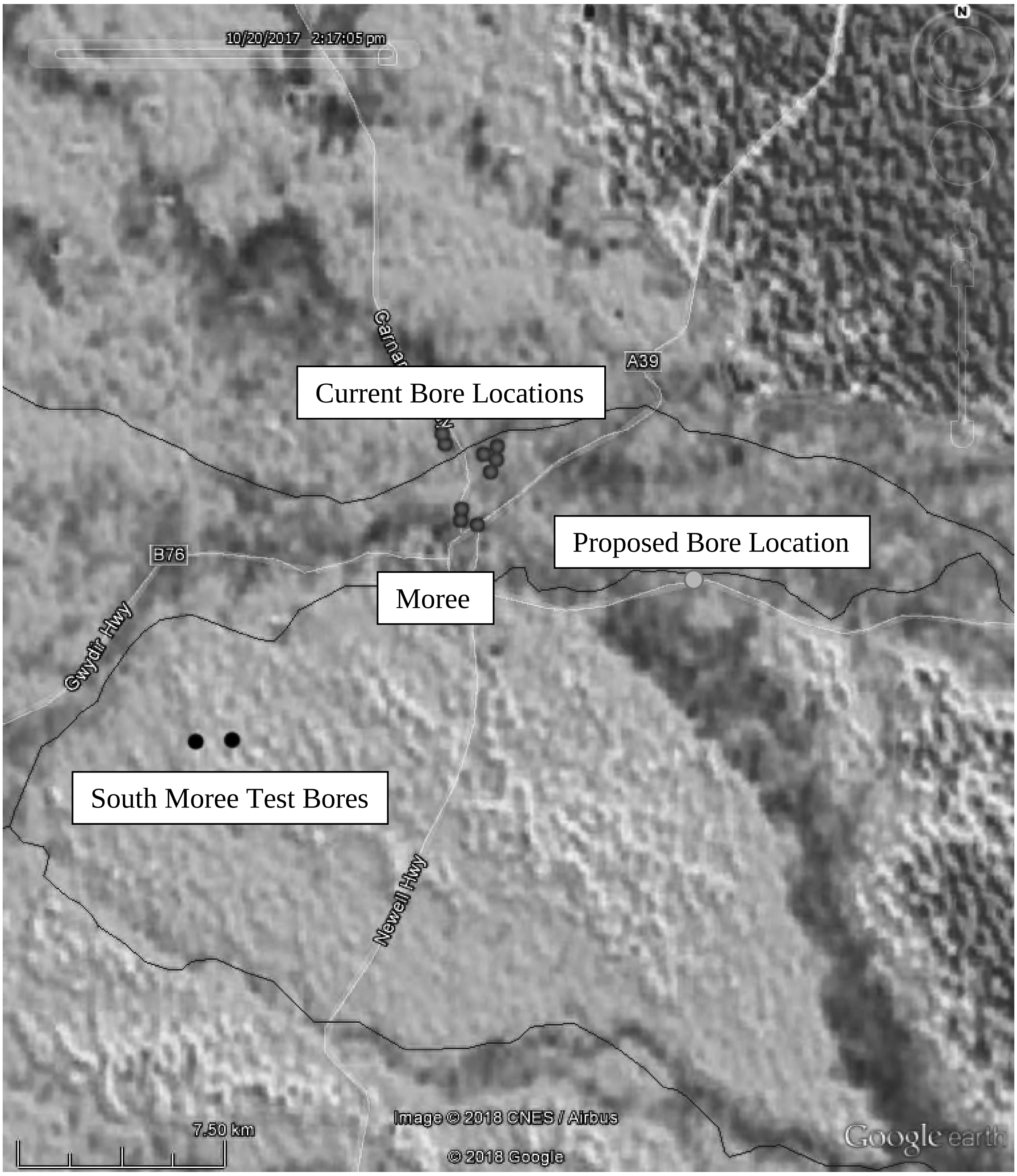
The results from the survey, as can be seen in Figure 3, show that the town water supply bores for Pallamallawa will not affect the neighbouring bores as palaeochannels are separated by less permeable sediments. Information gathered from the returned signal strength revealed the influence of each bore was limited to approximately 50m.

2.1 Further Work

Due to the success showed with the Pallamallawa Bore investigation MPSC asked Geo9 to investigate potential water sources in the Moree area.

At the time, MPSC had drilled two bore south of Moree and was expecting flows of at least 30L/s. Flow tests performed once the bores had been drilled gave less than satisfactory results with one bore producing 15 L/s and another producing 2 L/s.

An investigation by Geo9 showed that MPSC was lucky to get 15 L/s in this area due to the geology in the area which may not able to produce large quantities of water at the depth of drilling. The investigation of potential water sources around Moree revealed possible locations for potential future bores and confirmed that current locations for town water supply bores were adequate, as can be seen in Figure 4.



<u>Figure 4:</u> ***Moree Bore Investigation – Blue = Alluvium - Greater Chance of Water, Green/Red = Colluvium - Lesser Chance of Water***

3.0 CONCLUSION

Moree Plains Shire Council engaged Geo9 to complete a hydrogeological study for a replacement bore at Pallamallawa due to imminent failure above both screens within the original bore.

The results of the study indicated that the construction of a new bore would not affect the aquifer and would not affect neighbouring bores within 50 m of the proposed location.

Further work completed by Geo9 enabled MPSC to locate potential bores sites within the Moree surrounds that could be further investigated to ensure their suitability for town water supply.

4.0 ACKNOWLEDGEMENTS

Many thanks to Maya and Paul from Geo9 for their excellent work on the project and for helping with the technical aspects of the paper.

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THE PIPE BREAKS PROJECT - CASE STUDIES IN MANAGEMENT OF CONTAMINATION RISKS FROM REPAIRS AND RENEWALS

Paper Presented by:

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THE PIPE BREAKS PROJECT - CASE STUDIES IN MANAGEMENT OF CONTAMINATION RISKS FROM REPAIRS AND RENEWALS

Natalie Crawford, *Manager Business Operations,* Atom Consulting

ABSTRACT

This paper discusses case studies developed as part of the Water Research Australia project 'Assurance measures to manage potential contamination risks from pipeline repair or renewal (Stage 1)'. The research involved in the project helped to identify and assess the extent of microbiological contamination risk from pipeline renewal and repair works in Australia and identify measures to manage these risks. Identification of current management practices was undertaken through case studies and an online survey distributed to Australian water utilities.

1.0 INTRODUCTION

Renewing and repairing water mains, valves and hydrants is regularly undertaken in water distribution networks. Renewals and repairs include all planned and unplanned interruptions (including pipe bursts) to the drinking water supply; for the context of this project it excludes installation of new supply mains.

There is evidence in the literature of increased microbial risk associated with mains bursts and repairs, although there is little Australian data. Some international research may not be directly relevant to Australian conditions and control measures (e.g. combined sewers- water and sewer mains laid in the same trench).

Water utilities across Australia currently have access to limited information regarding the contamination risks associated with renewal and repair work on water mains. Water Research Australia identified an industry requirement to gain a better local understanding of the contamination risk of renewals and repairs, including possible impacts from current management practices.

The project aim was to:

- Compile the range and nature of risks to consumers from contamination events associated with supply interruptions, and water main repairs and renewals, in Australia.
- Identify scenarios where the risks to consumers from contamination associated with supply interruptions, and water main repairs and renewals, are material.
- Provide guidance to water utilities on control strategies to minimise the likelihood of contamination, and how to monitor the effectiveness of these control strategies, to ensure that consumers are not exposed to unacceptable levels of risk

2.0 DISCUSSION

2.1 Current Control Measures

To identify current management practices for pipe repair and renewal work, Australian water utilities were surveyed, and case studies developed.

An online survey was distributed to Australian water utilities in November 2016. The survey asked utilities questions on the frequency and contributing factors for pipe break events, as well questions on the extent of their pipe repair and renewal work procedures and practices. A range of Australian water utilities (Figure 1) of different sizes responded to the survey (Figure 1 and Figure 2).

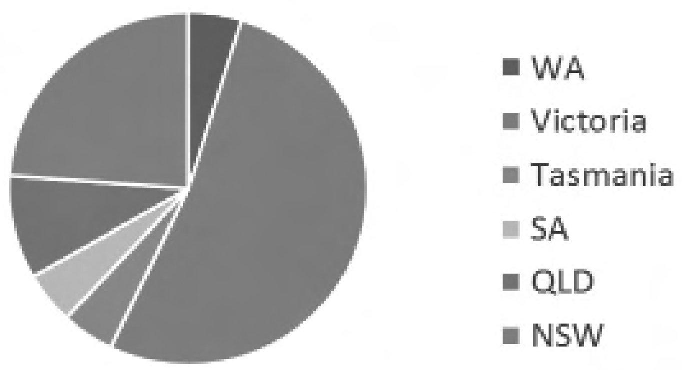

Figure 1: ***Breakdown of utility survey responses***

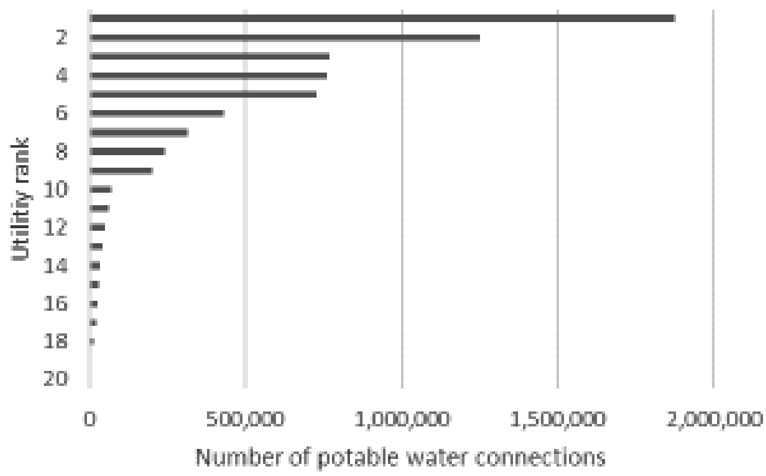

Figure 2: ***Breakdown of utility survey responses***

All utilities that responded to the survey reported they had either informal or documented pipe repair renewal works procedures in place, with 85% reporting procedures documented.

Case studies were developed to illustrate examples of good practice in the areas of governance, compliance, hygiene, operator involvement, risk assessment and disinfection. An analysis of the survey and case studies showed that the most common framework components currently in use by Australian utilities include:

- Flushing
- Excavation to below break
- Controlled shutdown
- Repair under pressure where able
- Mains isolation

Additional controls are implemented by some utilities, when managing high risk broken main, e.g. disinfection and sampling.

A summary of the percentage of control framework measures being implemented by surveyed utilities is shown in Figure 3. It was noted that some of the reported controls are for high risk repairs only, e.g. ozonation and chlorine dosing.

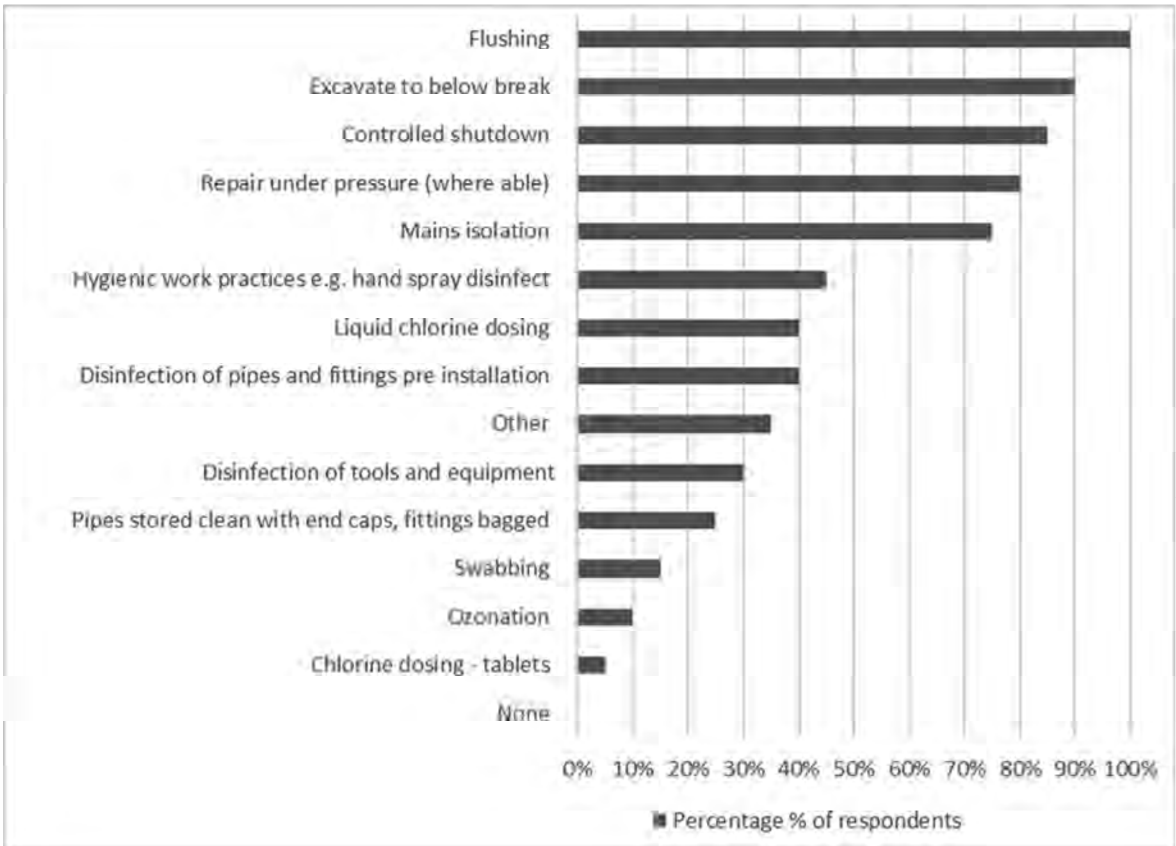

Figure 3: ***Implementation of pipe break repair and renewals control measures by surveyed Australian water utilities***

2.2 Flushing

Flushing is a common practice used by all surveyed utilities. Flushing was identified within the literature review as a key component in reducing the risk of water supply contamination. Generally, utilities flush to clear, based on a visual examination of the water. An area of improvement for many utilities is in the definition in the criteria at which flushing will provide an effective reduction in the contamination risk. A good practice example included the development of procedures referencing the WIOA flushing tables (three times volume) that are based on the AWWRF flushing velocities.

2.3 Hygienic Work Practices

Prevention of contamination using hygienic work practices is implemented to varying degrees across utilities. Good examples in the implementation of hygienic practices, include the development of a water hygiene framework that aims to prevent contamination by ensuring that all activities carried out in the distribution system are carried out in a hygienic matter. Another utility developed procedures to manage the risk associated with shared water and sewer crews. Operators had two sets of gum-boots of two different colours stored in separate lockers and at the start of works, tool and equipment were disinfected, and placed on plastic mats to prevent contamination. It was noted that provision of hygienic equipment or kits (e.g. mats, chlorine solution, hand sanitizers) is key in ensuring that good hygiene practices can be easily implemented.

2.4 Disinfection

Disinfection, either from chlorine dosing or ozonation, is used by many water utilities primarily only for high risk contamination breaks. One utility uses ozonation for high-risk repair events, such as following contamination by sewage from damage to an adjacent sewer pipe. Utilities reported constraints to implementation including time off-line needed to get C.t, particularly in chloraminated systems and the need for competent and trained staff to undertake work.

2.5 Monitoring

Most utilities undertake some form of monitoring after a pipe break repair, either for all repairs or dependent on the level of risk. It is important, when monitoring samples are taken, that there are definable limits and clear actions that should be undertaken if limits are exceeded. One water utility undertook both pre-and post-repair sampling of chlorine residual and turbidity, which was then compared to zone map averages and operational limits, with defined actions if data varies from comparison values. Constraints identified for not undertaking sampling included inadequate operator training and competence in taking samples, system awareness, sampling equipment and meter availability.

2.6 Governance

Over half of utilities surveyed use sub-contractors to undertake pipe repair and renewal works. Governance and compliance can be key in ensuring contamination risks are being adequately managed. Examples of good practice included governance through outcome-based contractual requirements and compliance audits to ensure implementation.

2.7 Training

The majority of surveyed utilities undertake some form of training in pipe repair and renewal works. Examples of good practice included the development of targeted documentation and training specifically at field staff, resulting in increased understanding and uptake. Producing simple documentation, rather than extensively documented procedures, allowed the process to become embedded within everyday work practices. The flexible and practical nature of a program developed by one of the utilities allowed staff buy-in and ownership in managing the contamination risks associated with repair works in the distribution system.

2.8 Pipe Break Framework

A pipe repair and renewals control framework was developed (Table 1), considering existing control strategies and utility specific risks. Due to the varying controls used and degree of implementation currently being undertaken, the developed framework aims to be flexible while allowing for areas of improvement to be identified based on individual utility risks. The pipe repair and renewals control framework has been developed in line with the Australian Drinking Water Guidelines (ADWG 2011) Framework for the Management of Drinking Water Quality which was developed to guide the design of a structured and systematic approach to assuring safety and reliability of drinking water quality.

To consider the risk to public health from the repair or renewals, an onsite dynamic risk evaluation should be undertaken to evaluate the appropriate controls to be used to manage any potential to risk to public health. Key factors identified for effective site evaluation assessments include:

- Training and awareness of staff in potential contamination risks
- Documented dynamic risk assessment process
- Documentation of control measures in place for levels of risk identified on site
- Identified escalation and reporting process.

Onsite control repairs should be based on individual risks both to the utility and from site specific conditions.

Table 1: ***Summary of control framework***

Step	Item	Detail
Step 1: Risk approach	Utility specific hazards	Identify hazards and hazardous events specific to a water supply system or utility
	Risk categories	Define level of risk that the hazard would introduce
	Risk controls	Identify existing and proposed controls that manage the hazard for each risk category
	Control effectiveness	Evaluate the effectiveness of the control (such as, through the prevention or reduction of the hazard)
	Supporting areas	Identify governance, training, communication protocols, documentation and reporting requirements and areas for research and development
Step 2: Pipe break repair event	On-site control measures should be implemented appropriate to site-specific risks and conditions	On-site dynamic risk assessments should be used to select appropriate controls. Key on-site control measures to be evaluated include: Repair under pressure Flushing Hygienic work practices Disinfection Testing
Step 3: Evaluation and review	Periodic and ongoing review	Identify and undertake a schedule of compliance audits and implement ongoing review

3.0 CONCLUSION

A control framework has been developed for use by Australian water utilities, considering existing control strategies and utility specific risks. Due to the varying controls used and degree of implementation currently being undertaken by water utilities across Australia, the developed framework is flexible while allowing for areas of improvement to be identified based on individual utility risks.

The pipe repair and renewals control framework has been developed to be in line the Australian Drinking Water Guidelines (ADWG 2011) Framework for the Management of Drinking Water Quality (the ADWG Framework).

If a water utility already has a framework in place, it is recommended a gap analysis be undertaken against the developed framework to identify to identify areas where additional controls are required.

4.0 ACKNOWLEDGEMENTS

The authors are grateful to Water Research Australia and all the water utilities that providing technical support for this collaborative project, with acknowledgement to Central Highlands Water, Coliban Water, Goulburn Valley Water, SA Water, South East Water, Sydney Water, TasWater, Unitywater, Water Industry Operators Association of Australia, Western Water and Yarra Valley Water.

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FAILURE MECHANISMS OF PROTECTIVE COATINGS FOR CONCRETE

Paper Presented by:

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12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
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FAILURE MECHANISMS OF PROTECTIVE COATINGS FOR CONCRETE

Michael Wheatland, *Business Development Manager,* Calix Limited

ABSTRACT

Regardless of the technology chosen, every protective coating will eventually come to the end of its life. Selecting the right technology gives a better opportunity to do this in a planned way. When selecting a technology to protect a concrete surface, it is critical to understand how and why they fail, and more importantly, the cost that will be incurred to repair or replace the coating.

Mechanisms of failure can range from blistering, increased porosity, cracking and sheet collapse due to wall adhesion failure. Some cracking failures can exacerbate acid attack by allowing accumulation of acid inside the failure. While sheet collapse, there is a risk of water flow blockage in channels at the bottom of the asset which can result in high emergency repair costs.

Some surface coatings can be very sensitive to surface water, humidity and dust on the surface during the application process, risking early life failure. Salt content that has penetrated a surface, called white metal, has a strong negative effect on the adhesion of polymer coatings, but assists in the adhesion of some chemical barrier coatings such as PROTECTA-Mag™.

Repair or replacement of a failed protective coating ranges from simply water washing through to an expensive confined space entry with hot work and manual handling to remove the coating. This can be particularly difficult when the coating has collapsed inwards and blocked the outlet of the asset. This whitepaper investigates the end of life decommissioning costs of the protective coatings available in the market to determine the whole of life cost of application of a type of coating.

1.0 INTRODUCTION

Sulphide acid corrosion is the primary cause of concrete asset failure within waste water collection and treatment networks. The sulphuric acid is concentrated on all surfaces above the water line by the combination of condensation on the cold pipe with hydrogen sulphide gas that is generated from the wastewater.

There are many factors which contribute to how quickly acid forms:

- Nutrient content within the wastewater allows faster bacteria growth
- Warm environment increases growth
- Long retention time within sealed rising mains can enhance anaerobic growth
- Turbulence of wastewater can release dissolved hydrogen sulphide
- Salinity of surrounding ground water increases attack
- Acid attack only occurs above the high-water line

Figure 1: ***A pump station inlet well showing typical hydrogen sulphide corrosion***

As there is no ‘Silver Bullet’ protection solution, understanding the whole product lifecycle of a protection system is essential in making an informed decision about the type of protection that would work best in a specific situation.

2.0 DISCUSSION

When Calix started performing demonstrations for local councils along the east coast of Australia a common theme that was repeated regularly was the unhappiness with premature failures of protective coating products, and the lack of support or solutions if there was an issue with the product. Often when the question of warranty claim was asked after a failure, it was met with blame shifting by both the manufacturer and the applicator.

During a demonstration run in Mullumbimby, NSW we encountered our first major failure of a physical barrier where the adhesion between the coating and the wall had failed, resulting in the coating peeling off the wall like a banana peel and collapsing into the manhole, blocking the flow. We have since discovered that this is quite a common problem with epoxy and polymer coatings.

Since this initial experience at Tweed Heads we have come across many different types of coatings that have failed within waste water collection and treatment networks across Australia, New Zealand and the USA.

As a company, Calix has a culture of being open and honest about shortcomings, and we prefer to focus on the improvements that we have made along the way and how we have rectified any problems that have arisen. So, amongst these observations you will find examples of issues and failures of our own PROTECTA-Mag™ product.

This investigation is based on visual inspection of coating failures, investigated through anecdotes and discussion with asset managers and operators across the Australia-Pacific region and do not reflect the statistical results of any individual product or operator. But using these experiences trying to identify strengths and weaknesses of the three common coatings and demystifying the end of life behaviour.

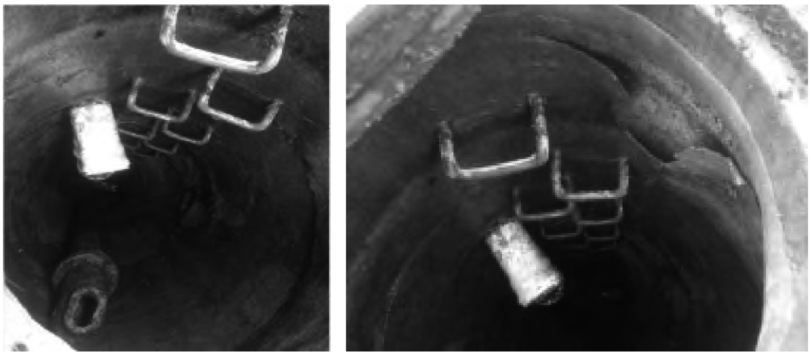

Figure 2: ***Example of a typical polymer liner failure***

3.0 OBSERVED FAILURE MECHANISMS

Although many wastewater systems may visually look good for many years after installation, if hydrogen sulphide is present the acidification process has already begun. A scratch test on the surface gives a better indication as to the depth of the acid penetration and concrete mass loss

Figure 3: ***Without protection some concrete assets degrade quickly***

Photos in Figure 3 show concrete surfaces which have been blasted with water or scratched to expose the extent of the concrete mass loss.

Figure 4: ***Epoxy manholes showing initial signs of peeling near top lip (left) and blistering that traps acid behind (right)***

The Photos in Figure 4 show epoxy polymer coating in the initial stages of failure where the edges peel away from the edges of the surface, and later in the failure stage where acid has been trapped behind the coating against the surface, concentrating the acid attack on the concrete. All physical barrier polymer coatings have a similar failure mechanism of peeling and bubbling as seen with the polyurethane in Figure 5 which can be very costly to remove at end of life.

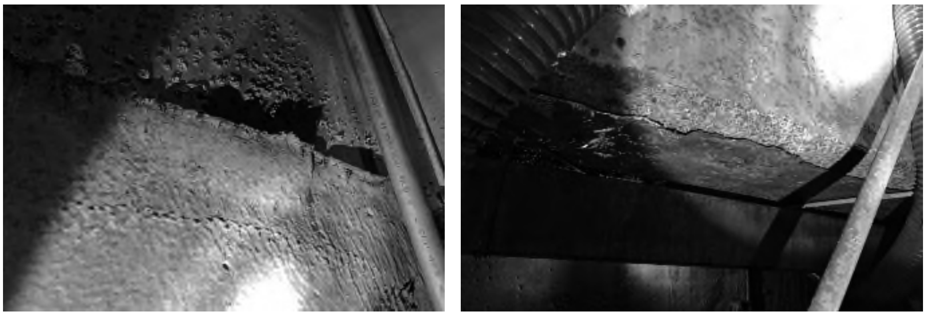

Figure 5: ***Lower polyurethane coating peeling away from surface while upper epoxy blisters due to bubbles in application***

The Calcium Aluminate Cement coating in Figure 6 has come to the end of the life, having been consumed by the acid within this rising main discharge manhole.

Figure 6: ***Calcium Aluminate Cement consumed by strong acid attack***

Magnesium Hydroxide coatings like PROTECTA-Mag can suffer from early life failure if the product quality and application process are not adhered to. The photos in Figure 7 show the issues that can be faced if the manhole lid is not sealed to prevent water ingress through the lid.

A PROTECTA-Mag coating that was fully intact and neutralising the acid but had been discoloured by a nearby gum tree releasing tannins into the stormwater which resulted in streaks down the hole is shown in Figure 8.

If an appropriate procedure of Magnesium Hydroxide coating is not followed, coatings applied at the wrong thickness can result in the material cracking and falling off the concrete surface.

Figure 7: ***MHL Coating taken off by storm water coming through lid***

<u>Figure 8:</u> ***PROTECTA-Mag showing discolouration (left) and cracking (right)***

4.0 CONCLUSION

When it comes to sewer corrosion coating protection system, asset owners have a right to be cynical when assessing new products and technologies. Often their first experience with coatings is dealing with a failed liner which is blocking the wastewater flow or dealing with an applicator that doesn't want to honour a warranty claim. By understanding the technologies, asset managers can assess a pump station, inlet works, or manholes based on their conditions, and assess full lifecycle costs of each product.

Asset Condition	Ideal Coating	Upside	Downside
Brand New	Polymer Barrier	• Visually appealing • Prevents acid contact with concrete if in good condition • Durable against erosion	• Hazardous product • High cost of install • Surface preparation is extensive • Expert application required • Costly to remove • Difficult to reapply • Any bubbles or cracks can increase acid attack • Sheet failure can result in pipe block
Minor Corrosion	Chemical Neutralisation	• Non-Hazardous Product • Low cost of install • Applied Online • Completely stops corrosion • Easy removal for reapplication or alternative coating selection • Reapplication low cost	• Not suitable for direct water impact • Manhole lids need to be sealed • Expert application required
Major Corrosion	Chemical Neutralisation	• Non-Hazardous Product • Low cost of install • Applied Online • Completely stops corrosion • Easy removal for reapplication or alternative coating selection • Reapplication low cost	• Not suitable for direct water impact • Manhole lids need to be sealed • Cannot provide structural support • Cannot stop water ingress
Failed or Holes	Cement / CAC	• Provides structural repair • Provides repair of water ingress • CAC is more chemical resistant than concrete • Can replace grout in bricks	• Hazardous product • High cost of install • High acid environments consume coating quickly

In all cases, doing something to protect the concrete assets is better than doing nothing. The alternative is uncontrolled failure of the asset resulting in unpredictable costs due to blockage, injury or other damage to vehicles or impact on businesses.

When looking to apply a product, the project manager should consider the consequences of early failure or end of life removal and reapplication of the product, as costs of removing a polymer coating can vastly exceed the initial application cost.

The best overall solution is to find a supplier you can trust to correct arising problems, continually improve their product and honour the warrantee.

5.0 ACKNOWLEDGEMENTS

Acknowledgement must go to the water authorities whom were able to assist us with the early testing and development of the PROTECTA-Mag product.

Tweed Heads Council, Byron Bay Council and Gold Coast City Council were instrumental to giving Calix the first full run of manholes.

Western Water was a great help to let us test and develop the product and application method within the network using manholes and pump stations.

Tauranga City Council in New Zealand were very understanding when we had an early failure of the coating due to the application process, allowing us to iterate the coating rectification process.

Perhaps the activity that resulted in the most progress in the shortest time was the performance of a Technical Assessment Group Study which involved Yarra Valley Water, Coliban Water, South East Water. Being some of the earliest trials of the PROTECTA-Mag product, the product and the process was not yet robust enough to cope in that environment. However, using the learnings from the application process and the inspections that followed allowed the Calix team to pinpoint the key failure mechanisms and adjust the product formulation and application procedures to mitigate these risks.

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HIGH PRESSURE WATER JETTING – ARE YOU OPERATING SAFELY?

Paper Presented by:

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HIGH PRESSURE WATER JETTING – ARE YOU OPERATING SAFELY?

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ABSTRACT

The cleaning of sewer pipes and the clearance of sewage blockages has seen an increasing reliance being placed upon High Pressure Water Jetting (HPWJ) systems to complete these difficult work tasks.

The use of high pressure water is a serious business undertaking for any water utility or service contractor. Any HPWJ activity can potentially result in injury or death when appropriate safety precautions are not followed, especially when undertaken by inexperienced or untrained operators.

High Pressure Water Jetting (HPWJ) operators who handle dangerous and expensive equipment should be trained and certified to meet the Australian Standard AS/NZ 4233.1:2013 – High Pressure Water Jetting Systems Part 1: Safe operation and maintenance.

AS/NZ 4233.1:2013 describes two different classes of high pressure systems. Class A = Low pressure & Class B = High pressure.

The standard also stipulates that operators of Class B equipment shall be appropriately trained through an RTO in accordance with the HPWJ "Units of Competency".

In recognition of these requirements and Safe Work Australia' "Guide for Managing Risks from High Pressure Water Jetting, the Sydney Water Corporation has recently implemented a training program for its HPWJ sewer cleaning staff.

Trained operators are more likely to use equipment safely, responsibly and efficiently. They are also less likely to cause injury to themselves or others nearby. Having a certified workforce also reduces the risk of damaging expensive HPWJ equipment or sewerage assets.

This paper will outline the requirements of the HPWJ standard and provide a case study of Sydney Water's recent and ongoing training and competency program for HPWJ operators.

1.0 INTRODUCTION

The original AS/NZS 4233 (Interim) High pressure water systems – Safe operation and maintenance was released in 1994 for industrial review and comment.

Following on from this interim standard in 1999 two (2) joint AS/NZS 4233 Parts 1 & 2 standards were then made available as follows:

- Part 1 – Safe Operation and Maintenance, providing requirements and guidance for the operation and maintenance of water jetting equipment, and
- Part 2 – Construction and Performance, detailing requirements for the design, construction, testing, inspection and safeguarding of high pressure water jetting systems.

In 2013 a revised AS/NZS 4233 Parts 1 & 2 was released to reflect current industry best practice and the rapid technological advances since publication of the previous version.

The objective of this revised Standard is to provide users of water jetting systems with requirements and guidance concerning the safe operating practices to protect and safeguard equipment users and other persons (e.g. general public) who may be near high pressure water jetting operations.

The principal differences between the 1999 and 2013 versions of AS/NZS 4233 standard included:

- Changes in technology including personal protective equipment (PPE), electronic control systems and hold-to-activate devices,
- Machinery including remote and automated,
- Training including new national units of competencies for HPWJ operators,
- Systems of work including maximum reaction forces and mechanically held devices, such as water blasting guns and high-pressure lances.

In addition, much of the previous informative content (i.e. guidelines) in the standard has now been made normative content (i.e. rules of operation, which must be complied with by operators) including the need for specific PPE and the formalised training of High Pressure Water Jetting Operators.

To further assist persons and businesses undertaking high pressure water jetting activities, Safe Work Australia released guidelines in December 2013 titled “Guide for Managing Risks from High Pressure Water Jetting”. This publication provides an easy to follow summation of the AS/NZS 4233.1:2013 standard and a good learning resource for the training of HPWJ operators.

The AS/NZ 4233.1:2013 standard describes two (2) different classes of high pressure water jetting systems as follows:

- Class A (Low Pressure), for water jetting equipment systems with an output capability greater than 800 bar litres per minute and less than 5,600 bar litres per minute, and
- Class B (High Pressure), for water jetting equipment with an output capability of more than 5,600 bar litres per minute.

Noting that the term “Bar Litre per Minute” is a measure of the energy produced by a high-pressure water jetting system expressed as a product of pressure (Bar) and volume per unit of time (litres per minute).

For example, if your sewer jetting cleaning machine has a maximum output pressure of 4,000 psi which is equivalent to 276 Bar pressure (i.e. dividing 4,000 by 14.5 to convert psi to Bar pressure) and the water flow through the pump hose and jetting nozzle is 50 litres per minute (e.g. 1,000 litre tank emptying in 20 minutes of jetting operation) then:

Bar litres per minute = 276 x 50 = 13,800 Bar litres minute.

Therefore, this sewer jetting cleaning machine would be classified as a Class B system.

The AS/NZS 4233.1:2013 standard now stipulates that operators of Class B equipment shall be appropriately trained through an RTO in accordance with the HPWJ “Units of Competency”.

There is also a requirement for verification of competency or refresher training to be completed at appropriate intervals **not exceeding** two (2) years.

Following on from the adoption of the revised AS/NZS 4233.1:2013 and the requirement for all Class B HPWJ equipment operators to be trained and assessed as competent, several national competencies were developed and released in December 2015 as follows:

- MSMSS00003 - Use high pressure water jetting equipment
- MSMSS00004 - Operate a high-pressure water jetting system
- MSMSS00005 - Operate a drain cleaning system

A number of Registered Training Organisations (RTO) are now providing accredited training courses to deliver these national competency standards for HPWJ operators and supervisors.

2.0 DISCUSSION

High pressure water jetting (HPWJ) is a process of using a stream of pressurised water to remove material, coatings or contamination and debris from the surface of a work piece or material substrate. In the case of wastewater systems, HPWJ is now a standard work practice for the cleaning of sewer pipes and the clearance of sewage blockages.

The use of high pressure water is a serious undertaking for any water utility or service contractor. Any HPWJ activity can potentially result in injury or death when appropriate safety precautions are not followed, especially when undertaken by inexperienced or untrained operators.

Common hazards and risks include the water jet piercing the skin, being hit by flying debris, equipment failure and/or exposure to noise. Other hazards associated with high pressure water jetting in wastewater systems include; working in confined spaces, biological hazards from raw sewage or asbestos pipes, toxic gases, fall hazards, respiratory and eye hazards, conflict with other underground utility services, electric shock and potential exposure to hazardous chemicals.

There is also the potential to damage wastewater infrastructure or cause environmental harm if the equipment is not operated in accordance with manufacturers' guidelines and adopted organisational procedures.

When water is pressurised, it becomes a potentially deadly force that can easily result in serious injuries when a water jet comes into contact with skin or eyes.

In fact, a water jet injury is very similar in nature to a gunshot wound because the extent of internal damage cannot be easily seen by simply looking at the external wound, which can be a very small hole and/or not easily observed on the skin surface.

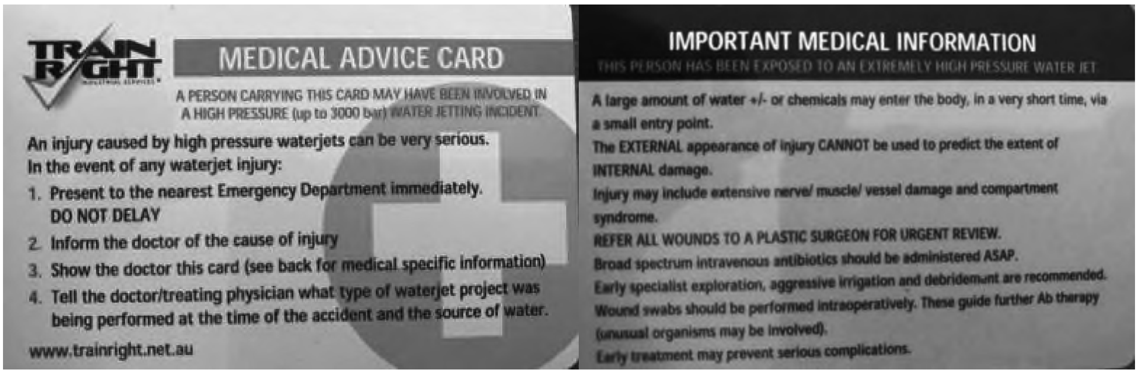
Specialist medical advice is that any HPWJ injury should be treated with the same urgency as an amputation injury. "It cannot be emphasised strongly enough that the eventual severity of disability is very dependent upon the immediacy of treatment, with rapid and educated treatment there is a reduced risk of amputation or loss of function of the limb".

To assist in the immediate first aid and medical treatment of HPWJ injuries AS/NZS 4233.1:2013 (Clause 9.5 Medical Alert Card) includes are requirement for all HWPJ operators to carry a waterproof medical alert card which shall:

- Outline the possible nature of injuries and post-accident infections that can be caused by high pressure water jetting, and
- Provide details of immediate first aid treatment until medical treatment can be arranged.

An example of a Medical Alert Card used for any HPWJ Operator is provided below in Figure 1.

This Medical Advice Card also includes more detailed medical treatment information to assist triage staff and physicians in dealing with potential nerve/muscle/vessel damage and infectious complications due to the nature of raw sewage.



<u>Figure 1:</u> ***Medical Advice Card (Courtesy Trainright Industrial Services)***

2.1 Case Study – Sydney Water High Pressure Water Jetter Training

Sydney Water (SW) services a large area including; 25,000 kilometres of wastewater pipes, 677 pumping stations, 14 recycling plants and 16 wastewater treatment plants with over 250 maintenance field staff. On average SW responds to 65 waste water events every day in its area of operations.

In 2003, SW introduced a fleet of HPWJ vehicles (Jetters) to its field staff. These Jetters were to replace hand rodding vehicles to increase efficiency and the quality of work, as well as reducing incidents from using the hand rods and ratchets.

The initial training and assessment for the new Jetters was developed by SW in conjunction with the equipment manufacturer. In retrospect, the training was primarily focussed on the safe use of the equipment rather than safety for the operator. This was in part due to the lack of experience and understanding of working with these new Jetters.

Following an internal review of its HPWJ and sewer drain cleaning activities, SW identified that there was a need for staff to complete nationally recognised training (Skills Set MSMSS00005 – Operate a drain cleaning system) through a registered training organisation (RTO) in accordance with the revised AS/NZS 4233.1:2013.

SW then went to the market for a vendor with the ability to deliver this training but also consider its internal training and assessment as well as the experience of its operators. Trainright Industrial Services was selected to provide these services to SW.

The recognised prior learning (RPL) process developed by Trainright and supported by NSW TAFE (North Coast) for SW's existing staff meant less time off the job as well as recognition for the experience staff had gained over many years in the wastewater business.

This also ensured that staff were provided with up to date industry knowledge and training in relation to the safe operation and maintenance of HWPJ systems used for the cleaning of sewer mains and removal of sewage chokes and blockages. This also helped to provide an interesting and engaging RPL and training experience even for the most experienced HPWJ operators.

In addition to its existing experienced staff, SW has in the last six (6) months employed forty (40) new staff. Whilst these new staff were able to attend the MSMSS00005 training they will now continue to gain practical experience in the workplace under the direct supervision of a qualified HPWJ operator.

Following the completion of appropriate period practical experience these staff would then be assessed and if successful deemed competent for this qualification and be recognised as an experienced HPWJ operator at Sydney Water.

Sydney Water provided dedicated training facilities at its Potts Hill Depot with classrooms, a manhole and sewer mains which were used to complete both RPL assessments of experienced HPWJ operators and training for new staff.

To date the training program has been delivered to 170 of SW's staff and has been universally well received. The main benefit being a raised awareness of all the hazards associated with HPWJ operation. This has led to staff having a greater incentive to follow all safety procedures as well as the use of the prescribed PPE.

This has been one of the best received training programs SW has undertaken, mainly due its relevance to what staff do in the field and in no small part due to the two (2) trainers delivering the program. Their professionalism and passion along with their knowledge and industry experience has given them a high level of regard amongst SW's staff, not an easy thing to achieve in any workplace.

SW recognises the risk its field staff are exposed to each day when working with these Jetters and having this program has made mangers more comfortable knowing that their staff are well trained and competent to carry out this potentially dangerous work.

SW is currently working with Trainright to develop the most appropriate arrangements to complete the 2-yearly reassessments and this will be finalised once the current training program has been completed.

In 2017, SW's safety team identified the use of HPWJ systems on asbestos cement (AC) pipe contravenes WHS Regulations Chapter 8, Part 8.5, Division 3, Section 446. Although SW's wastewater network does not contain many AC pipes, to continue to perform jetting on AC pipes, SW would require an exemption from SafeWork NSW.

SW then engaged an asbestos specialist to test the effects of HPWJ upon AC pipes. The initial test was encouraging, and SW will be conducting further testing in early 2018 and potentially determine a safe work practice when using HPWJ on AC pipes.

In the meantime, all clearing work on AC pipe is completed using the rodding process only.

3.0 CONCLUSION

High Pressure Water Jetting (HPWJ) operators who handle dangerous and expensive equipment should be trained and certified to meet the Australian Standard AS/NZ 4233.1:2013 – High Pressure Water Jetting Systems Part 1: Safe operation and maintenance.

Trained operators are more likely to use equipment safely, responsibly and efficiently. They are also less likely to cause injury to themselves or others nearby. Having a certified workforce also reduces the risk of damaging expensive HPWJ equipment or sewage assets.

The recent MSMSS00005 RPL assessment and training programs completed at Sydney Water has seen a noticeable improvement in workplace practices and safety compliance associated with drain cleaning activates.

The authors would suggest that the water industry needs to also consider the development of a code of practice covering all water related HPWJ activities including; drain cleaning, and non-destructive excavations, to provide guidance on these work activities and the protection of assets and infrastructure.

4.0 ACKNOWLEDGEMENTS

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IMPROVING OPERATIONAL MONITORING WITH THE NSW DRINKING WATER DATABASE

Paper Presented by:

Sandy Leask

Author:

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12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

IMPROVING OPERATIONAL MONITORING WITH THE NSW DRINKING WATER DATABASE

Sandy Leask, *Senior Policy Advisor, Water Unit | Environmental Health Branch,* NSW Health

The NSW Health Drinking Water Monitoring Program, implemented in 2001, includes the NSW Drinking Water Database to store the drinking water quality results from samples taken around the state, and provide reporting to NSW Health, water utilities and other stakeholders. Until 2017 the Database could only store results from the testing of drinking water monitoring samples collected in distribution networks.

A need was identified to allow water utilities to record and report on their operational monitoring data, in addition to the end-point monitoring results currently stored in the Database. Allowing utilities to input operational monitoring data helps to shift some of the focus from end-point testing to a preventive risk management approach, consistent with the Australian Drinking Water Guidelines. Operational monitoring data is also a precursor for reviewing water quality data leading up to and during incidents.

The Database has now been set up so that water utilities can create sample sites:

- In their raw water sources,
- Throughout their treatment plants, and
- At other sites in the distribution system, such as reservoirs and pump stations.

There is a manual data entry method to type results directly into the Database. However, whole spreadsheets of results can also be entered in a much simpler and quicker direct upload process. Historic data can be entered, so that utilities can put results back to 2001 into the Database, to complement their drinking water monitoring results.

The new Database can accommodate many new kinds of data:

- Cyanobacteria counts
- Volumes and dose rates
- Electrical conductivity measures
- Records of activities, such as reservoir inspections or main flushing.

The NSW Health Water Unit is keen for water utilities to make use of these improvements. Staff can visit utilities to help you set up the Database to record your operational data. We think that operators will find more uses for these new capabilities in the Database than we can think of ourselves. Please prove us right.

The introduction of drinking water management systems across NSW has resulted in closer attention to critical control points (CCPs). In many towns there has been sustained improvements in drinking water quality, including lower treated water turbidity, higher and more consistent chlorine residuals, and improved microbiological quality.

The trend for improved water quality can be shown at a state level for all regional utilities.

The percentage of samples with no *E. coli*, no total coliforms, free chlorine in an acceptable range (>0.2 mg/L and <5.0 mg/L), and the mean state-wide free chlorine concentration have been increasing from 2001 to 2017. The proportion of samples with free chlorine within acceptable range has risen from below 50% in 2002 to nearly 90% in 2017.

Close monitoring of CCPs has allowed water utilities to identify opportunities to improve operations and even better protect the health of the communities supplied. Information from CCP monitoring has also been used for applications for greater investment in drinking water supply hardware.

SOLAR ODOUR CONTROL

Paper Presented by:

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Sewer Vent Supplies and Repairs (SVSR)

12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

SOLAR ODOUR CONTROL

Duncan Reynolds, *Regional Marketing / R&D Manager*, Sewer Vent Supplies and Repairs *(SVSR)*

ABSTRACT

Concern over the dependence of NSW sewage networks on irrecoverable, imported filter media to control the emission of odorous gases has generated a demand for a more sustainable alternative. Recommendations from the University of NSW and a subsequent feasibility study revealed titanium dioxide has catalytic properties for the control over majority of typical sewage gases. Titanium dioxide requires activation, which is commonly sourced from photons of wavelengths under 400 nm, though doping the catalyst makes it active using visible light. To determine whether sunlight conditions typically found in NSW would be capable of activating titanium dioxide, a sample of nano-sized particles were tested in November of 2017. Titanium dioxide nanoparticles coated onto an aluminium surface proved capable of oxidising a solution of methylene blue on a typical summer day. A titanium dioxide coated photoreactor, which could be retrofitted into pre-existing networks, could therefore be a more sustainable alternative to current filter media.

1.0 INTRODUCTION

Taking advantage of NSW's abundant solar energy for wastewater treatment is not a new idea. Using photovoltaic panels for powering pumps, dosing units and fans as well as dewatering sludge in solar drying beds are all common practice. This paper will focus on a promising new process which continues this trend; wastewater odour control using solar energy and catalytic nanoparticles.

In February 2017 SVSR initiated an ambitious research partnership with the University of NSW to conduct a detailed feasibility study for the application of solar-activated catalytic nanoparticles to achieve odour control in reticulated sewage networks across NSW.

Our goal was to investigate the potential scientific, engineering and commercial potential for products/processes which:

- Perform the function of odour control for a wide range of sewage gases;
- Have minimal change-out periods and are cost-effective to the Utility/Council;
- Can be sourced from within Australia and ideally disposed of without landfilling (measured in terms of a life cycle assessment), and;
- Can be manufactured within Australia to provide employment in the growing advanced manufacturing sector, in compliance with relevant WHS Acts and Regulations, EPA, and all other statutory requirements.

2.0 DISCUSSION

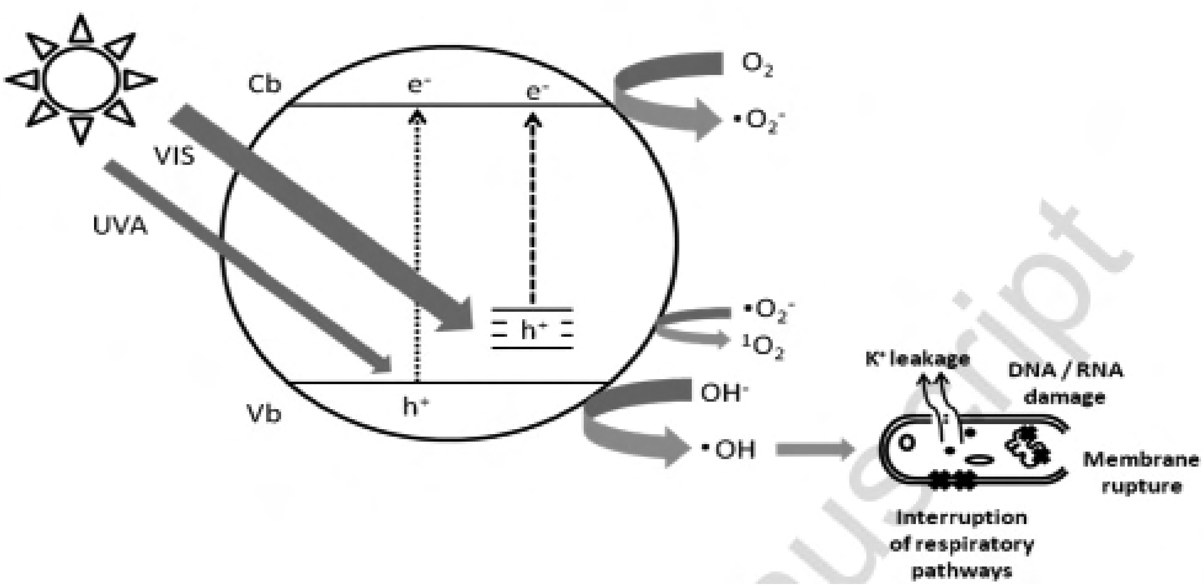
Due to the wealth of literature and product reviews as well as current research and trials both here and overseas, SVSR decided to focus particularly on titanium dioxide (**TiO_2**) Engineered Nano Materials (ENMs). We asked ourselves if there are global trends, products or processes which can meet any, or all, of the above criteria. Could anything be added to existing products, for example as an impregnate, to achieve these outcomes?

2.1 Introductory Science

Titanium dioxide is an inorganic compound which is extracted from mineral sands in many parts of the world. While bulk and sub-micron sized TiO_2 pigment has been used for many years in sunscreens, paints and building materials, TiO_2 ENMs for catalytic applications are a more recent development. Internationally and increasingly within Australia, TiO_2 ENMs are popular materials for catalytic reactions as they have a low activation energy, comparative low cost and relative lack of environmental toxicity (El-Kalliny, 2014).

While most research has focussed on TiO_2 as a photocatalyst, activation can be achieved using alternate sources of energy. As a photocatalyst, titanium dioxide absorbs photons at wavelengths below approximately 400 nm (the UV region of the spectrum), which promote oxidation/reduction reactions on its surface, eventually forming Reactive Oxygen Species (ROS) such as the hydroxyl radical (OH•) (Portella, 2012). By way of comparison, the hydroxyl radical is a more powerful oxidant than ozone, chlorine and hydrogen peroxide (Pelaez, 2012).

ROS interact directly with oxygen and sewage compounds such as hydrogen sulphide (H_2S), Volatile Organic Compounds (VOCs) and Volatile Sulphur Compounds (VSCs). These sewage gases can be totally degenerated and chemically converted to carbon dioxide, water and odourless inorganic compounds as demonstrated in Figure 1.



<u>**Figure 1:**</u> ***An illustrative representation of the general photocatalytic oxidation process (Pelaez, 2012).***

The activation energy required to produce ROS is dependent on the physical properties and purity of the titanium dioxide. Pure ("un-doped") TiO_2 ENM requires approximately 400 nm wavelength photons, which accounts for only 5-6% of solar radiation. Doping the crystalline structure of titanium dioxide with noble metals, gases and other elements reduces the activation energy required (Pelaez, 2012). Common dopants include nitrogen, carbon and sulphur. These doped types of titanium dioxide require less energetic photons to be activated. Research has suggested they are active in the visible light spectrum and have been used in research and pilot-plants internationally for solar-based environmental decontamination (Portella, 2012).

The production of ROS can also be achieved by incorporating **TiO_2** into mesoporous sieves containing transition metals or metalloids such as activated carbon and zeolites (Liu, 2013).

2.2 Engineering and Design of Novel Odour Abatement Technology

Given the variation in odorous locations and conditions throughout NSW reticulation sewage networks, the design of odour control units presents a significant challenge. While it is outside the scope of this paper to provide a detailed engineering analysis for any site or for a wide variety of target gases, a literature review of the removal of H_2S over TiO_2 nanoparticles found the following site conditions ideal for the suitability of a photoreactor (Alonso-Tellez, 2012; El-Kalliny, 2014):

1. H2S levels < 15 ppm
2. Gas flowrates << 5 L/s
3. UV-A irradiation > 5 mW/cm2
4. Temperature between 60-80 ˚C
5. Humidity < 20% RH
6. pH > 9
7. Borosilicate glass, UV transmissible reactor cover
8. Periodic backwashing with mildly alkaline fluids

A photocatalytic system will obviously benefit most from direct solar exposure during summer months in areas where UV levels are highest. The incorporation of a solar collector, such as that pictured in Figure 2, into the final design would also increase the potential for TiO_2 ENMs to control odours.

Importantly, research suggests commercially available products can adsorb contaminants even without exposure to light, with the material adsorbed decomposed by the titanium dioxide photocatalyst on exposure to light (Nonami, 2004).

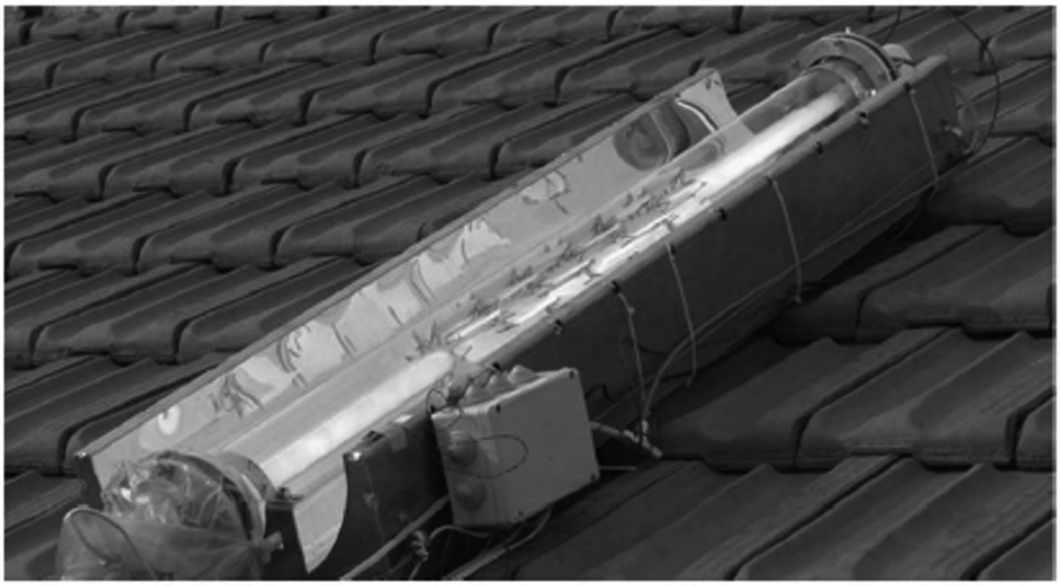


__Figure 2:__ ***Sample photoreactor. Note the UV bulbs set on a timer side-mounted to the unit. During this experiment, bulbs were activated during non-daylight hours (Portella, 2012).***

2.3 Testing Commercially Available Odour Abatement Products

Titanium dioxide ENM’s are coated onto various substrates and sold as odour abatement and environmental decontamination products internationally. SVSR conducted an experiment on a commercially available TiO_2 photocatalyst to assess its oxidative potential.

Methylene blue (MB) was chosen as our sample pollutant. When contacted with suitably illuminated TiO_2 a solution of methylene blue (MB) will undergo an oxidation/reduction reaction – forming a colourless solution of leucomethylene blue (LMB) (Vasquez, 2016). When MB is contacted with irradiated TiO_2, the hydroxyl radicals generated are believed to promote the forward reaction as per Figure 3.

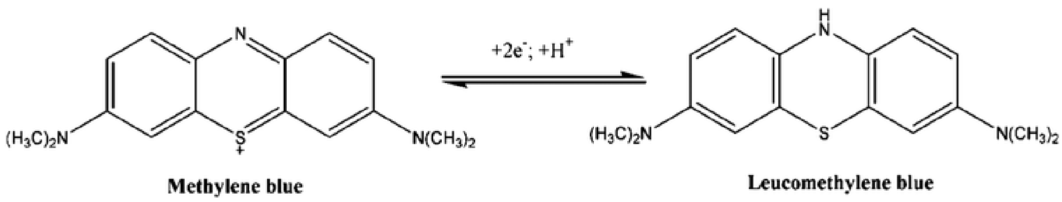


Figure 3: ***The chemical reaction which represents the bleaching of methylene blue*** (ACC, 2017).

The sample was assessed by visually monitoring under sunlight in Sydney in November, 2017. Photographs were taken periodically throughout the oxidation and compared for results as shown in Figure 4.

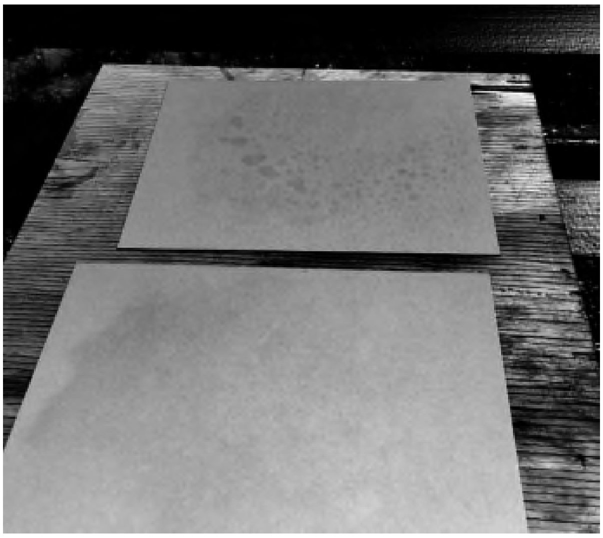


Figure 4: ***Methylene blue applied to two aluminium substrates, (top) without a TiO_2 coating and (bottom) with a TiO_2 coating.***

From Figure 4, after approximately 25 minutes a clear difference was observed between the coated and uncoated samples in terms of MB and LMB concentrations. The uncoated sample converted significantly less of the same amount of applied MB to LMB as per a visual assessment. SVSR believe this is qualitative evidence that the TiO_2 coated sheet displays oxidative potential when exposed to sunlight as reported within the literature.

2.4 Sustainability and Life Cycle Assessment

Mineral sands containing rutile and ilmenite are the sources of TiO_2. Australia's economically available resources, on average, represent the world's largest economic resources in 2012 (Miezitis, 2012). Significant available reserves are found in Western NSW and Western Australia.

While a full and detailed Life Cycle Assessment (LCA) of TiO_2 ENM's as a source of odour control material is outside the scope of this report, given the proximity of required raw materials, SVSR believe we could expect to see significant improvement over current materials used.

2.5 Safety in Manufacturing

The process of converting bulk TiO_2 processed ores into ENM's for odour control would require potentially hazardous manufacturing processes. The safety of the personnel involved as well as emissions controls to protect the general public must be considered.

Unfortunately, there are currently few Australian workplace and public exposure standards for ENM's. Reports produced overseas note that workplace exposure standards for micron-sized materials are not appropriate for controlling risks from nano-sized particles due to ENM's distinct physical properties. For example, the Unites States and Japan have recommended exposure limits for TiO_2 ENM's, which are based on primary particle size and are lower for ENM's (Morawska, 2012):

- 0.3 mg/m^3 for United States
- 0.6mg/m^3 for Japan

For comparison, the maximum inhalable Australian Workplace Exposure Standard for micron-sized titanium dioxide is 10 mg/m^3 (Morawska, 2012).

2.6 Areas for Future Research

According to our preliminary research, SVSR have identified the following areas requiring future research:

- Assessing non-photonic forms of activation energy e.g. electrical current provided by DC photovoltaic panels.
- Quantifying required change-out periods and a more detailed assessment of the process chemistry for typical sewage gases, including characterisation of spent TiO_2 ENMs to assess their suitability for incineration and/or reuse.
- Completion of a detailed LCA, including trials for the manufacturing process.

3.0 CONCLUSION

We have shown the conditions under which the emerging process of environmental decontamination using TiO_2 nanoparticles could be applied to the abatement of sewer odours in NSW. While site-specific assessment is required to determine the suitability of TiO_2 ENM's for each odorous location, the TiO_2 ENMs tested by SVSR were activated on a summer's day in NSW. Furthermore, we have shown that with additional research, the incorporation of titanium dioxide ENM's into odour control units across NSW would benefit our environment, our economy and our community.

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OPTIMISING FILTERED WATER TURBIDITY AT GRAHAMSTOWN WTP

Paper Presented by:

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OPTIMISING FILTERED WATER TURBIDITY AT GRAHAMSTOWN WTP

Michael Holmes, *Process Engineer, Veolia*

ABSTRACT

This paper discusses how online instrumentation was used to fine-tune the alum dose at Grahamstown WTP (GTWTP). The WTP employs conventional treatment processes including coagulation, sedimentation, granular media filtration and disinfection using chlorine to treat surface water and/or bore water. GTWTP had been operated in an "enhanced coagulation" mode to maximize removal of contaminants including pathogens since April 2015 in response to the East Coast Low (ECL) incident that led to an increased pathogen challenge in source water. The alum dose was set to 90 mg/L as product to achieve a coagulation pH in the range 5.9 to 6.0 as there is no dedicated pre-lime dosing in the process. Later the alum dose was reduced to 75 mg/L with a coagulation pH around 6.2. The GTWTP continued to achieve filtered water turbidity targets when the alum dose was recently optimised at 60 mg/L.

1.0 INTRODUCTION

1.1 Online Turbidity Measurement

Pathogenic bacteria, viruses and protozoa including *Cryptosporidium* and *Giardia* pose the greatest and most tangible risk to drinking water safety (NRMMC, 2011). Conventional WTPs employ coagulation, clarification, granular media filtration and chlorination processes. It is important to optimise coagulation, clarification and filtration processes at these WTPs to achieve low filtered water turbidity as disinfection with chlorine does not inactivate *Cryptosporidium* oocysts and it has limited success with Giardia cysts due to the long contact time required to achieve the necessary chlorine residual contact time (C.t.) values (WRA 2015). Therefore, chlorine disinfection cannot be used as a sole treatment barrier where the water is sourced from multi-use catchments that are vulnerable to pathogen contamination (WRA 2015). At present it is not possible to detect pathogens in filtered water in real time and the online measurement of turbidity serves as a surrogate indicator of pathogens in filtered water. When integrated with a supervisor, control and data acquisition (SCADA)/hazard analysis and critical control points (HACCP) system, online turbidity is the only practical way to monitor and control pathogen removal using media filters (WRA 2015). This paper presents filter turbidity performance at Grahamstown WTP (GTWTP) during the period 2016-2017. This period includes the transition from the WTP being operated in an 'enhanced coagulation' mode to being optimised for low filtered turbidity.

2.0 DISCUSSION

2.1 Treatment at Grahamstown WTP

The GTWTP has a peak supply of 257 MLD and consists of two conventional treatment stages. Stage 1 was designed to treat surface water pumped from Grahamstown Dam (GTD). The treatment process comprises alum coagulation with coagulant aid (non-ionic polymer, dosed at 0.12 mg/L), followed by upflow clarification. Clarified water is filtered using mono media conventional rapid gravity sand filters.

Stage 2 uses conventional treatment processes to treat GTD source or the Tomago sand beds source (via Tomago Borefield) with alum coagulation followed by horizontal flow sedimentation. Settled water is filtered using conventional rapid gravity dual media filters. The combined filtered water from Stage 1 and Stage 2 is then adjusted for pH using lime, disinfected with chlorine and fluoridated with fluorosilicic acid prior to entering the clear water tank. Figure 1 presents the schematic of GTWTP SCADA showing the plant overview.

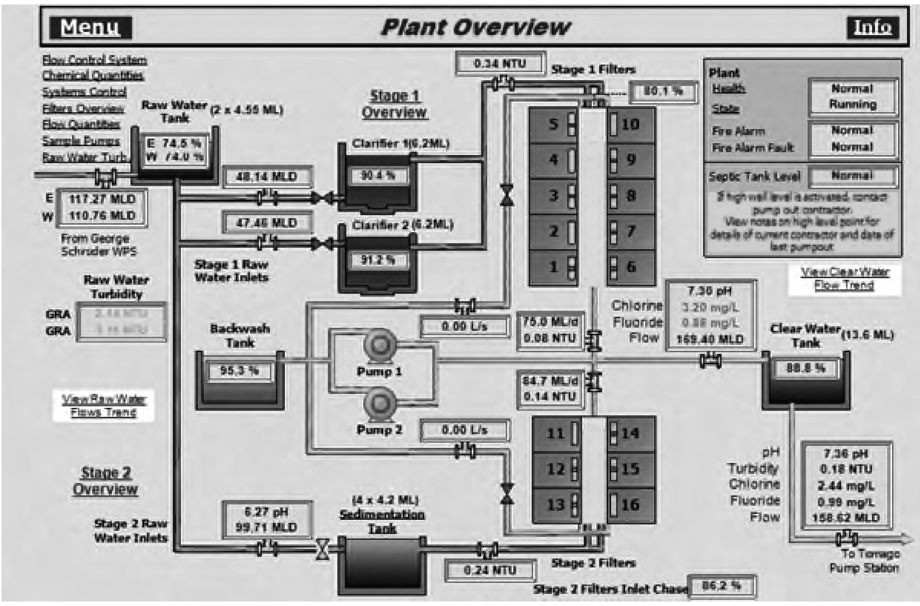


Figure 1: ***Schematic of Grahamstown WTP SCADA showing Plant Overview***

2.2 Turbidity Critical Control Points

Water quality at GTWTP is protected using an integrated SCADA/HACCP system. Individual filter turbidity monitoring and control is an important system component. The Hunter Water filtration performance requirements are aligned with filtered water turbidity recommendations in ADWG. Good filtration performance is dependent upon optimised pre-treatment performance including coagulation dose and pH control as well as the type and depth of media, backwash process (incorporating air scour, bed expansion etc.), filter ripening, head loss characteristics, flow rates and backwash storage (WRA, 2015). The alert, alarm and shutdown critical limits specified in the Veolia HACCP tables are aligned with operational requirements, the recommendations of the ADWG and the proposed Health Based Targets (HBT) (WSA, 2015).

ADWG stipulates that for effective management of chlorine resistant pathogens the turbidity of water leaving individual filters should be <0.2 NTU and should not exceed 0.5NTU at any time (NHMRC, NRMMC, 2011). The operational target and critical requirements for filtered water turbidity at each filter at GTWTP are based on continuous on-line measurement from individual filter outlets and continuous on-line flow measurement from the filter flow meter. These requirements are:

- Target requirement is $\leq$0.2 NTU for more than 95 percent of flow through the individual filter for each month.
- Critical requirement is $\leq$0.5 NTU, must not exceed 0.5 NTU for > 15 minutes.
- The aspirational target is $\leq$ 0.15 NTU for more than 95 percent of flow through the individual filter for each month. This would allow an extra 0.5 log removal of protozoa cysts through the plant based upon the proposed HBT (WSA, 2015).

2.3 Filter Online Turbidity Measurement and Data Assessment

Online turbidity analysers

A project was undertaken to replace the online turbidity analysers installed on individual filters at GTWTP and a trial was undertaken to evaluate different candidate analysers. The analyser selected was the Turbimax CUS52D with the Liquiline CM444 Controller (Endress and Hauser). This sensor was specifically designed to measure turbidity at the low range in filtered water at WTP. The sensor employs the 90° light scattering principle in accordance with ISO 7027 and meets all the requirements of this standard (no divergence and a maximum divergence of 1.5°). Measurement is done using a wavelength of 860 nm. Analysers certified to ISO 7027 standard are compliant with the Good Practice Guide and ADWG requirement for filter turbidity measurement (WRA, 2015; NHMRC, NRMMC, 2011). The analysers were installed near the filter outlet sampling point to minimise the length of the sample pipe and avoid delay time. The analysers were mounted on a panel in the filter gallery and located at shoulder height to allow ergonomic operation and maintenance. Sample is pumped to the analysers and a flow switch alarms low flow conditions to SCADA. The new turbidity meters were commissioned in October 2016.

Turbidity data assessment

Water quality data from CCP online analysers installed at GTWTP is assessed using the Water Quality Database (WQD). This data includes online turbidity measured at the outlet of individual filters. The WQD was developed by Hunter Corporation and is maintained by Veolia. Raw unprocessed data produced by the online turbidity analysers is transmitted from SCADA to the WQD. The WQD assesses turbidity performance while the filter is filtering against operational critical limits and aspirational target and summarises performance.

2.4 Particle Count Monitoring

Filtered water particle counts at GTWTP are measured using an online particle counter plumbed to the GTWTP Stage 2 combined filtered water sample point. Output from this analyser is integrated to SCADA for trending. In addition, daily measurement of combined filtered water grab samples from GTWTP Stage 1 and Stage 2 are also performed using a bench particle counter in the size range >2 micron and >10 microns. Particle count data is used for process optimisation only as there are no operational or regulatory targets for particle counts. Figure 2 presents the trend in particle count density in Stage 1 and Stage 2 filtered water for particles > 2 microns during the study period with the alum dose. Particle counts remained relatively low (< 100 counts per mL) even when the alum dose was reduced to 52 mg/L.

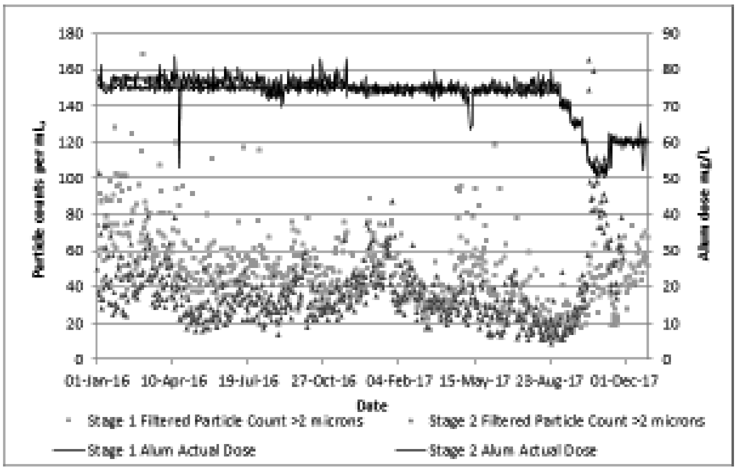


Figure 2: *Alum dose and filtered water particle counts*

2.5 Operational Response at GTWTP to the ECL Super Storm Incident

On 21 and 22nd April 2015 much of NSW including the Hunter region was subject to the East Coast Low (ECL) "Superstorm" (O'Donoghue and Shah, 2016; Morrow et al., 2017). Heavy rainfall and strong winds led to large amounts of stormwater entering the GTD. Inflows to the GTD catchment included runoff from urban, agricultural and natural catchments. During this event, raw water turbidity at the GTWTP increased from less than 2 NTU to a peak of 12.6 NTU on 25th April and remained above historical 95th percentile turbidity levels of 4.6 NTU for two more weeks after the ECL storm event (Morrow et al., 2017). In response to this event, GTWP was operated in an 'enhanced coagulation' mode (O'Donoghue and Shah, 2016; Morrow et al., 2017). Mr K Craig was interviewed, and it was explained that the alum dose was increased to a maximum dose that did not allow the alum dosed water pH to fall below pH 5.9 to minimise the risk of soluble aluminium breakthrough in filtered water. The dose could not be further increased as GTWTP does not have pre-lime dosing to control the coagulation pH. This mode was used to maximise contaminant removal including pathogens (K. Craig, 2018, pers. comm). Enhanced coagulation normally refers to coagulation controlled to low pH conditions to increase removal of natural organic matter. The alum dose was initially increased to 90 mg/L (as product) immediately after the storm and then reduced to 75 mg/L in June 2015. The alum dose employed at GTWTP prior to the ECL was 50 mg/L and this represented the typical dose required at GTWTP to achieve turbidity removal under normal conditions at the time.

2.6 GTWTP Operation and Filter Performance Following the East Coast Low Incident

Source Water

Source water was provided from the GTD and remained relatively stable throughout the study period (2016-2017). Raw water pH ranged from 6.5 to 7.7 (mean 7.2), raw water turbidity ranged from 0.8 to 3.6 NTU (mean 1.8 NTU) and raw water colour ranged from 10.5 to 30.9 HU (mean 17 HU).

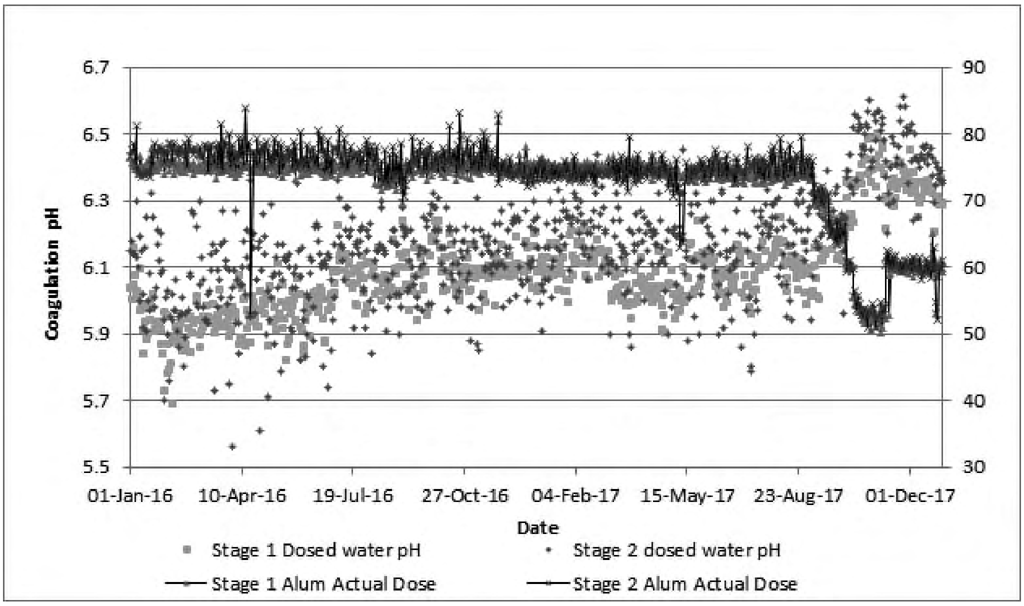
Coagulation and filter performance

The GTWTP continued to be operated in 'enhanced coagulation' mode using an alum dose of 75 mg/L following the ECL until October 2017.

It was then decided to reduce the alum dose to a rate that achieved operational and aspirational filtered water turbidity targets. Three factors influenced this decision:

1. The inherent stability of the raw water supplied to GTWTP;
2. Confidence gained by operators using the new individual filtered water turbidity analysers to detect changes at low turbidity levels.
3. The filters were achieving full compliance with filtered water operational and aspirational targets.

There are several approaches that can be taken when optimising the alum dose at a WTP for low filtered water turbidity including jar tests and using online instrumentation such as streaming current, zeta potential and UV254 measurement (Ratnaweera and Fettig 2015). The approach taken in this study was to reduce the alum dose in small steps (approximately 5mg/L) and review filter performance. Alum dose changes were made over a period of several weeks in the period September to November 2017. This approach was taken to avoid breaching operational and aspirational filter targets. Figure 3 shows the alum dose and dosed water pH trend for the study period. The dosed water pH increased from pH 6.1-6.3 to pH 6.3-6.6 when the alum dose was reduced from 75 to 52 and then 60 mg/L.



<u>Figure 3:</u> ***Alum dose and dosed water pH***

No deterioration in filter turbidity for Stage 1 (mono media) or Stage 2 filters (dual media) was detected until the alum dose was reduced to < 60 mg/L. At alum dose rates in the range 52-55 mg/L, short duration spikes in turbidity occurred when filters were brought on line following a backwash or to meet increased flow demand. Filter aid (non-ionic polymer) is not normally dosed at GTWTP and was introduced at a dose rate of 0.02 mg/L in an attempt to control filter ripening/start up turbidity spikes. However, headloss increased and filter run length reduced so filter aid poly dosing was halted. Trends in head loss and alum dose for Filter 3 are shown in Figure 4 to demonstrate this response, the circled area shows an increase in headloss when filter aid polymer was dosed. Interestingly, this response to filter poly aid dosing was also observed in Stage 2 filters (dual media) but to a lesser extent. Throughout the study period, all filters at the GTWTP (Stage 1 and Stage 2) achieved full compliance with individual filter online operational and aspirational turbidity targets, achieving < 0.2 NTU and <0.15 NTU respectively for 95 percent of the month

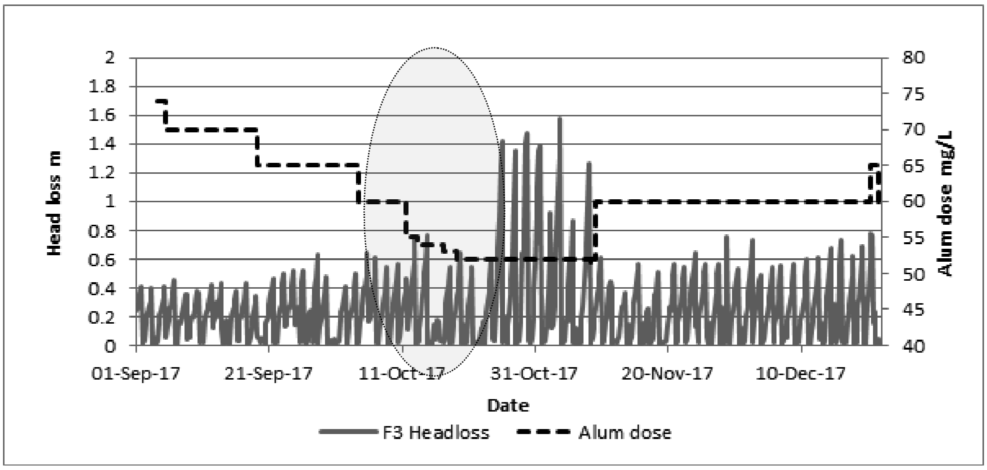


Figure 4: ***Stage 1 3 Filter 3 (mono media) head loss and alum dose – headloss circled area shows increase in head loss when filter aid polymer was introduced***

3.0 CONCLUSION

- Coagulation pH, filtered water particle counts (in the size range >2 microns), individual filter turbidity and filter headloss were monitored and found to be useful when fine-tuning the alum dose at GTWTP.
- The approach taken whereby the alum dose was reduced in small steps can be used when raw water conditions are stable. However, a different approach is required when rapid changes in raw water quality are found and dose rates must respond quickly.
- GTWTP is achieving low filtered water turbidity and is well placed to comply with proposed future HBT turbidity targets.

4.0 ACKNOWLEDGEMENTS

Thank you to James Morrison (GTWTP Supervisor) and the Operators at GTWTP.

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DIFFUSER REPLACEMENT – OUT WITH THE OLD, IN WITH THE NEW

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Tamworth Regional Council

12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

DIFFUSER REPLACEMENT – OUT WITH THE OLD, IN WITH THE NEW

William (Bill) Constable, *Process Operator Westdale WTP*, Tamworth Regional Council

ABSTRACT

The aeration system at the Westdale Waste Water Treatment Plant (WWTP) was nearing its life expectancy and performance was beginning to wane. With every minor failure in equipment another bank of diffusers was needed to be turned off which reduced the plants aeration capacity. The grommet attachment style diffuser was deemed to be inadequate. An Expression of Interest and a Tender was called for to replace the diffusers.

It was decided that our operations team would install the new diffusers. There were a few challenges encountered during the installation process, however we overcame them all and now have a completely new set of aeration diffusers operating successfully.

1.0 INTRODUCTION

The Westdale WWTP upgrade was completed in 2011 and included 4 new Intermittently Decanted Aeration Lagoons (IDALs) as the source for Primary and Secondary treatment of waste water. Each IDAL consists of 5 banks of air, each bank has 10 lateral air pipes off the header pipe and every lateral pipe has 40 disk diffusers. In short there are 50 lateral rows of pipes about 17 metres long with a total of 2000 diffusers in each tank. These pipes are raised off the floor with roughly 140mm clearance at the shallow sides to about 300mm along the centre channel.

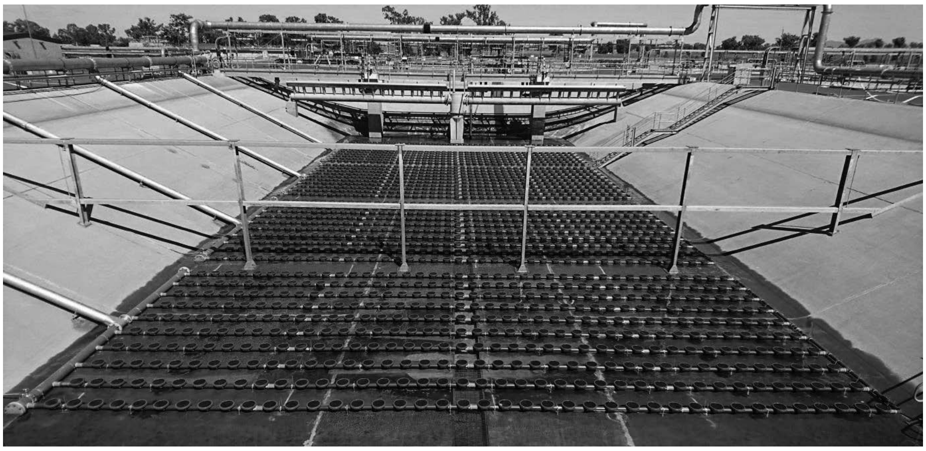


Figure 1: ***IDAL 1 empty and clean***

Westdale WWTP services domestic and industrial wastewater customers and is a 14.8ML/d ADWF wastewater treatment plant. Industrial customers, mostly from food processing all have onsite treatment and contribute roughly 4ML/d to this total.

2.0 DISCUSSION

The diffusers in use in the 4 IDALs at Westdale WWTP were at the end of their design life. The method of attachment with grommets of the original diffusers had resulted in some diffusers becoming detached off the lateral pipes.

This caused further issue by allowing activated sludge to flow into the lateral air pipes and then pushed through other diffusers partially blocking them.

The Tender for the Diffuser Replacement called for a maximum Standard Oxygen Transfer Rate (SOTR) of 700kg of oxygen per hour per IDAL and to remove the grommet method of attachment amongst other requirements. The accepted Tender uses a saddle type bracket for the diffuser which locks around the pipe removing the risk the grommet type attachment presented.

2.1 Cleaning

To carry out the replacement works each IDAL was emptied and cleaned to allow easy access to the floor area. Before an IDAL was taken offline we as operators would reduce our Mixed Liquor Suspended Solids (MLSS) in the week before sending extra Waste Activated Sludge (WAS) for the first IDAL to the Sludge Lagoons. For the next 3 IDALs the extra WAS was used to seed the previous IDAL now with new diffusers and help get it back online.

Each IDAL took around 2 weeks to clean adequately down to the floor with the use of lay flat hoses and a "water cannon". The water cannon was purchased after the cleaning of the first IDAL and made a huge difference to the time of hosing out by helping operators control angle and concentrate water flow. Sludge was hard to fully hose out between the brackets and pipes so once sludge levels were almost to the floor and all the diffuser pipes exposed the focus shifted to pipe removal.

Figure 2: ***Hosing without and with the cannon***

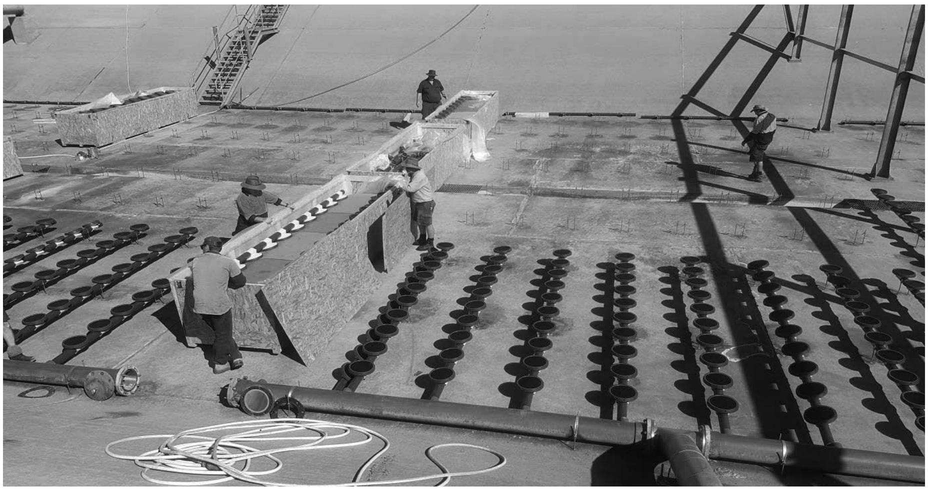
When all the lateral pipes had been removed all remaining sludge was hosed down to the channel and sump. IDAL 1 was used for SOTR testing so extra time was spent with high pressure hoses cleaning back to concrete to reduce any potential effect on the testing. There was a decent amount of rag build up on brackets through each IDAL. Most of this was removed with use of high pressure jetting and using a hoe to push larger build ups off brackets and shovelling into a skip bin. On a side note wet rag was heavier but easier to push and break off brackets. Dry rag seemed to cling a lot more.

2.2 Pipe Removal

Once most of the Activated Sludge was removed to make cleaning of the tank easier we arranged for a local crane company to lift out the old diffusers and pipes as well as put in place our access steps. This involved wearing waders undoing all the top brackets off the pipework and disconnecting lateral pipes from the header pipes. For the first 2 IDALs we lifted the pipes out as full lengths but as we progressed to IDAL 3 and 4 we cut them in half and thirds. Moving the full lengths (roughly 17 metres) was awkward and cumbersome. The shorter lengths were a lot easier for staff and the crane operators to manoeuvre and handle.

2.3 New Pipes and Diffuser Installation

With the floor clean and old pipes out of the way all the new equipment could easily be installed. Each new lateral consisted of 4 lengths of PVC pipes with each pipe containing 10 already fitted diffusers. The preassembled aeration pipework arrived in 5 metre long pallet boxes and within a few hours of boxes being lifted into the IDAL floor, all the pipework was sitting in position on the existing brackets ready for boxes to be removed out of the way.



<u>**Figure 3:**</u> ***Unpacking boxes and placing diffuser pipes on brackets***

Pipes were joined with PVC couplings which included rubber seals. With the new pipework each lateral set of pipes was also joined by manifold piping at the tail end. Also, part of the new installation required more pipe brackets to reduce sag and bowing of pipes. In total there were 5 more brackets per lateral installed to distribute the load.

I designed a jig of sorts from parts and timber in the shed as a hole spacing guide the same as the brackets to drill the holes for more accurate positioning of anchors. It butted up against the pipe spaced nicely between 2 diffusers with room to put your feet to hold the jig as one drilled. The prototype lasted for the full duration of the job – just.

Drilling, tapping in the anchors and screwing in the threaded rods was very time consuming and chewed through many a rechargeable battery for our hammer drill. All the brackets are supported on threaded rods, so with down time between IDAL's, a lot of these rods were prepared with nuts, washers and brackets saving time during install. All the rods required tightening into the threaded anchors before adjusting the levels of the brackets.

With a laser level each bracket was raised and lowered (unless lucky enough for it to be level to start) to level the diffusers across the IDAL. In many cases 2 turns of a nut here and 3 down there until all 680 sets of brackets per IDAL were level (13 sets per lateral – 8 old and 5 new plus 30 on the manifolds).

Once all brackets were levelled, the diffusers were levelled so they were sitting flat and tightened down. Due to the length of the new bracket rods an "extension" socket was devised using PVC pipe and normal socket to spin the nuts most of the way down the rod saving a lot of time and fatigue.

2720 nuts per IDAL (and I'm sure hallucinations) down the track……. it's all over. Nearly.

One final job was then left, to check the tension of all the diffusers with a special diffuser tightening tool. 2000 adjustments later…. we're finished.

2.4 Bubble Testing

Now we get to test all the hard work we've done for the last 3-4 weeks. After running potable water into the first IDAL, it's time to crack open the air valve gently and just a little bit.

<u>Figure 4:</u> ***Bubble testing before commissioning***

Alas there are a few leaks here and there, most fixed with a gentle tap and adjustment of a joiner or occasionally the installation of a new diffuser unit but as discussed in the next Section there were a few bigger issues with some of the header pipes.

For the remaining 3 IDALs reclaimed effluent was used for bubble testing.

2.5 Problems Along the Way

The biggest issue encountered along the install was with the header pipes before the lateral pipes. The original pipes are heavy wall PVC and over the 6 years in service they were sagging a little in the middle between brackets. Whilst this didn't really cause much concern initially it was discovered many had small leaks when bubble testing the diffusers. When the header pipes were unbolted it was found that the lip holding the welded uni-flange on was cracked and in some cases was all but broken off the header pipe altogether. On some the spigots off the header pipes also had small leaks where they had been welded.

Figure 5: ***Leak found on header pipe flange***

For the first IDAL (not knowing the extent of the issue in the other 3 IDALs) this header pipe was repaired using the existing pipe and a new uni-flange.

In the second IDAL one header pipe was replaced with a complete stainless steel pipe as the original couldn't be repaired easily.

The third IDAL saw the worst 3 (most distorted) header pipes replaced but bubble testing later revealed more leaks on the remaining header pipes so 4 more were replaced with stainless steel construction.

The fourth IDAL saw all the PVC header pipes replaced with stainless steel.

All remaining PVC header pipes are now programmed to be replaced if or when that IDAL is offline and emptied.

3.0 CONCLUSION

The replacement of the diffusers except for a few delays from external factors went well with a good base infrastructure for the future. All new pipework should need little attention until it comes time to replace diffuser membranes in roughly 5 years.

The saddle clamp style diffuser appears to be less likely to become detached over time compared to the grommet style that has been replaced and thus reduces potential issues with MLSS getting into air lines and diffusers.

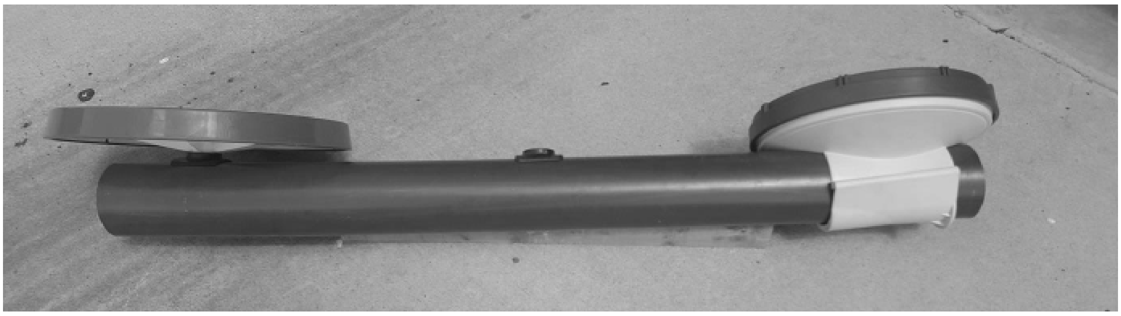


Figure 6: ***Old style diffuser & grommet, grommet, and new style saddle clamp diffuser***

Replacement of existing PVC header pipes with stainless steel was necessary in some IDALs. And it is already planned with any future works to replace the remaining header pipes with stainless steel. This will minimise pipe failure and increase the working life of the overall aeration system.

The operations team put in a great effort to get ready for important deadlines. SOTR testing included an international specialist with one member coming from overseas. Bubble testing on IDAL 4 was finished the week before Christmas.

Overall, replacing the Westdale aeration diffusers was quite a lot of work, physically taxing, but we are happy with the result. Hopefully the next 5 years or more will be essentially trouble free operation of this important area of the plant.

4.0 ACKNOWLEDGEMENTS

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Lynken Dickson, Jarrod Lye – Trainee Process Operators Westdale WWTP
Travis Hutton – Process Operator Calala Water Treatment Plant

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BENEFICIAL USE OF BIOSOLIDS AS A SOIL CONDITIONER

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BENEFICIAL USE OF BIOSOLIDS AS A SOIL CONDITIONER

Barry Young, *Sewer Process Technical Officer,* Kempsey Shire Council

ABSTRACT

This paper discusses the experiences of a rural council to manage the ever-growing costs to dispose biosolids by taking an environmentally sustainable, socially responsible and economically productive approach.

Kempsey Shire Council (KSC) operates seven sewage treatment plants (STPs) across the Macleay Valley with different treatment process trains. Traditionally STP sludge, or biosolids, was transported to Fredericton Sanitary Depot (or nightsoil disposal yard) and later to KSC landfill waste disposal site. Due to stringent Environmental Protection Authority (EPA) requirements and associated cost implications, KSC looked at options. KSC Sewer Process Team proposed land disposal as a viable option to use biosolids as a soil conditioner in cattle grazing paddocks. In collaboration with an organic recycling entity and a local farmer, KSC disposes all its biosolids since 2010 in compliance with EPA guidelines and licence conditions. KSC applied 2100 tonnes of biosolids in 2016/17 as a soil conditioner.

The disposal process is challenging at times due to sludge removal and dewatering scheduling, technical hiccups caused by the nature of the sludge and dewatering, and difficulties in biosolid disposal due to weather conditions, etc. Different demographics and commercial operations contributes to certain chemical compositions of biosolids. However, routine and targeted quality monitoring, ongoing communication with regulatory authorities and a well-managed mutually beneficial collaborative arrangement can ensure a smooth operation.

1.0 INTRODUCTION

Historically KSC treated its wastewater in seven different STPs and disposed the sludge (biosolids) at the Fredericton Sanitary Depot (or nightsoil disposal yard) first and later at landfill waste disposal site. In the early 2000s, stringent Environmental Protection Authority (EPA) requirements and disposal costs required KSC to look at viable alternative options.

In a particular case, West Kempsey STP encountered ongoing challenges associated with digester sludge dewatering. Despite the process modifications with different polymers and brands, KSC dewatering units showed little or no success to achieve optimum dewatering and sludge characteristics. STP Operators recognised that urgent planning was required for emptying two sludge lagoons at West Kempsey STP.

KSC's Technical Officer Sewer Process approached a specialist contractor with dewatering experience and larger equipment to quote on emptying the smaller lagoon first, and the quote was within the allocated budget.

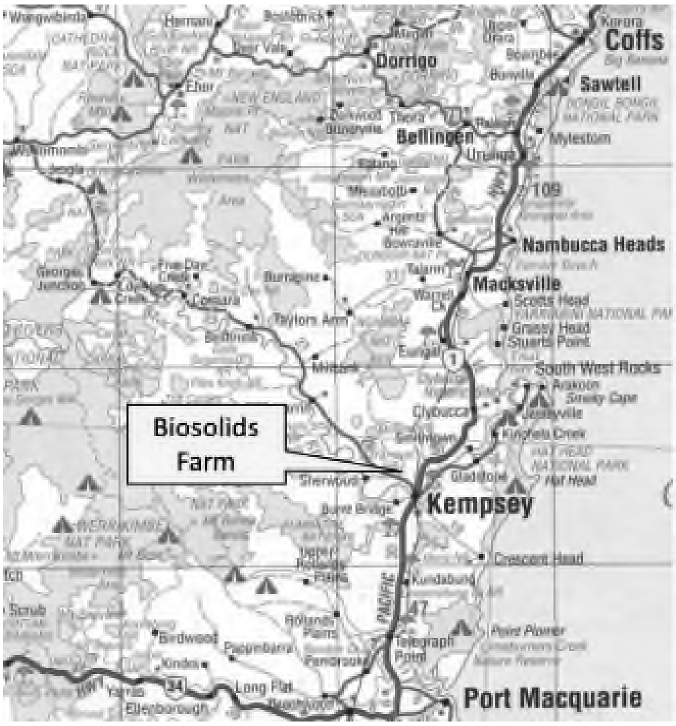
However, the Sewer Process Team was convinced that emptying the larger lagoon there was above the allocated budget and proposed an alternative option in consultation with the dewatering contractor and knowledge providers. The idea was to lower the disposal cost by locating a suitable farm in the area that would be able to take the biosolids and use as a soil conditioner. This process was to be undertaken as a trial, but ideal expectation was also to locate a farm within suitable transport distance to cover all STPs of KSC.

As the selection criteria for a farm, Sewer Process Team looked at size, location, access for all elements and the land owner's commitment in making the biosolids application happen. Sewer Process Team shortlisted a suitable area to meet the criteria and identified a farmer who sounded very committed in forming a partnership with KSC to benefit both himself and KSC with respect to this biosolids application. At the time of engagement, this farm was running about 30 head of cattle, and the pastures were not sustainable in the dry weather hence cattle had to be removed from site.

EPA (under the NSW Department of Environment, Climate Change and Water at that time) was consulted regarding this proposal. Arkwood Organic Recyclers drafted the Review of Environmental Factors (REF) for all parties to review. EPA commented on the REF report and discussed a regulatory framework, including the *Biosolids Exemption 2008* and *POEO Act*. The three parties, KSC representatives, the farm owners (The Secombes) and Arkwood Organic Recycling met to discuss the process onsite at the farm in 2010 to commence proceedings and to agree on adhering to the biosolids guidelines, WHS guidelines and REF. Arkwood would be the main operator of this site according to the agreed protocols. The Secombes were to ensure earthworks, incorporating the biosolids into the soil, grass seeding, erosion and odour control, cattle restrictions, and other conditions as outlined in the REF. KSC were to continue to supply biosolids while maintaining the biosolid quality requirements.

The biosolids application site is located at about eight kilometres west of Kempsey (Figure 1). The size of the farm is approximately 66 ha.

The farm owner took the initiative upon himself to approach all available property owners (except the adjoining neighbour, who was holidaying at the time) in the vicinity to explain the biosolids-related activities on his property and offered to facilitate a site visit to observe how this process was implemented. The discussions included the extra truck movements, dust, noise and possible odour. This approach was well received with positive feedback from the property owners. Subsequently, biosolids application at this site commenced on 17 June 2010.



<u>Figure 1:</u> ***Location of Biosolids Farm***

2.0 DISCUSSION

2.1 Trial for Farm Application

In 2010, Arkwood Organic Recycling commenced the dewatering the digester sludge from the West Kempsey STP. It was not a straightforward process.

The West Kempsey STP was first constructed in 1939 and was augmented in the mid-1980s with large trickling filter unit and other associated processes with a design capacity of 12,000 Equivalent Persons (EP).

The large sludge lagoon at West Kempsey STP was not emptied since Year 2000. Access to the site and setting up was challenging due to movements of large equipment. The initial considerations included the followings:

- Dense vegetation along internal access road
- Site gate access, which was located opposite the high school access
- Locked gate at the road with limited driveway
- Movement and establishment of large dewatering equipment
- Inward and outward movement of rigid trucks
- Staff movements around the site (sewer process operators and contractors)
- Staff awareness (tool boxing) and induction (all parties)
- Access out of normal work hours
- Operator competency

Biosolids samples were collected from the sludge lagoon at the start and at every 100 tonnes until completion. These samples were routinely forwarded for analysis at a NATA accredited laboratory ensuring the biosolids meet Contamination Grade (B or C) and Stabilisation Grade (B) (*Environmental Guidelines: Use and Disposal of Biosolids Products*, EPA 2000) before application.

Emptying of the large sludge lagoon took approximately 54 days, and more than 4,000 wet tonnes of sludge was removed. Approximately 2,500 dry tonnes of biosolids was applied to the farm by 375 truckloads in two designated areas (Figure 2).

Figure 2: ***Trial biosolids application sites in 2010 (No 1 and No 2)***

2.2 Farm Establishment and Application of Biosolids

A large temporary earth bund was constructed using a D7 Dozer on top of the first ridge (Figure 2) within Lot No 2 to house the incoming truckloads of biosolids.

With the tractor and spreader ready for work, loading of the spreader commenced using a 4x4 telehandler loader, the application commenced along the eastern, northern and southern boundaries of Lot No 1, keeping the buffer zone set. Along the western boundary, the operators prepared a more substantial buffer zone for the flowing creek as required.

The farmer used his own machinery following the biosolid spreader, ripping and ploughing the biosolids into the ground as per the REF. Once the biosolids were applied to ground, the farmer had a maximum time of 36 hours to have all the biosolids-applied area covered. The farmer then had the opportunity to sow the desired crop to feed his cattle.

According to the agreement, EPA could undertake unannounced visits to inspect the setup and operations. During their first visit, EPA asked a series of questions to ensure that the proper procedures were followed. Technical Officer Sewer Process was at the site during the first EPA visit. EPA sought information regarding the truck movements, tonnage application rate, laboratory analysis records of biosolids and how KSC managed the operations from the STP to the farm. EPA officers took soil and biosolids samples from various areas of the farm for their analysis.

Upon satisfactory results in terms of biosolid quality, economic benefits and favourable impacts of biosolids application, all three parties agreed to expand the biosolids application on this same farm.

The application sites were expanded beyond Lots No 1 and No 2 for this purpose, and biosolids from other STPs were also sent for land application.

In a favourable environment for cattle, the farmer sustains a higher cattle population now with over 125 head of cattle and a transient population of 70 calves. The paddocks conditioned by biosolids withstand dry seasons and enable the famer to maintain the cattle throughout the year.

2.3 Initial Problems and Solutions

KSC understood there would be no magical solutions for challenging problems and there would be room for improvement to the operations and was prepared to find solutions to teething issues.

Access road into the farm (Figure 2) is also a stock route for public use which requires the main gate to be kept closed at all times. One of the KSC obligations is to ensure that all vehicles arriving and leaving this site are clean of biosolids, as the rear dual wheels are known to pick up small amounts of biosolids despite the general washing down of the truck body and the wheels.

EPA contacted KSC with a complaint that small heaps of biosolids were found along the access dirt road. Technical Officer Sewer Process attended that site and found a small amount that fitted into a small plastic bag, collected photos and forwarded back to the EPA Grafton.

Sewer Process Team had manufactured a trailer-mounted washdown unit consisting a bulky bin (1000L), Honda firefighter pump and retractable hose with hose reel locked on a flatbed trailer mounted on a skid with centre lift or folk mounts. With this setup now, KSC demonstrated that the biosolids lodged within the dual wheels could be effectively removed to avoid any complaints regarding trucks leaving biosolids spilt on the roads. Further, Sewer process team had modified the drop-off point by constructing a hard stand tipping point.

KSC ensured that the truck drivers were aware to keep the gate closed always when entering and exiting the property, KSC had adjusted the start time on the farm to 7.00 am for the truck movements.

Continued truck movements along the dirt road created dust issues especially in our dry hot months. The farmer undertook regular maintenance of the dirt access road inside his boundaries with a small grader, KSC had also engaged a water cart at times to suppress the dust for the residents along the main road as needed.

Rainfall is a concern during the application of biosolid, the operation should cease during and after the rain. The stormwater catchment inside the bunded area should be managed accordingly to the agreement among KSC, Arkwood and the farmer.

Cattle were a dynamic part of this farm when the trial commenced. According to the REF, there is a 30-day withholding period before the animals are allowed back over this ground since the application of biosolids. Lactating cows are required to be kept away from the biosolids applied area for 90 days. Extra fencing along various boundaries had to be installed at the farmers cost, to manage the cattle access.

When the farmer took the Sewer Process Team around the applied areas, he indicated that it was costing him more in operations because he had to purchase more cattle, with the extra improvements over his pastural land could now cater for more animals. In 2018, The Secombes are running 125 head of cattle with 70 calves. Approximately 3.2 ha of land is used to grow millet, with 60 tonnes of silage has been harvested into round bales for extra feed or sale.

2.4 All Kempsey Shire Council STP's

All our Sewerage Treatment Plants (STP's) dewatering of biosolids have been added to this farm for disposal which are included on the Review of Environmental Factors.

Table 1: ***All the Kempsey Shire Council STPs***

STP	Design Capacity	Major Process
Hat Head	1250 EP	Activated Sludge, Filtration, Chlorine disinfection
Gladstone	1000 EP	Activated Sludge, Tertiary Treatment (ponds)
Frederickton	1000 EP	Activated Sludge, Tertiary Treatment (ponds)
Crescent Head	4500 EP	Activated Sludge, UV Disinfection
South West Rocks	12000 EP	Activated Sludge, Chlorine disinfection
South Kempsey	4000 EP	Activated Sludge, Tertiary Treatment, Chlorine disinfection
West Kempsey	12000 EP	Digester Sludge, Tertiary Treatment (ponds)

3.0 CONCLUSION

This project has been a success for KSC and the local farmer, environmentally and financially.

The farmer has had significant improvements on his pastures which has allowed for increased cattle supply and sustainability with the addition for cropping. This project has now been operational for over seven (7) years, complete coverage across all designated paddocks, re-sample of soil by Arkwood Organic recyclers and sent for analysis to determine application rate of biosolids. There has been expression of interest from other property owners within our area for the supply of biosolids. This farm has also been handy for our neighbouring Councils at various times they have been able to dispose of their biosolids at this site. Asset Sharing.

4.0 ACKNOWLEDGEMENTS

Many thanks to Kempsey Shire Council supporting Managers & Sewer Process staff involved in this challenging project.

Arkwood Organic Recyclers for being part of this project and Eric and Sue Secombe for allowing KSC to trial and then implement the beneficial use of biosolids application to their farm.

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Review of Environmental Factors (REF)

OPERATOR CERTIFICATION AND TECHNICAL COMPETENCY IN WATER OPERATIONS

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12th Annual WIOA
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OPERATOR CERTIFICATION AND TECHNICAL COMPETENCY IN WATER OPERATIONS

Kathy Northcott, *Technical Operations Officer,* Water Industry Operators Association

ABSTRACT

In the water industry, operational staff have a direct influence on water quality and, consequently, may have an impact on environmental and public health outcomes. A water business that can demonstrate their people have the skills and knowledge to safely and competently carry out their roles in water industry operations provides assurance to regulators, communities and the users of drinking water and recycled water. That message being, staff are capable of identification and appropriate response to drinking water, wastewater and/or recycled water quality risks and incidents.

Recent major public health incidents (e.g. Flint Michigan, USA, and Havelock North, NZ), and the outcomes of subsequent investigations, have highlighted the critical importance of technical competency in the water industry. This recognition of the level of risk posed by poor management of water treatment and networks has reinvigorated interest in the development of industry licensing and certification schemes for water operations professionals worldwide.

This paper is intended to communicate examples of good practice in implementing technical competency in water industry operations. The Operator Certification Framework will be presented as an example of implementation of a technical competency framework, demonstrating approaches for planning and delivery of learning and development (L&D) programs to achieve this.

1.0 INTRODUCTION

Regardless of the specifics of role and responsibilities, technical staff in the water industry need skills and knowledge in the following areas:

- Workplace Health & Safety
- Quality & Risk Management
- Team Skills – such as Self-management, Communication & Leadership
- Technical proficiency

The scope of this paper is primarily the *Quality & Risk Management*, as well as *Technical Proficiency* requirements of water industry operations staff. Together, these two areas form the basis of a technical competency framework suitable for operational staff to manage public health and environmental risks.

The Certification Framework for Operators within Drinking Water, Wastewater and/or Recycled Water Treatment Systems (Certification Framework) provides a set of nationally consistent criteria that define and recognise minimum levels of technical competency and capability. The Framework is designed for those operators who manage the treatment of water, wastewater and/or recycled water, to ensure that the final product does not have an adverse impact on public health or the environment, and that its quality is fit for purpose and safe to use. The Certification Framework is not intended to over-ride the local regulatory requirements placed upon a Drinking Water Supplier, Wastewater Authority or Recycled Water Supplier.

Instead, Certification provides an assurance to regulators, communities and users that operators are competent to manage drinking water, wastewater and/or recycled water quality, and can identify and respond to water quality risks and incidents.

The Certification Framework introduces a minimum level of technical competency for Certified Operators across all states and territories by aligning skills, knowledge and competency requirements to national Vocational Education and Training (VET) standards. Further, the Certification Framework ensures that there is a requirement for the on-going maintenance/development of skills and knowledge.

WIOA is currently the endorsed certifying body for the Certification Framework. The Water Industry Operator Certification Scheme (Certification Scheme), which complies with the requirements of the Certification Framework, opens the door for operator certification in all Australian States and Territories. The aim of the WIOA Certification Scheme is to verify that an operator meets the minimum competency requirements certification, and is, therefore, by extension, qualified and competent to perform their role within the water industry.

2.0 IDENTIFICATION OF TECHNICAL COMPETENCY REQUIREMENTS

The first step in designing an organisational technical competency framework is identifying the roles that the framework will relate to. For each role identified there should be a position description which outlines; key responsibilities, qualifications, experience, and other relevant skills (e.g. drivers licence, first aid)

Based on each position description, it should be possible to create a list of technical roles and competency skills sets across an organisation. In broad terms water businesses will have technical roles that fit into the following categories:

- Operational – such as Catchment management, Bulk water transfer, Water/Wastewater/Recycled water treatment, Networks and Distribution.
- Maintenance (may or may not be part of operations – depending on organisational structure)
- Process engineering
- Water quality/ Process science.

Table 1 gives an example of an operator's qualifications and skills requirements. Note this table does not cover the specific OH&S training or business systems training requirements of the role.

<u>Table 1:</u> ***Operator technical skills requirements based on position description***

Role	Qualification/s	Technical Skills
Operator	Certificate II, III or IV in appropriate water industry operations stream from the National Water Package (NWP).	• Operation of water treatment systems, processes and/or networks • Water quality sampling and analysis • Capability to perform basic mechanical, electrical and / or instrumentation maintenance • Application of quality management systems and procedures • Using computers and process control systems

Based on the position description, and knowledge of the operational activities and processes managed, it should be possible to create a technical skills matrix specific to each operational role. The skills matrix contains the required training and competencies for an operator to carry out their duties.

For example; a drinking water operator works at plant with the following treatment processes:

- *Potassium Permanganate dosing*
- *Powdered activated carbon dosing*
- *pH and alkalinity adjustment*
- *Coagulation/flocculation*
- *Dissolved air flotation*
- *Granular media filtration*
- *Chlorine disinfection (gas)*
- *Fluoride dosing*

Using this example, a drinking water operator would be required to have technical knowledge and skills in; drinking water quality and risk management, environmental risk management, sampling and testing for water quality, operational knowledge and skills for treatment processes, and skills in calibration of equipment and instrumentation relevant to their treatment process.

Table 2 gives an example of the skills matrix for this water operator. Process specific technical competencies are mapped directly to units of competency from the National Water Training Package (NWP). Units of competency that are required to achieve certified operator status under the Certification Framework and WIOA Certification Scheme are shown in black.

3.0 ONGOING PROFESSIONAL DEVELOPMENT TO MAINTAIN SKILLS

Supporting staff to maintain professional skills and knowledge throughout their career is one of the biggest challenges businesses face. Managing a large workforce with disparate skills sets, as well as meeting any regulatory requirements for ongoing training can be expensive and time-consuming.

To address this, the WIOA Certification Scheme takes a broad-ranging and flexible approach to Continuing Professional Development (CPD) through a simple points-based recertification process, which can be implemented in a cost-effective way. The recertification points required for an operator for each period of recertification, currently set to 5 years for the Certification Framework, are specified in Table 3.

Hence CPD does not just include formal training programs or conferences. WIOA recognises a large range of L&D activities, allowing certified operators and managers to choose those options that best suit their learning styles and preferred L&D pathways. For the WIOA Certification Scheme, development activities are classified into the following categories:

- Accredited Training
- Non-Accredited Training
- Other Activities
- Significant Workplace Project
- Exceptional Activities

Table 2: ***Example skills matrix for a drinking water operator***

		Quality/Risk		Treatment Processes							
Technical Competency	**NWP Unit of Competency**	**Health & environmental risk**	**Water quality testing**	**Potassium Permanganate**	**Powdered activated carbon**	**pH and alkalinity adjustment**	**Coagulation/flocculation**	**Dissolved air flotation**	**Granular media filtration**	**Chlorine disinfection (gas)**	**Fluoride dosing**
Quality and Risk Management											
Risk management principles of the water industry	GEN001	■									
Environmental & Licensing Procedures	GEN003	■									
Management of change			On-the-job								
Sampling and testing											
Sample/test Water	GEN007		■								
Laboratory testing	GEN009		■								
Drinking water treatment											
Iron and manganese removal	TRT014			■							
Activated Carbon	TRT034				■						
Chemical dosing						On-the-job					
Coagulation/Flocculation	TRT015						■				
Dissolved Air Flotation	TRT033							■			
Granular media filtration	TRT041								■		
Chlorine (gas) disinfection	TRT013									■	
Fluoride dosing	TRT012										■
Maintenance			trade qualification or equivalent on-the-job experience								

Table 3: ***Required points accrual for recertification for different operational streams***

Classification and Complexity Rating	Required Points
DRINKING WATER - LOW	5 in 5 years
DRINKING WATER – HIGH	15 in 5 years
WASTEWATER - LOW	5 in 5 years
WASTEWATER - HIGH	15 in 5 years
RECYCLED WATER	15 in 5 years

3.1 Planning and Undertaking Professional Development

CPD should be carefully planned and managed such that the points are accumulated throughout a 5year recertification cycle. This ensures that the operator does not have a large burden of training to undertake towards the end of the cycle. Required training and development should be discussed and documented between manager and staff member during annual performance appraisals or through a process of competency assessments.

Taking your preferred L&D style into consideration is important for planning professional development. The **VAK learning styles model** suggests that most people can be divided into three preferred styles of learning, or a combination of the three styles. These are described as follows:

- **Visual** learning style - prefers seen or observed things.
- **Auditory** learning style - prefers listening.
- **Kinaesthetic** learning style - prefers physical experience.

Additionally, there are three main modes of delivery of learning. Typical preferred learning delivery modes include:

- **Formal learning** – training courses, seminars and presentations, reading technical books & journals. Ideally makes up no more than 10% of learning.
- **Coaching/Mentoring and knowledge sharing** – mentoring programs, team-based development activities. Makes up about 20% of learning
- **Work-related** – informal learning through projects and special assignments, job rotations and networking activities. Up to 70% of learning via this mode.

For example; a certified drinking water operator who works at a conventional filtration plant is required to undertake 15 points of professional development in a 5year period. The operator prefers to learn on-the-job and be more hands-on (kinaesthetic). As such, over the 5 years, in consultation with their manager and as per their annual performance plan, the operator undertakes the CPD Program outlined in Table 4.

3.2 Maintaining Records for Professional Development

Keeping track of professional development activities and points allocations can be a relatively simple process. WIOA provides a downloadable “Individual Professional Development Register” on their certification website. This is a simple excel spreadsheet where staff can record activities they have undertaken that meet the criteria for points. In addition to the professional development register, documentary evidence of activities undertaken also needs to be provided. Table 5 provides examples of suitable evidence of various activities.

4.0 CONCLUSION

Using the Certification Framework, and WIOA’s Operator Certification Scheme as an example, this paper demonstrates how to develop an organisational technical competency framework for water industry operations professionals, along with a systematic process for managing ongoing professional development to maintain competency. Recognition of informal learning as a major component of L&D can also open the door for more beneficial and cost-effective learning in the workplace.

5.0 ACKNOWLEDGEMENTS

Thanks to the team at WIOA for their support in the preparation of this paper.

Table 4: ***Example of a 5 year plan for CPD activities for a certified drinking water operator***

Year 1 - Activities	Activity type	Description	Points
Special Project	On-the-job, Kinaesthetic	Undertake an investigation into changing the coagulation dosing chemical used onsite. Make operational changes, write and issue report on project outcomes	4 points awarded, based on project report
Year 2 - Activities			
Attendance at a water industry conference, trade show, field day or meeting with published agenda	Social/Networking, Auditory, Kinaesthetic	Attend WIOA Exhibition, talk to trade delegates about new equipment and products and how they might improve the operation.	1 point based on evidence of registration to exhibition
Attend a water treatment focused in-house training course with Q&A discussion	Formal Learning, All learning styles	In-house training seminar on optimising granular media filters	1 point based on training register and training session agenda.
Year 3 - Activities			
Participate in a rotation, exchange or secondment program	On-the-job, Kinaesthetic	3 week secondment to another water utility where the operator works as part of a team but under direct supervision.	3 points based on evidence of daily log or work diary for duration of the secondment.
Year 4 - Activities			
Attend a training session approved or conducted by a state/territory regulator	Formal Learning, Visual, Auditory	Attend a water quality seminar delivered by water industry experts, and approved by WIOA and the state regulator	3 points based on evidence of registration to attend seminar.
Year 5 - Activities			
Provide a public presentation in relation to the relevant area certified	Social/Networking, Kinaesthetic	Run a plant tour for staff from a visiting water utility	2 points based on evidence of the site tour – E.g. CPD activity statement signed off by direct line manager
Attendance at a relevant water industry specialty event	On-the-job, All learning styles	Attend a Water Interest Day organised by the WIOA state advisory committee	1 point based on evidence of registration to the event
			15 Points

Table 5: ***Examples of CPD activities and evidence provided for points accrual***

CPD Category	Activity	Evidence
Accredited Training	Undertake appropriate unit of competency from NWP	Verified copies of statements of attainment for NWP units of competency from RTO
Non-Accredited Training	In-house training seminar on optimisation of relevant treatment processes	Training attendance register and copy of training agenda/program
Other Activities	Attend relevant industry conference	Conference registration (including no of days registered). Conference agenda/program
Significant Workplace Project	Undertake a process investigation or optimisation study	Project report
Exceptional Activities	Mentor a junior operator	Mentoring agreement and report

INTERNET OF THINGS – WATER UTILITIES – HYPE VERSUS REALITY

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12th Annual WIOA
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INTERNET OF THINGS – WATER UTILITIES – HYPE VERSUS REALITY

Mark Halliwell, *Business Development Manager,* Taggle Systems

ABSTRACT

The Internet of Things is here. According to some spruikers, it will change the world we live in, connecting every conceivable sensor to the internet and making data available to all who want it at next to no cost. Communications network providers claim that their network is the best, the only one we'll ever need to achieve great things using vast amounts of data that will cost next to nothing to gather from the field.

Sounds too good to be true? It probably is. When it comes to new technology, there is always a degree of hype around what can be done and, inevitably, it will take time to sort out what's real from what is just the enthusiasm of the marketing department.

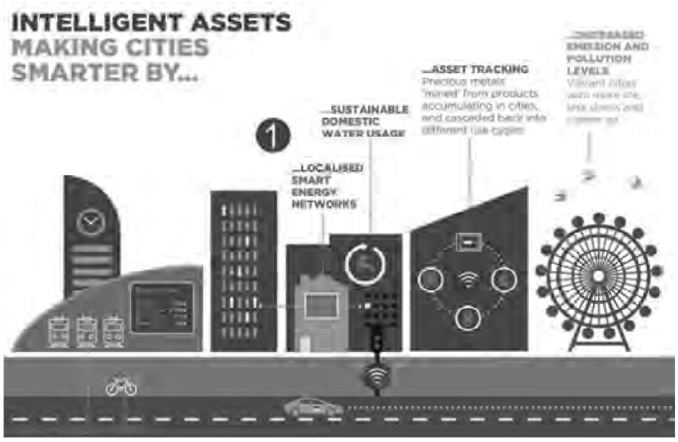
This paper seeks to highlight some aspects of the hype and reality associated with the use of the Internet of Things in some aspects of the water industry. Following a quick introduction to IoT and its components, it will discuss some of the elements around which there has been a degree of over-exuberance.

1.0 INTRODUCTION

What is the Internet of Things?

Postscapes, in its IoT Overview Handbook (1) says this about the Internet of Things: "The Internet of Things sits at the intersection of sensors, networks, design, business models, and a wide range of industries. At its simplest, the IoT is the idea that wireless communication and digital intelligence can be embedded into everything around us — clothing, vehicles, buildings, flowerbeds, even the ground beneath our feet. Underlying this transformative concept are complex and interwoven layers of physical, digital and human infrastructure that will allow billions of devices to collect, transmit and receive data through the Internet."

Like other great technological shifts throughout history, the IoT is changing the way we work, the way we play, the way we learn and the way we organize societies. It has the potential to make us better informed, healthier, more productive, and more connected; and it introduces new challenges for privacy, safety and regulation."



<u>Figure 1:</u> ***Smart Cities are coming!***

Now, in 2018, the Internet of Things is being talked about everywhere. It underpins everything that is "Smart": Smart Cities, Smart Phones, Smart Watches, Smart Refrigerators and so on. Almost daily, we hear and read about new devices that have been connected to the internet, web-enabled, to make our daily lives more convenient and productive.

2.0 COMPONENTS OF THE INTERNET OF THINGS

In simple terms, the components of the Internet of Things can be described as:

- Sensors – to interface with the real world
- Communications – to transport data to/from the field to the cloud
- Data storage – to manage the vast quantities of data collected by sensors
- Analytical tools – to process data into information
- Organisational structures that encourage collaboration, innovation, and the application of that information to solve problems

2.1 Sensors

Sensors are everywhere! They can anything from simple devices such as a switch to determine if a door is open or closed, more sophisticated instruments that measure multiple parameters in a water treatment plant, to cameras that sense motion, identify faces and beyond.

In general, sensors fitted with a communications device and a battery for use as an IoT device, can be described as an endpoint. As noted later, the cost of endpoints is a major factor in the viability of any IoT system that involves many thousands of endpoints

2.2 Communications

When discussing internet and communications, the methods that immediately come to mind are Ethernet, Wi-Fi, Broadband (ADSL, Cable) and mobile networks such as 3G and 4G. The Internet of Things, at least from a consumer perspective adds Bluetooth, RFID and, to a lesser extent, Zigbee. All of these have been around for quite a long time now and, while they are still in use, there are newer technologies that are starting to drive the Internet of Things market to new heights. These can, mostly, be grouped together as Low Power Wide Area Network or LPWAN technologies.

LPWAN technologies seek to transfer small amounts of data at relatively slow speeds over long distances using very little power. The result is that it is now possible to attach a radio device to sensors powered by small batteries and be able to transmit data over many kilometres for periods of 10 years and more without having to change the battery.

Examples of LPWAN technologies in use in Australia include, NB-IoT, Taggle, Sigfox and LoRa. While all these types of LPWAN, each has its own characteristics and suits some types of applications better than others.

2.3 Data & Analytics

Water service providers already use several software platforms. Billing, SCADA, GIS, hydraulic and hydrologic modelling (2). Data collected from many types of sensors that can now be deployed economically can now be fed directly into these platforms.

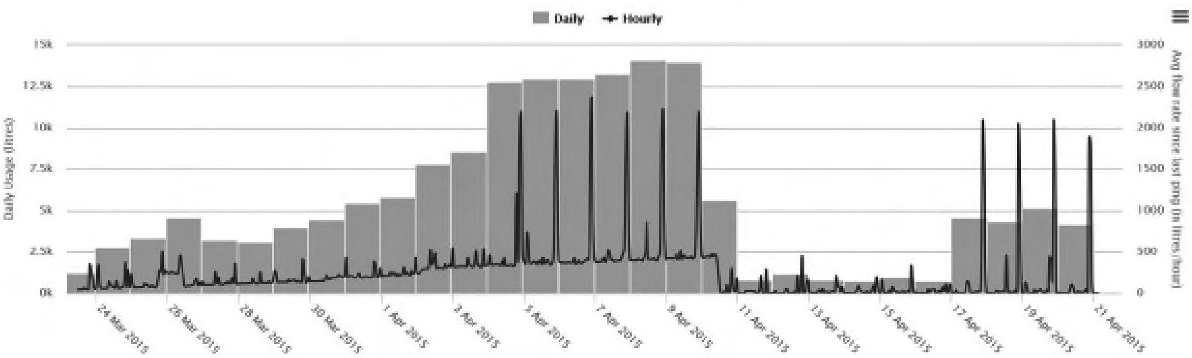
Billing can be completed in days instead of weeks, SCADA and GIS professionals can now have much greater context relating to their systems and hydraulic and hydrologic models can finally be fed with near real-time, broad scale data to improve their accuracy and usefulness.

Meter data management (MDM) platforms are now starting to emerge, providing WSPs with tools to monitor water usage at the consumer level, manage related customer communications and reticulation network behaviour. Web-based customer portals giving access to their billing information and a mechanism to create email and SMS alerts are also available.

3.0 INTERNET OF THINGS AND WATER UTILITIES

One area where IoT is having quite an impact is in the world of water utilities, particularly here in Australia. A growing number of water service providers (WSPs) have employed or are starting to employ LPWAN communications to collect water consumption data from water meters across entire communities, for example. This data is helping to inform utilities and their customers about water use patterns, potential water losses and measures that might be taken to better manage demand for water, a precious resource in many parts of the country.

LPWANs are also being used to collect data from in-pipe water pressure sensors. This data, typically fed back to a SCADA system, is helping to modulate water pressure to ensure that performance requirements are met while, at the same time, keeping pressure to the lowest allowable level. This management of pipe pressure is key to the longevity of the infrastructure where unnecessarily high pressure is known to be a significant contributor to cracks and fractures.



<u>Figure 2:</u> ***Graph of water consumption data indicating leak that has been fixed***

Water quality sensors are now being added to the mix of sensors from which data can be gathered using LPWANs. The bane of most water service providers, water quality is probably the most important key performance indicator for a WSP. Having a low-cost communications option for such devices is making them less expensive to operate and will likely lead to more being installed.

Low-cost sewer overflow sensors are now finding their way into chambers at many water utilities. Aside from the obvious benefit of being able to warn of a potential overflow, something every water utility wants to avoid, these sensors, combined with data from others such as rain gauges and water level sensors, are also providing clues about inflow and infiltration issues. Knowing the recent history of rainfall and, perhaps, the level of nearby creeks, the speed of increase of levels in sewers can quickly identify if inflow or infiltration is occurring. This can help reduce the cost of testing.

Figure 3: ***LPWAN-connected sewer overflow monitoring***

Rain gauges installed across a water supply service area can provide contextual data for a number of potential situations. In addition to the sewer monitoring described above, knowing how much rain falls in an area combined with detailed water use within the area can provide useful information on how potable water is being used for outdoor use. This can then be used to inform community education programs about water use and the need to conserve water.

Figure 4: ***Rain Gauge***

4.0 HYPE VS REALITY

There has been a lot of discussion within Australia's water industry over the past 5 years or so about how the Internet of Things will impact the sector. While significant progress has been made with many great examples of how the technology is helping the industry, there continues to be a degree of hype about the issue that causes uncertainty in the minds of many who are charged with deciding the direction to be taken by their organisations.

Areas where confusion appears to exist are:

- Network types
- Network coverage
- Costs
- Use of data

4.1 Network Types

In considering IoT network options, it is worth considering that not all networks are suitable for all applications. Radio communications and their various forms are akin to roads, highways and vehicles. All vehicles, cars, trucks, bicycles, buses and the like, use roads and highways in much the same way that the different forms of IoT communications networks use the radio spectrum. When choosing a vehicle, you normally pick the right one for the job. You use a truck to carry freight from one city to another, a bus to commute to and from work or a maybe bicycle for a trip to school and back. All these forms of transport co-exist quite well, except for the occasional collision.

And so it will be with IoT networks. Sigfox, Lora, Taggle, NB-IoT and others will each find their niche on the radio spectrum highway and users will be able to choose according to their need for various network attributes and abilities. The real decision to be made by utilities will be which network best suits particular applications. The data collected across these networks is, in the end, just data and, with the availability of open data communication standards, it will become just another commodity to be used in whatever platform the user chooses.

4.2 Network Coverage

Radio network planning is a dark art and it is only when IoT network equipment is in place and endpoints have been deployed that you can have any real confidence that coverage is established.

Providing network coverage for mobile phones is relatively simple compared to providing IoT network coverage for endpoints that may be installed in pits with cast iron lids. For example, an IoT-connected water meter that is close to or under the ground has a battery that provides more than 10 years' service and a power output many times less than a mobile phone. Ensuring data delivery from such devices over many years without revisiting the endpoint is a far more difficult challenge that requires more than just mounting an antenna somewhere and declaring that coverage is available all around it.

4.3 Costs

Perhaps the most hyped aspect of the Internet of Things is its cost. While it is quite true to say that Low Power Wide Area Networks lower the cost of collecting data from widely distributed endpoints, some of the figures that are promoted greatly distort peoples' expectations.

A typical endpoint comprises a sensor, a communications device (transmitter or transceiver), perhaps some data storage, a battery to support its expected life, an enclosure and suitable mounting arrangements.

The more functionality that is required to be carried out within the endpoint, the great the componentry and, by extension, the cost. The choice to employ an endpoint with one-way or two-way communications has a big impact on its cost as the latter inevitably requires a much bigger battery. In all battery-powered endpoints, it is the cost of the battery that dominates the unit cost, especially if it's expected to provide many years of reliable in-the-field service without battery replacement.

4.4 Data

One of the great misconceptions around the Internet of things is that the data will solve all problems. While it is certainly true that many problems will be solved through having the huge volumes of data that can be collected using Low Power Wide Area Networks and other forms of communications, the data itself does nothing.

It was described earlier that one of the components of The Internet of Things is "Organisational structures that encourage collaboration, innovation, and the application of that information to solve problems". By this, it is meant that the data must be looked at from every angle by fresh minds that are open to looking at old problems in new ways. Apparently unrelated data needs to be examined closely to reveal hitherto unknown relationships that might lead to new ideas.

An example of how data can be correlated to identify previously unknown unknowns (3) involved the correlation of data from a sewer overflow sensor, a rain gauge and a water level sensor. By examining the data, it was discovered that a particular sewer overflow sensor indicated an overflow at a time just after heavy rainfall and at the height of a king tide that increased the level of a creek adjacent to a sewer chamber.

What was not known was that a baffle on the chamber was locked in an open position, causing it to flood the chamber when there was a combination of both heavy rainfall and a king tide. It was only by looking at the various data in concert that the correlation led to a field inspection which identified the problem.

5.0 CONCLUSION

The Internet of Things is changing many aspects of daily life, many for the better, some of questionable value. It will, over the next few years, evolve at a fast pace and bring evermore complexity to the way we organise our communities and the services provided, including water and sewerage services.

The aim of this paper was to call attention to the fact that there is a degree of hype surrounding the Internet of Things and to provide the reader with some examples along with a more realistic portrayal of what it has to offer.

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INNOVATION & CONTINUOUS IMPROVEMENT SUPPLYING UP TO 85% OF SYDNEY'S DRINKING WATER

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INNOVATION & CONTINUOUS IMPROVEMENT SUPPLYING UP TO 85% OF SYDNEY'S DRINKING WATER

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ABSTRACT

Operating and maintaining a continuous flow water filtration plant with strict quality specifications for a long term requires the plant to be robust and reliable. With the original design and construction aimed at providing an efficient and effective process, there is always room for improvement and with good systems and a stable workforce, the opportunity for improvements to the plant and process emerge.

This paper explores the process of identifying and implementing modifications over 20 years, aimed at improving safety, process, chemical handling, maintenance, quality control and many more parameters. Over 500 modifications have been identified, investigated, implemented and logged since the plant commenced operations in 1996. The resulting reliability of the plant assisted in the decision to extend the 25-year BOO contract by 14 years, taking it through to 2035, converting to a BOOT contract.

1.0 INTRODUCTION

In 1993, Prospect Water Partnership was awarded the contract to design, build, operate and maintain the Prospect Water Filtration Plant for 25 years. The plant commenced operations in September 1996. Raw water was provided from several sources including Warragamba Dam, Upper Nepean System (Avon, Cordeaux, Cataract and Nepean Dams) and Prospect Reservoir. Prospect WFP is the fourth largest filtration plant in the world.

Prospect WFP (see picture below as Figure 1) treats raw water provided by Sydney Water, via WaterNSW and supplied high quality water to Sydney Water for distribution to its customers. Sydney Water rates its drinking water as "amongst the world's best".

There were interesting challenges that needed to be addressed in the design, including:

- Only 5.2m head available to maintain gravity flow through the plant, requiring flow splitting to each filter of 2% accuracy
- Development of chemical mixing systems to ensure efficient and rapid dispersion throughout the four large contact channels, each 4m wide x 6m deep
- Filtrate removal occurring directly on the filters, eliminating the need for a sedimentation stage, requiring a fast filtration rate and low backwash water demands. Filtration rate is up to 24m/h and the plant uses 50% less water during backwash
- Infrastructure with initial capacity of 3,000 ML/d with the ability to expand capacity in the future to 4,200 ML/d
- Currently supply up to 85% of Sydney's drinking water, enough for 4 million people. The plant is classified as Critical Infrastructure by the NSW Government.
- Requirement to run 24/7 balancing inflows and production to meet demand schedules. This results in limited maintenance windows for critical equipment
- Meeting Australian Drinking Water Guidelines (ADWG) and Department of Health requirements

To support the operation & maintenance, the plant has gained certification and works to:

- ISO 14000 Environmental Management
- AS 4801 & ISO 9001 Quality Management System
- OHSAS 18001 Occupational Health & Safety Management System
- MHF Major Hazard Facility (Licence)
- Work closely with Emergency Management Bodies
- ISO 55001 for Asset Management

In operating the plant to meet demand schedules under strict finished water quality guidelines for continuous operation, the PWFP plant team has consistently challenged the norm and taken all challenges head-on to make improvements. This requires a dedicated team, supportive systems and procedures, innovation, management support, plus a collaborative client in Sydney Water.

Figure 1: ***Prospect Water Filtration Plant***

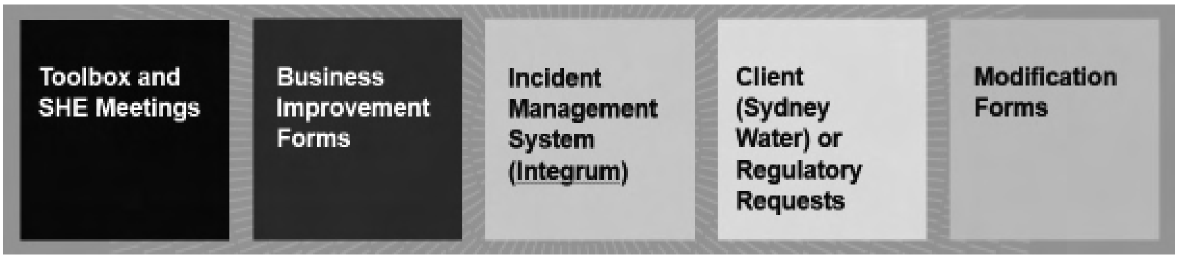
2.0 DISCUSSION

As with the design and construction of any infrastructure, and in this case specifically water infrastructure, there are generally gaps between the final constructed product and what the Operations & Maintenance (O&M) team wants or needs. Many of these "gaps" are only discovered once the plant is operational and when maintenance needs to be performed. That is when a robust Management of Change needs to be in place.

Since the commencement of operation in 1996, there have been over 500 Modifications identified, investigated, designed, implemented and logged. These are captured in the PWFP "Mod Form Register". Elements of the system utilised by PWFP are as follows.

2.1 Innovation and Continuous Improvement Process

A continuous improvement and innovation programme needs to be able to identify opportunities for improvement and then be able to work through the process. Figure 2 below illustrates elements of the Prospect Water Filtration Plant's process.



<u>Figure 2:</u> ***PWFP Innovation and Continuous Elements***

Examples of the capture and processing of ideas is incorporated into the various elements, as follows:

- Toolbox and SHE Meetings – Toolbox meetings are held daily with the whole team and the meetings cover health, safety & environment, plant performance and process issues, maintenance tasks, location of works and who is working on site plus any other items. These meetings often generate positive discussion and opportunities for improvement. These meetings are supplemented with the quarterly Safety, Health & Environment (SHE) meetings
- Business Improvement Forms (BIF) – all staff are requested to complete BIFs where hazards or potential for improvement are identified
- Integrum is the corporate Incident and Document Management System and is used to track BIFs. BIFs are allocated to the appropriate person and they are tracked and measured against required completion dates
- Client (Sydney Water) or Regulatory Requests – often there will be changes in legislation, regulatory requirements or requests from Sydney Water to changes in requirements. These are processed through the appropriate channels
- Modification (Mod) Forms – This is the Management of Change tool and Mod Forms are used to document potential modifications or changes required. Raising a Mod commences the process of investigations, risk analysis, potential benefits, savings or safety improvements. The process is carefully managed as part of the quality system and includes any changes to procedures, documentation or drawings.

2.2 Modification Process

Since 1996, there have been over 500 recorded Modifications. The Mod Form process incorporates the following elements:

- Reason for the Modification
- Description of the changes that would be required
- Process assessment of the proposed changes
- Safety assessment and risk review
- HAZOP and design reviews
- Project/Modification budget and justification
- Drawings, documentation and procedures updated

Modifications will be developed for:

- Process optimisation,
- Safety improvements,
- Reliability, operability and asset management/maintenance
- Any other significant change.

Following is a snapshot of some of the Modifications recorded through this process:

- 1998 – Mag flow meters installed to contact channel chemical dosing pumps to provide closed loop chemical dosing optimisation
- 1998 – pH adjustment to the Stormwater Pond for environmental benefits
- 1999 – particle counters installed in the filter gallery to help ensure filtered water quality
- 2000 -1 fluoride unloader installed for safe handling of materials
- 2005 – chlorine evaporator digital temperature control to reduce risk of nitrogen trichloride formation
- 2008 – filter backwash blowers soft starters to reduce starting current and risk to operation
- 2009 – residuals thickener sludge monitoring for process efficiency improvement and reduced operational risk
- 2010 – pH buffering to dose CO2 and additional lime for alkalinity control.

2.3 Innovation and Continuous Improvement Benefits

For 20 years, PWFP has operated continuously at 100% availability. The ongoing innovation and continuous improvement programme, robust systems and procedures, a high safety awareness and compliance and committed personnel is instrumental to the ongoing O&M of PWFP and contributed significantly to the renewal of the contract. Their commitment to safe working practices is also to be commended.

The environmental benefits of PWFP's improvements are also significant, and includes:

- All waste wash water is recycled
- Sludge is dried & beneficially used
- Minimal waste from any source
- All discharges are licensed and monitored
- Low energy footprint (gravity flow through plant)
- Other benefits

3.0 CONCLUSION

A robust system that allows PWFP to identify and explore opportunities and improvements, combined with the support structure and management systems, allows for a high level of innovation and continuous improvement necessary for continuing to consistently deliver high quality water that meets all contractual obligations and meets the demands of our stakeholders.

This process will help guide Prospect Water Filtration Plant through the next 18 years of the contract and aims to meet all challenges and opportunities that emerge.

Figure 3 below demonstrates the key elements of success.

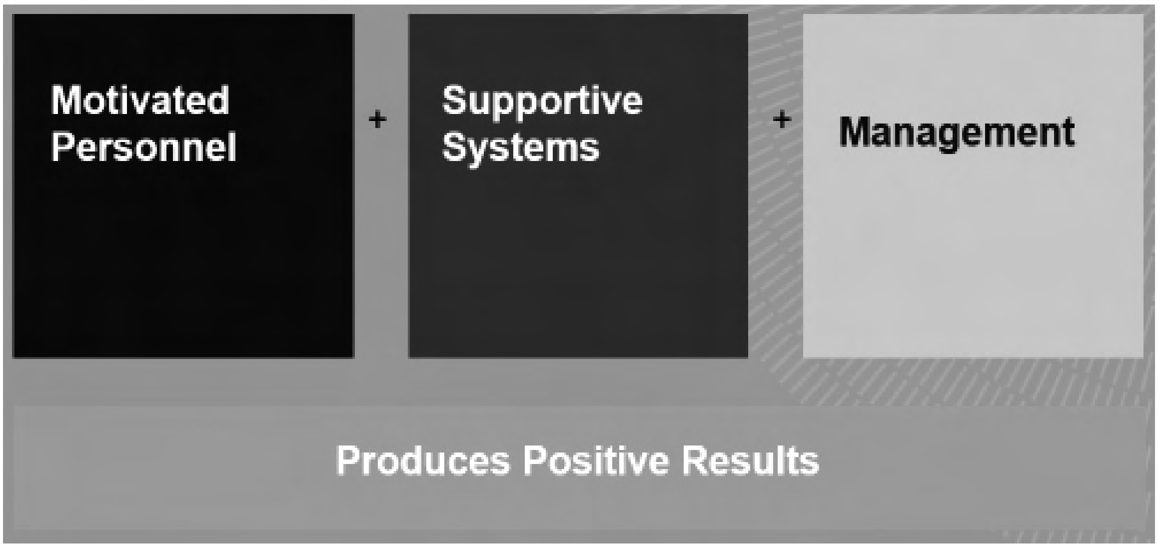


Figure 3: ***PWFP Key Elements of Success***

4.0 ACKNOWLEDGEMENTS

I would like to acknowledge the dedicated team at Prospect Water Filtration Plant, many of whom have been there since the commencement of the contract, and all of whom are committed. I would also like to acknowledge the ongoing close working relationship we have with Sydney Water who takes responsibility for distribution of the high-quality drinking water to the residents of Sydney.

Figure 4: ***Prospect Resident***

THE USE AND DEVELOPMENT OF A CHLORINE MODEL TO IDENTIFY RE-DOSING LOCATIONS FOR BONNY HILLS

Paper Presented by:

Tom Phillips

Authors:

Tom Phillips, *Water Treatment Plant Operator,*
Jack Budgen, *Industrial Chemical Engineer Trainee,*

Port Macquarie Hastings Council

12th Annual WIOA
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THE USE AND DEVELOPMENT OF A CHLORINE MODEL TO IDENTIFY RE-DOSING LOCATIONS FOR BONNY HILLS

Tom Phillips, *Water Treatment Plant Operator,* Port Macquarie Hastings Council
Jack Budgen, *Industrial Chemical Engineer Trainee*, Port Macquarie-Hastings Council

ABSTRACT

This paper outlines the process of identifying re-chlorination site(s) for the Camden Haven section of the Port Macquarie Hastings Water Supply Scheme. The idea of a secondary chlorination site in Bonny Hills will allow for the maintained residual in the Transit Hill Reservoir in Port Macquarie to be reduced from ~2mg/L, furthermore it will allow the rezoning of the Lake Cathie reticulation from Transit Hill to the Bonny Hills reservoir. This will alleviate issues in Lake Cathie due to the high chlorine levels and remove the need for the zone to be fed off the trunk main and Pressure Reducing Valves (PRV) providing a much more stable water supply.

The determination of the location for the site at Bonny Hills was based off the use a chlorine decay model through the software program Mike Urban. The model uses the water rates data from the network, water quality and chlorine decay rates to predict the behaviour of the water throughout the distribution network. The Gas Chlorine site at Bonny Hills was commissioned in February 2018 and has allowed for the decommissioning of the Sodium Hypochlorite dosing at the North Haven Booster pump station. Gas chlorine has many practical and safety benefits over sodium hypochlorite, and given the location of the Bonny Hills reservoir, it is a prime location for the installation of a gas system.

A further investigation because of this study was the determination of the next potential chlorine re-dosing location after Bonny Hills. Through the methods outlined in this report, the next location was found to be Lakewood Reservoir with the subsequent decommissioning of the Sodium Hypochlorite dosing at the Kew/Kendall Booster pump station.

1.0 INTRODUCTION

1.1 Port Macquarie Hastings Water Supply Scheme

The source water is pumped from the Hastings River at Koree Island in Wauchope, it is then transferred to either Port Macquarie off Creek Storage Dam or Cowarra off Creek Storage Dam. For the Camden Haven section of the Scheme, water is transferred from the Transit Hill reservoir in Port Macquarie, to Bonny Hills, then onto Laurieton, Lakewood and Kendall, creating a lengthy distribution network and the need for re-chlorination sites as to maintain a residual. Another issue that arises due to this lengthy distribution network, is a rise in pH, which is controlled by Carbon Dioxide dosing at Bonny Hills. A summary of the Hastings District Water Supply Scheme can be seen in Figure 1.

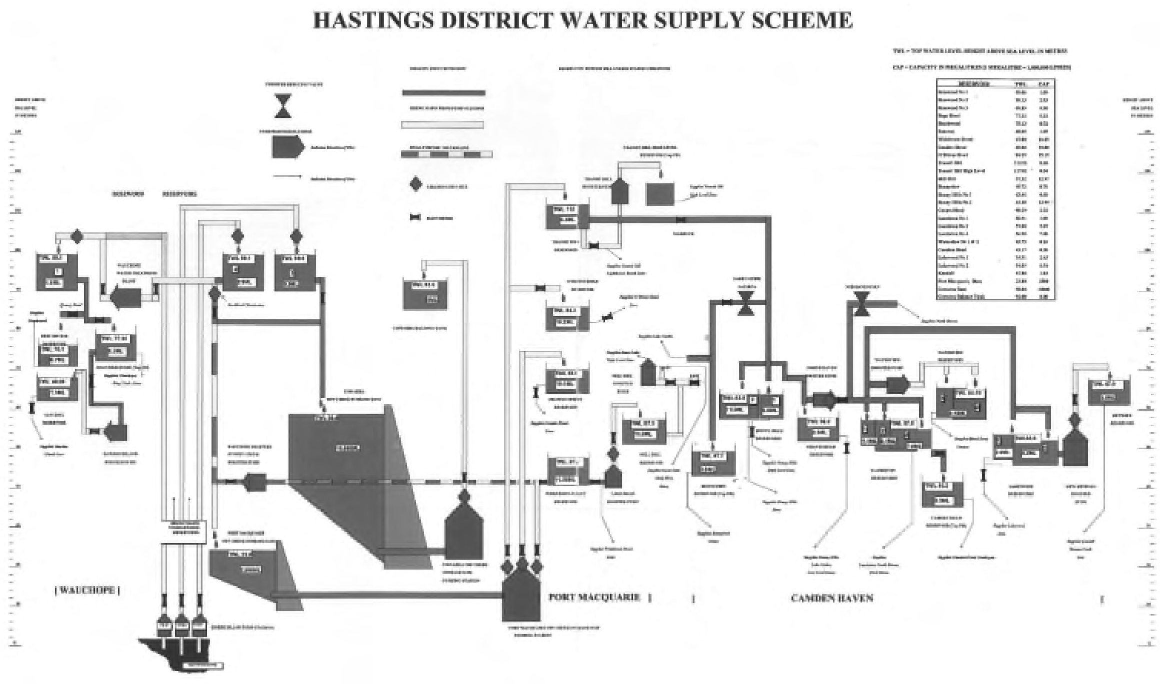


Figure 1: *Hastings District Water Supply Scheme*

1.2 Benefits of Gas Chlorine over Sodium Hypochlorite

Gas chlorine has many practical and safety benefits over sodium hypochlorite. The system at Bonny Hills will be the second Gas Chlorine system in our scheme, after Sancrox, which has been operational for just over two years, proving to be successful in maintaining better residuals throughout the network with a lower maintained residual in the reservoir.

Table 1: **Chlorine Gas / Sodium Hypochlorite Comparison**

	Chlorine Gas	Sodium Hypochlorite
Decomposition (Degradation of potency with time – releasing chlorine gas)	None	High (Limited Shell Life)
Required Storage Space	Minimal	High
Concentration by Weight of Available Chlorine	100%	3%-12.5%
By-Product Formation	THMs, HAAs	THMs, HAAs, bromate and chlorate formation
Application	Clean and Reliable	Messy with potential for crystallisation of pumps, valves and dosing lines
Cost	$484.49/70kgs	$665/kL
Cost comparison	$484.49/70kgs	$372.40/560L @ 12.5%, equivalent to 70kgs of gas
Transportation Costs	Minimal	High

Table 2: ***Chlorine Gas Practical and Safety Benefits***

Practical Benefits	Safety Benefits
Maintains a more stable residual throughout longer distribution networks.	Gas systems are now vacuum systems.
Dosing of Sodium Hypochlorite increases the pH, the Gas System shall reduce the Carbon Dioxide dosing currently at Bonny Hills.	Leak detection and automatic closing of cylinders with actuators.

2.0 DISCUSSION

From an Operators point of view, we were required to maintain unnecessarily high residuals in some reservoirs, to maintain a residual in other reservoirs and in the lengthy reticulation network. This also included dosing of Calcium Hypochlorite tablets into dispensers, particularly during the summer months with increased temperatures where it would have been otherwise impossible to maintain a chlorine residual.

A temporary dosing and recirculation system had been previously installed and trialled at the Bonny Hills reservoir. This proved to be successful in increasing the residual in Bonny Hills, however being a manual dose of sodium hypochlorite through the recirculation system, it required an operator to be on site and was not a viable long-term solution.

The new gas system would be installed on the inlet to the reservoir and would dose automatically during the fill cycle. Dosing chlorine gas on the inlet to the 13ML reservoir during the fill cycle will provide adequate mixing energy within the reservoir to ensure a consistent residual on the outlet. This will mean that the customers are not receiving water with high residuals at some times, and a low residual at others.

2.1 Use of the Chlorine Model

Port Macquarie Hastings Council uses the Mike Urban software package to provide an estimation of water demand, future trends in water quality, water age and chlorine decay. The main use of the model in this project was the chlorine decay seen throughout the Water Supply Network. The inputs to the model were the current water quality seen at the main reservoirs, chlorine dosing locations (including their dosing rates) and the chlorine decay rates (based off a combination of literature and experience). The model has the system's Water Rates data built in, allowing an estimation of the water demand/turnover of the network. The model was then set to run for a time frame of a minimum of 2 weeks to allow the system to come to an equilibrium before results were observed with accuracy.

The main aim of a new dosing location was to reduce the high chlorine residual in the Transit Hill Reservoir. In the model, 1.5 mg/L was set for Transit Hill (previously at 2mg/L) and the chlorine decay throughout the network was observed. After running the model, it was evident that the chlorine level in Bonny Hills was heading towards our low Critical Control Point, and hence this was chosen as a potential re-dosing location. The location and remoteness from customers of the Bonny Hills Reservoir as well as the

ability to use the reservoir to rezone the Lake Cathie water supply (refer to Section 2.2) were other advantages of using Bonny Hills as a gas chlorine re-dosing location.
An example image of the model in action can be seen in Figure 2.

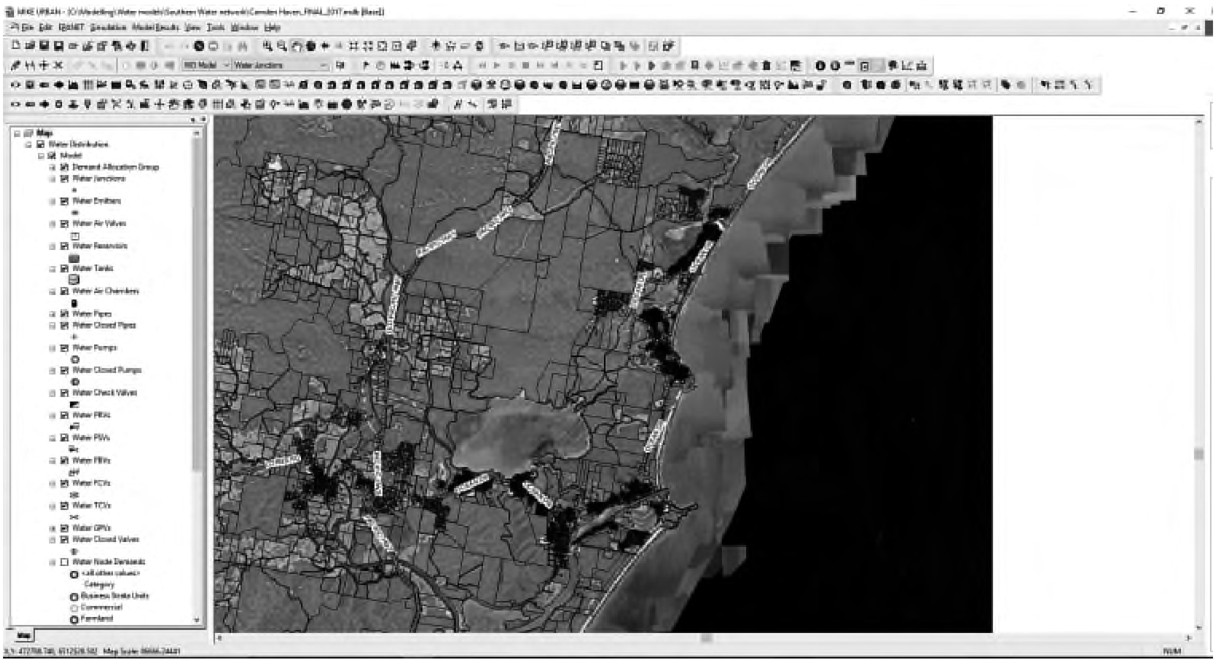
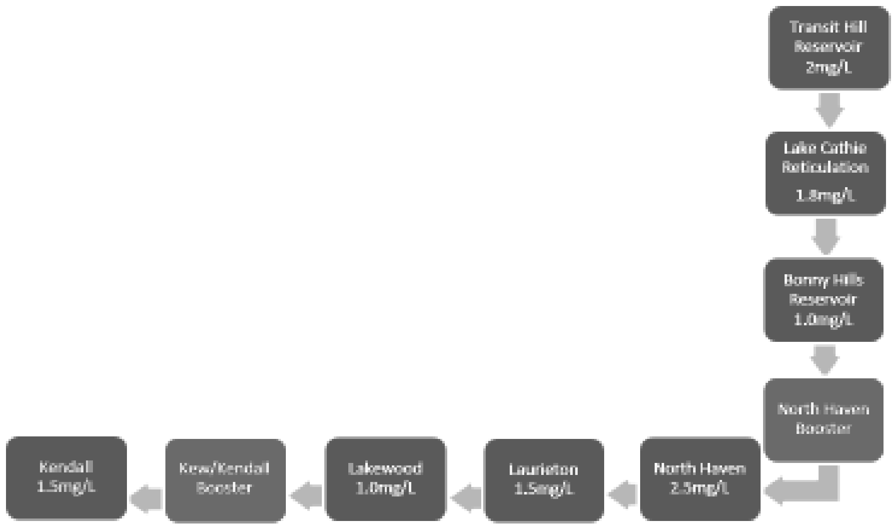


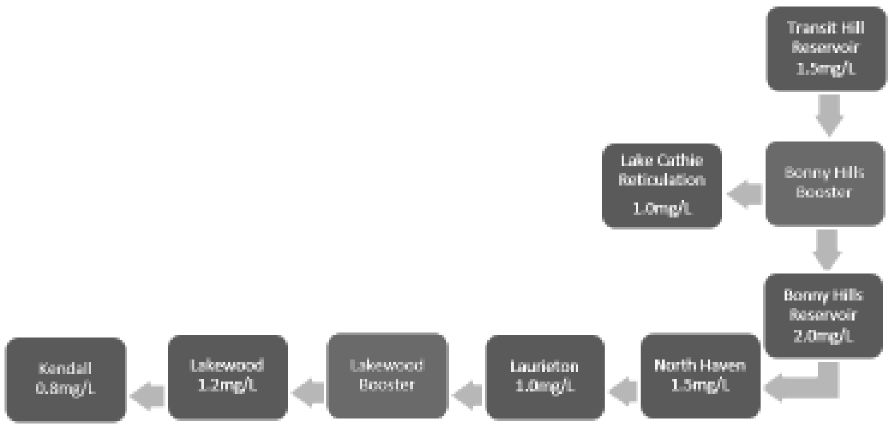
Figure 2: ***Use of the Mike Urban Model to Predict Chlorine Decay***

The second project in which the model was used was the removal of the Kew/Kendall Booster Sodium Hypochlorite dosing system and replacing it with a new chlorine dosing site at Lakewood. The two current dosing sites at the pump stations (North Haven and Kew/Kendall) presented many operational issues and caused several water stability problems due to dosing directly into the trunk main. With these switched off and the Bonny Hills dosing system turned on, the model was used to determine where the next required dosing location was needed. Based on this, Lakewood Reservoir was chosen as the next re-dosing site to provide enough of a residual to reach the end of the Network (Kendall).

A comparison between the Camden Haven Section of the PMHC Water Supply Scheme before and after the use of the model is shown in Figure 3 (a & b).



(a)



(b)

Figure 3: ***Comparison of Camden Haven Section of the PMHC Water Supply Before (a) and After (b) the changes made by the Model***

2.2 Rezoning of Lake Cathie

Lake Cathie is a small township located between Port Macquarie and Bonny Hills. Currently Lake Cathie is zoned off the Transit Hill reservoir in Port Macquarie. Lake Cathie is fed directly off the trunk main and three pressure reducing valves (PRV's). Typical chlorine residuals in Lake Cathie are 1.8-2 mg/L.

Lake Cathie can be rezoned to be supplied from the Bonny Hills reservoir, however given the information from the chlorine decay model, the current maintained residual of 1 mg/L in Bonny Hills is not high enough to maintain a residual in the Lake Cathie reticulation. This further increased the attractiveness of the new dosing location at the Bonny Hills Reservoir.

The new dosing location in Bonny Hills will allow for Lake Cathie to be rezoned and for the dosage at Transit Hill to be reduced. Transit Hill is 112m TWL (Top Water

Level Above Sea Level in meters), whilst Bonny Hills is 63m TWL. As a result, the rezone will make the PRV's redundant, and allow for more stable pressures throughout Lake Cathie.

2.3 Discontinuation of Calcium Hypochlorite Dosing

The installation of the new dosing system at Bonny Hills will result in the discontinuation of calcium hypochlorite dosing in Grants Head and Bonny View reservoirs. These two reservoirs are in Bonny Hills and are currently unable to maintain the required residual during the warmer months of the year. The chlorine model indicates that an increased residual in Bonny Hills will maintain the required residual in Grants Head and Bonny View. This eliminates the risks associated with Operators climbing and manually dosing the reservoirs, increases time efficiencies and reduces costs involved with calcium hypochlorite.

3.0 CONCLUSION

The use of the Mike Urban model of chlorine decay has been very effective in determining re-dosing locations within the Hastings District Water Supply Scheme. It has allowed for the decommissioning of old booster dosing systems, elimination of high chlorine residuals in reservoirs and the removal of calcium hypochlorite dosing. The model has been extremely efficient in predicting water demand, water age and quality as well as chlorine decay through a very lengthy distribution network.

4.0 ACKNOWLEDGEMENTS

Many thanks to Alan Butler (Water and Sewer Process Engineer) for providing me with this project and Luke Moane (Acting Water and Sewer Planning Manager) for assistance with the operation of the Mike Urban Model.

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OPTIMISING THE LIME-SODA SOFTENING PROCESS AT DUBBO'S JOHN GILBERT WTP

Paper Presented by:

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OPTIMISING THE LIME-SODA SOFTENING PROCESS AT DUBBO'S JOHN GILBERT WTP

Marnie Coates, *Senior Process Engineer,* Hunter H_2O

ABSTRACT

This paper is a case study on operational changes recently implemented at the John Gilbert WTP in Dubbo. The plant typically experiences very hard water. A lime-soda softening process is in place to ensure that treated water hardness is maintained below 120 mg/L which satisfies Dubbo Regional Council's customers. To achieve this, a large amount of slaked lime and soda ash are dosed into the plant's clarifiers to maintain a pH of approximately 10.4.

During a recent site visit, the plant operators were very focused on the fine tuning of the clarification process. Hunter H_2O identified that raw water hardness at the time was actually very good and the complications arising from the softening process could be eliminated by moving to a conventional treatment strategy when raw water hardness is low. Additionally, it was recommended that during times of moderate raw water hardness, a lime only softening process could be implemented. The outcome is that significant operational cost savings will be realised, and operators have better control over what is a very complex process.

1.0 INTRODUCTION

1.1 Water Treatment Plant Overview

The John Gilbert WTP is located off Macquarie Street, Dubbo and supplies water to the City of Dubbo and the Villages of Wongarbon, Ballimore, Mogriguy and Eumungerie, servicing a population of around 40,000. Dubbo has two sources of water: surface water from the Macquarie River and ground water from seven local bores. Bore water is pumped to John Gilbert WTP and passed through an aeration tower to strip carbon dioxide before mixing with the surface water. A portion of the bore water bypasses the aeration tower to the inlet of the re-carbonation tank to supplement the addition of carbon dioxide (CO_2) to reduce the final water pH.

The combined raw water is dosed with Powdered Activated Carbon (PAC) and contacted to adsorb algal toxins, taste and odour compounds and natural organic matter. The water then gravitates to either one or both of the solids recirculation clarifiers. Lime and soda ash are dosed at the clarifier centre well for softening of the water and ferric chloride is added for coagulation. Polymer is also added to the clarifier inlet to assist in the formation of flocs, enhancing solids settling. The clarified water is dosed with CO_2 and blended with bore water for recarbonation to reduce the pH. Chlorine can be dosed prior to filtration to assist in the removal of manganese if required.

Recarbonated water then passes through six gravity media filters which provide the final solids removal step in the process. Filtered water is dosed with chlorine for disinfection and fluoride prior to entering chlorine contact tanks and clear water tanks which are used as treated water storage.

1.2 Softening at John Gilbert WTP

Both the river water and bore water experienced at John Gilbert WTP are historically very hard waters (see Figure 1). The lime-soda softening process is in place to ensure that treated water hardness is maintained below 120 mg/L which satisfies Dubbo Regional Council's customers. To achieve this, a large amount of slaked lime and soda ash are dosed into the plant's clarifiers to maintain a pH of approximately 10.4.

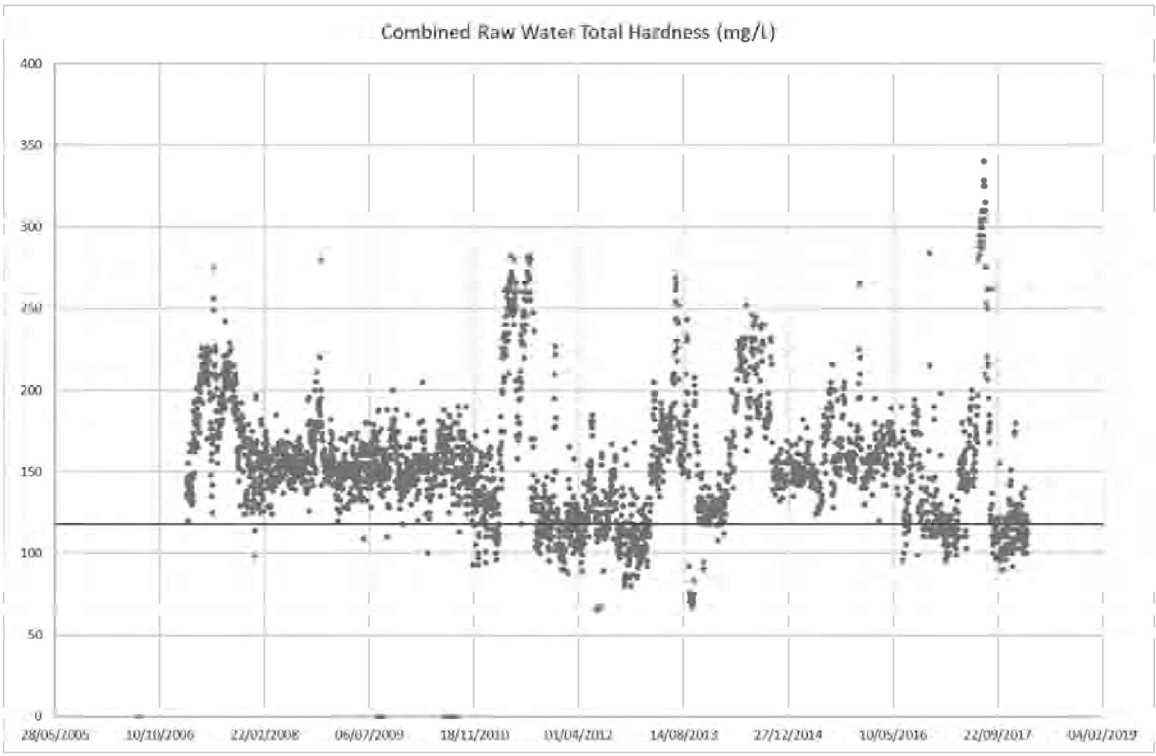


Figure 1: ***Total Hardness of the Combined River and Bore Water***

However, further analysis of the raw water shows that for a significant portion of time, the river water can be below the 120 mg/L hardness target. During these months, the operators at John Gilbert WTP still operated a softening process under the belief that this was the only way to provide effective clarification.

In 2017, Hunter H_2O was engaged by Dubbo Regional Council to provide operational assistance, particularly regarding the clarification process and softening requirements. Jar testing and full-scale trials were performed to examine the effects of coagulation with and without the addition of lime and soda ash.

2.0 DISCUSSION

Operators at John Gilbert WTP spend a significant portion of their work day fine tuning the softening process and operating and maintaining the lime dosing infrastructure. As well as the operational challenges, operating a softening process is significantly more expensive than conventional coagulation processes. However, after operating the plant in softening mode for decades, the operators required hard evidence that an alternative process could still provide effective results.

2.1 Optimising Softening

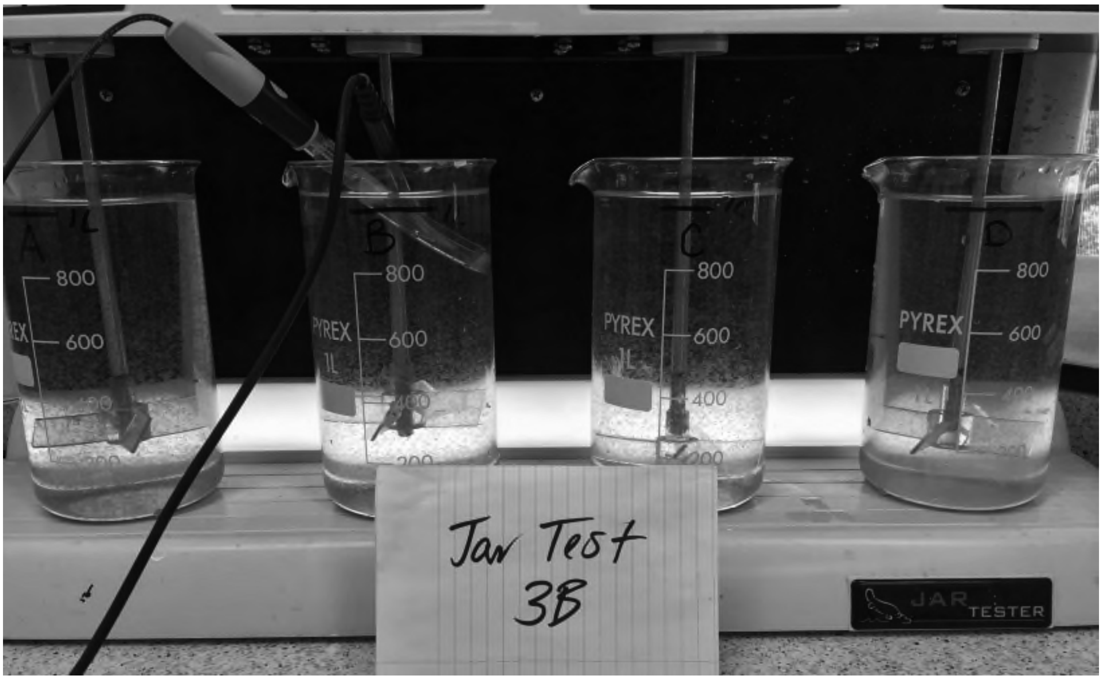
A jar testing programme was developed to investigate the softening and coagulation processes at the plant. At the time of the Hunter H_2O site visit, the raw water hardness was very low. Jar testing was conducted to determine whether the existing lime/soda softening regime was required or whether it was possible to further optimise chemical dose rates. The first jar test simulated the plant's existing operational strategy with the ferric chloride and polymer doses kept at 35 and 0.05 mg/L respectively and the coagulation pH maintained at 10.4. Soda ash doses of 90, 60, 30 and 0 mg/L were applied, and a lime dose of 165 mg/L was applied initially and increased as required in subsequent jars to maintain the target pH.

The jar test resulted in filtered water turbidity and colour being acceptable in all jars. As would be expected, total filtered water hardness decreased with increased soda ash dose rates however all jars were below 108 mg/L. These results showed that it was reasonable to assume that when non-carbonate hardness in the raw water is low, soda ash is not required.

2.2 Operating without Softening

After observing that total hardness in the river source was low at the time of the visit, it was decided to test whether conventional treatment would be effective in the absence of softening. Two jar tests were performed, one to optimise ferric dose rate and the second to optimise polymer dose rate.

Eight ferric dose rates were tested from 8.4 – 46.2 mg/L. A ferric dose rate of 38 mg/L was found to be optimal in terms of settled and filtered water quality. Similarly, seven polymer dose rates were tested, from 0 – 0.3 mg/L. Settled and filtered water quality were found to improve up to a dose rate of 0.15 mg/L; however, did not change significantly thereafter.



<u>Figure 2:</u> ***Jar Testing completed onsite at John Gilbert WTP***

A full-scale trial operating the plant without softening was conducted on Thursday, 19 October 2017. The plant's ferric and polymer dose rates were set to slightly higher doses in line with the results of the jar testing, the number of bores operating were reduced, and the bore water bypass was stopped. Chlorine was dosed prior to filtration as a precaution so that manganese levels were managed. The plant was operated on and off, as required, over 24 hours. The plant responded well with a stable sludge blanket and excellent water quality achieved throughout the trial.

As a result of this trial, Hunter H_2O developed operational targets around when and what level of softening is required with the aim being to significantly reduce chemical usage over the long-term. The full-scale trial showed that the softening process could be turned off and turned back on again quickly and easily with very little disruption to the plant. However, there were concerns over how a rapid increase in river water hardness would be responded to; particularly if it were to occur on a weekend. Different ways of predicting an increase in hardness at the plant were investigated and, ultimately, Dubbo Regional Council decided that online hardness monitoring of the raw water would be the most reliable.

2.3 Potential Cost Savings

Over the last two years, the raw water hardness has been much better than the historical average. An assessment of the frequency with which softening would be required based on a treated water hardness target of 120 mg/L was undertaken. Assessing the combined river/bore water blend, it was found that softening was required 68% of the time to meet a hardness target of 120 mg/L as $CaCO_3$. However, if the raw water sources were managed so that the high hardness bores were turned off when river water hardness was low, then softening would only be required on the river raw water approximately 47% of the time.

Whilst this paper only looks at lime-soda softening vs no softening for varying percentages of the year, others at Hunter H_2O have performed modelling which identifies the percentage of time when lime only softening is required (i.e. not dosing soda ash) which would provide additional chemical cost savings. The modelling has not been included in this paper.

For simplicity, two alternate treatment scenarios have been examined from a cost perspective. Chemical doses rates used over the past two years have been averaged to calculate the typical chemical cost of the softening process. These chemical dose rates have been adjusted in line with the jar test and full-scale trial results to estimate the average chemical dose rates under a conventional (no softening) scenario. The ferric dose rate was increased by 4 mg/L and the CO_2 dose rate was reduced by 76%.

<u>Table 1:</u> ***Estimated Average Chemical Dose Rates***

Chemical	**Softening Treatment**		**Conventional Treatment**	
	Clarifier 1	**Clarifier 2**	**Clarifier 1**	**Clarifier 2**
Soda Ash (mg/L)	68	62	0	0
Quicklime (mg/L)	155	121	0	0
Carbon Dioxide (mg/L)	8.5	8.5	2.0	2.0
Ferric Chloride* (mg/L)	40.8	43.5	44.8	47.5
Polymer (mg/L)	0.08	0.08	0.08	0.08

Combining these estimated chemical dose rates shown in Table 1 with the actual raw water quality from the last two years, theoretical annual chemical costs were able to be calculated.

Alternate Scenario 1: Assumes that river and bore water are used in their typical blend ratios. Softening treatment is applied for the 248 days per year when the combined raw water hardness is greater than 120 mg/L as $CaCO_3$. Conventional treatment is applied for the other 117 days per year.

Alternate Scenario 2: Assumes that river and bore water are used in their typical blend ratios only when combined raw water hardness is <120 mg/L as $CaCO_3$ (conventional treatment) OR when river water hardness is >120 mg/L (softening treatment). When river water hardness is <120 mg/L but combined water hardness is >120 mg/L, the raw water sources are managed such that the raw water being treated is maintained below 120 mg/L either by changing to lower hardness bores or switching off bores altogether. While ever raw water hardness is maintained below 120 mg/L it is assumed that softening is not required. Under this scenario, softening treatment is applied for the 172 days per year and conventional treatment is applied for the other 193 days per year.

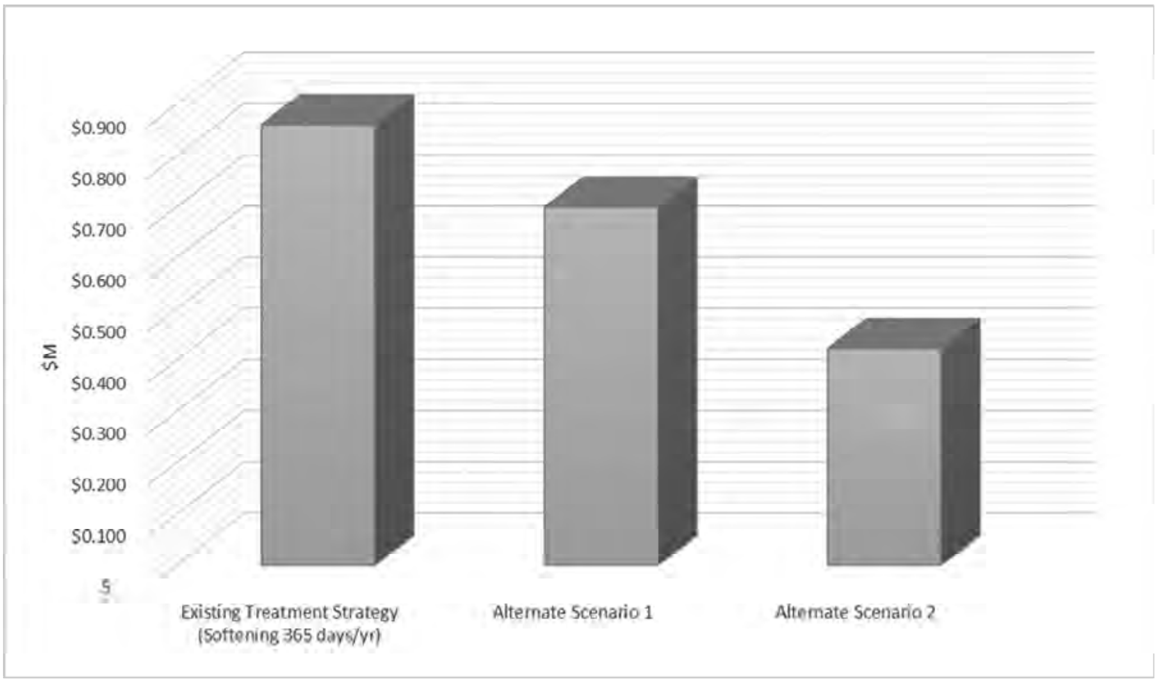


Figure 3: ***Annual Chemical Cost Estimates***

Whilst some years will require more softening than others, the results in Figure 3 show that significant chemical cost savings would have been achieved in the last two years by adopting either of the two identified alternate treatment scenarios.

3.0 CONCLUSION

Operating the lime-soda softening process is a necessary evil for the operators at John Gilbert WTP. However, by monitoring, assessing and managing the raw water sources it is possible to reduce the complications associated with lime and soda ash dosing by operating the plant in conventional mode for a significant portion of the year.

By adopting an alternate, more flexible, treatment philosophy at the plant significant chemical cost savings can be achieved. A cost saving of up to $160K per annum could be expected without the need for managing raw water sources any differently to what has historically been done. Cost savings of up to $437K per annum could be achieved if raw water sources were selectively managed to maintain raw water hardness below 120 mg/L.

Hunter H_2O is working closely with Dubbo Regional Council to implement these changes and identify other areas where the process can be optimised.

4.0 ACKNOWLEDGEMENTS

Thank you to the operators at John Gilbert WTP for supporting me during my onsite research.

Special thanks to Stephen Carter of Dubbo Regional Council for engaging me in this project and for his assistance with preparing this paper.

Also thank you to my colleagues, Yaode Yan, Peter Greenhalgh and Craig Jakubowski for the groundwork investigations and reviewing the findings.

QUIPOLLY DAM UPGRADE
INNOVATION – PART OF A BIGGER PICTURE

Paper Presented by:

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12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

QUIPOLLY DAM UPGRADE INNOVATION – PART OF A BIGGER PICTURE

Rod Batterham, *Water Services Manager,* Liverpool Plains Shire Council

ABSTRACT

Liverpool Plains Shire Council's (LPSC) utilisation of the Hydroplus Fusegates© system in the safety upgrade at Quipolly Dam has enabled significant cost savings on traditional constructed solutions, whilst at the same time, facilitated an increase in storage capacity of more than 55%.

The increased storage is now forming part of a bigger water security strategy for LPSC's towns of Quirindi, Werris Creek and Willow Tree. But, the next phase of the project faces a lot of challenges due to variable raw water quality.

1.0 INTRODUCTION

Built in 1955, Quipolly Dam is an on-stream drinking water dam situated roughly midway between the towns of Quirindi and Werris Creek in Northwest NSW. It has a zoned earth fill embankment that is approximately 21m high and 200m long, and prior to upgrade stored 5.2GL.

Faced with a daunting upgrade of the newly acquired dam through Local Government amalgamations in 2004, and starting basically from scratch, Liverpool Plains Shire Council had to put its nose to the grindstone to come up with some solutions, fast. Those solutions not only had to be cost effective, but also had to serve as the launch pad for the bigger picture of addressing water security problems in some of its larger water supplies.

Early in the process of operating the newly acquired water supply assets, and with pressure to show any progress towards addressing the dam's safety issues, there was the added complexity of having little information available to help develop upgrade strategies. Information relating to the age of assets, performance history, and known operational inadequacies were locked away in the mind of retiring operators, or in formats that didn't lend themselves to easy data extraction such as paper graphs squirrelled away in boxes of previous staff work files.

As there was no real direction available up to that stage, Council decided to approach the problem with what was effectively the situation anyway, a clean slate. This problem turned out to be our advantage, as any previous strategies that might have only focused on the singular use of the dam for its current purpose of supplying only the town of Werris Creek was now seen in a new light. With the opportunity that the newly amalgamated Council needed to see its assets as better utilised when integrated into the new Council entity's operations, Quipolly Dam was viewed now as an asset, and not necessarily a liability.

Now that the dam can store more water, the final phase of LPSC's water security strategy is to utilise this water source in conjunction with groundwater supplies in a regionalisation of its water supply systems. With funding now realised for this project, the challenges of dealing with a widely variable water source is the next focus.

2.0 DISCUSSION

Following notification by the NSW Dam Safety Committee of a High C consequence categorisation for Quipolly Dam, Council undertook a risk assessment to identify what the deficiencies were, and to develop concept solutions to address those risks.

With Council also wanting to value add the work that would be undertaken by contractors during the construction of a safety upgrade, the design brief was also added to increase storage by raising the impoundment height by 2m, which would yield approximately 55% more water at Top Water Level, also increasing the dam's capacity up to 8GL.

2.1 Risk Assessment Outcomes

Reports that were available from the previous dam owner indicated that the hydraulic capacity of the spillway was inadequate in being able to pass most design floods, without resulting in overtopping of the existing crest. Additionally, some geotechnical work had also identified that whilst the dam's core material was very stable and well compacted clay, the upper layers of the grassed crest itself was susceptible to desiccation cracking which could lead to a piping style of erosion failure. The dam had also been constructed prior to the practice of installing sand filters which left the top portion of the crest without a mitigation for a pipe erosion event.

A panel of consulting dam engineers, along with Council, undertook desktop risk analysis utilising recently reviewed investigations undertaken previously. The outcomes of the risk assessment identified five main failure mechanisms.

Table 1: ***Quipolly Dam Failure Modes – Percentage Contributions to failure.***

Failure Mode	Contribution
Flood Overtopping	63%
Piping adjacent to the spillway	22%
Piping in the upper crest	11%
Erosion in the spillway	2%
Other piping locations	2%

2.2 Design Options

Now that the magnitude and mechanism of risk information was available, the required features to address the failure modes were able to be identified and applied to the design.

The final design brief included the following components to address the identified risks;

- Raise the Crest Wall by 4.18m to prevent crest overtopping during flood
- 4.5m deep embedment of a concrete wall into the earth bank to prevent pipe erosion in the top layers
- Install a deepened section of the embedded concrete wall and subsoil drainage to control water infiltration adjacent to the spillway
- Extension of Spillway Training Walls to prevent embankment erosion at the base of the wall

With the inclusion of increased storage options being considered from the start as part of the safety design, the decision to utilise the Hydroplus Fusegates© (or Tipping Buckets) system to increase the storage height was also factored into the required safety designs.

2.3 Utilisation of Tipping Buckets

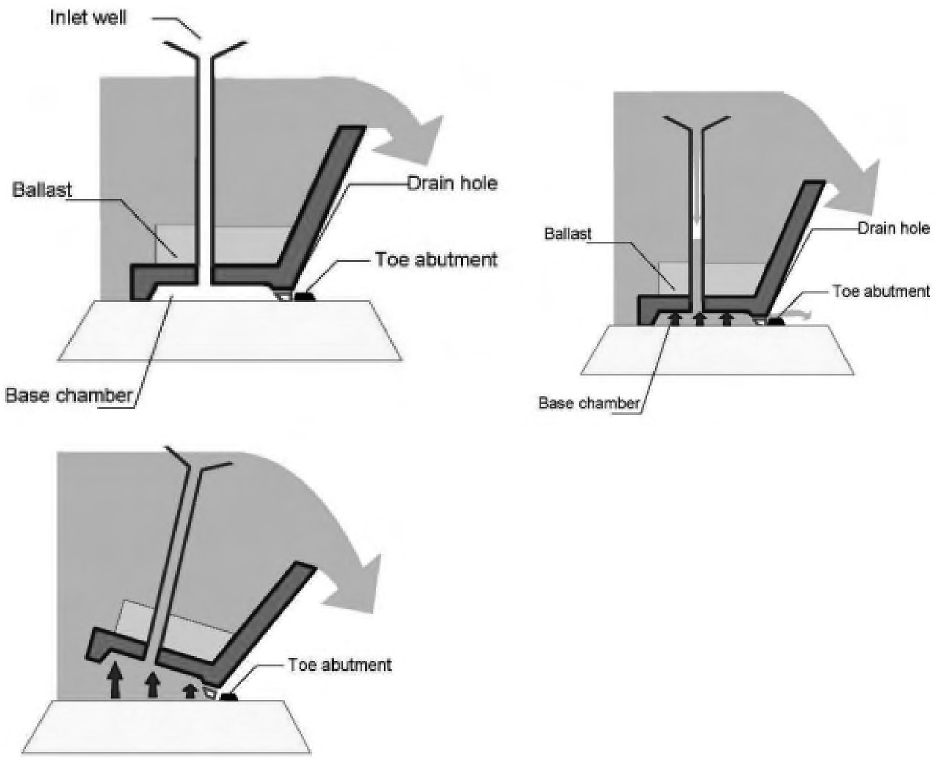
The use of tipping buckets not only increased storage capacity at Quipolly Dam, but improved the spillway capacity owing to the labyrinth style configuration. Improved flood routing in the spillway facilitated a lower required crest raising to detain rising flood waters, which in turn prevented the need for extensive earth buttressing to provide stability to a higher wall. This prevention of required stabilising fill was costed to have saved Council in the order of $10M. With the entire project costing just under $6.5M, the significance of this avoided cost can easily be realised. The cost of the increased storage component in the upgrade works was $1.2M which was fully funded by Council outside of the subsidised safety works.

Tipping buckets, work by allowing floodwater to enter a chamber at the base of the unit during flood. At predetermined levels of head above the unit the water inside the chamber produces an uplift force that initially "pops" the unit from its foundation base. With the fast, forward moving water during a flood, the unit is then transported down the spillway opening a section of the waterway area. At Quipolly Dam there are 4 sets of paired tipping buckets, totalling 8 units in all.

Units for Quipolly Dam were manufactured with millimetre accurate dimensions from reinforced concrete in Brisbane and transported to site. Each unit weighs approximately 23 Tonnes and is ballasted with between 6 to 9 Tonnes of additional concrete to differentiate the tipping sequences for each pair of units. The "snorkel" is manufactured with stainless steel to provide a long lasting component for little maintenance.

Figure 1: ***Installation of Fusegates within the original spillway width.***

An EPDM rubber seal spans the 30mm gap between the units whilst in place, allowing the units to pass each other easily if a tip occurs, but maintaining a sealed surface during impoundment duties.



<u>Figure 2:</u> ***Method of Tipping.***

A 1:20 scale model of Quipolly Dam's spillway was constructed for testing the tipping sequences, with pressure sensors used under the model units to check uplift settings. During testing it was identified that the entry of water into the spillway was not even because water that entered from the side caused various speeds across the width of the spillway which in turn caused variations in water height. This had the potential to cause problems for the tipping buckets as they might tip early, or late, if the height of water was artificially influencing the tipping sequence. To remedy this the upgrade works also required an extension of an upstream training wall to prevent flood water entering from the side of the spillway evening flow into it.

At the time that Council had decided to utilise the Fusegates©, only major water managers such as Snowy Water for their Jindabyne Dam, had used this French designed system in Australia. Liverpool Plains Shire Council was the first Local Government water authority to use the system.

3.0 CONCLUSION

Whilst not every dam owner can utilise tipping buckets for their dam upgrade, the application at Quipolly Dam has been a resounding success. Significant avoided costs, low maintenance units that increase water storage capacity for utilisation as part of a water security strategy has achieved the required outcome. It also showed a great belief in Council's use of innovative methods to be able to apply this type of treatment to a once in a lifetime project such as this upgrade was.

4.0 ACKNOWLEDGEMENTS

I would like to acknowledge the advice and assistance that was provided during the early stages of the upgrade design process for Quipolly Dam.

Both Paul Heindrichs and Norm Himsley spent time to provide the type of assistance required by a small Council on such a large project. Special mention should also go to Peter Ballantine from GHD who made the design work.

5.0 REFERENCES

Some sample references for books and websites and the layout is provided below.

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CO-EXISTING WITH TELECOMMUNICATION CARRIERS

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CO-EXISTING WITH TELECOMMUNICATION CARRIERS

Jason Ip, Riverina Water County Council / NSW Water Directorate

ABSTRACT

This paper is based on guidelines developed by NSW Water Directorate that help to:

1) Explain the Commonwealth's telecommunication legislative framework that Telecommunication Carriers (Telcos) are required to operate under, and

2) Promote how Local Water Utilities (LWUs) can use the same legislative framework to protect their assets and operations, and to meet their State's legislative requirements (e.g. NSW Public Health Act, NSW Work Health Safety Act, etc) to provide safe drinking water.

There are documented horror stories when the balance between the burden of Telco infrastructure on water assets and the LWU's need to manage its water supply integrity favour the Telcos.

Perhaps our water industry has unknowingly made things too easy for Telcos by simply (albeit sometimes grudgingly) allowing them to dictate how they install and operate their communication equipment on water assets. Or perhaps our State legislation associated with planning approvals, public health, water quality and workers' safety has become incompatible with current telecommunication legislation.

Whatever the case may be, there is now a stronger need for LWUs to understand and exercise their legislative rights to meet water supply and governance requirements, reduce their business costs imposed by Telcos facilities, and to highlight any legislative deficiencies so things can be fixed. This need is further compounded by TPG Telecom's announcement (April 2017) to become Australia's fourth Carrier operator, and the Australian Government releasing its strategy (October 17), to support the timely rollout of 5G in Australia including *"…streamlining arrangements to allow mobile carriers to deploy infrastructure more quickly..."*[1].

It's hoped that the information contained in the NSW Water Directorate's "*Third Party Infrastructure on Water Supply Reservoirs Guidelines, Parts 1 & 2*" will empower and motivate LWUs to protect our obligations to water quality, workforce safety, minimising capital and operational costs, as well as establishing a better a balance between LWU's and telecommunication needs.

1.0 INTRODUCTION

In June-July 2017, the Australian Government (through the Department of Communication and the Arts) sought submission responses on the '*Possible amendments to the telecommunications carrier powers and immunities*' legislation. Many stakeholders (such as water industry associations, water utilities, local governments, and various State government agencies) were unaware of this consultation process as they had not been directly notified of the proposed amendments by the Australia Government, though some still managed to submit their concerns at the last minute.

Submissions lodged can be viewed at: https://www.communications.gov.au/have-your-say/consultation-possible-amendments-telecommunications-carrier-powers-and-immunities

At the similar time, the Qld and NSW Water Directorates recognised the risks of telecommunication facilities on water supply reservoirs to water quality, worker's safety, water supply operations and asset management and were developing the following guidelines:

1. Third Party Infrastructure on Water Supply Reservoirs Guidelines – Volume 1 Engineering Aspects (September 2017 – available)
2. Third Party Infrastructure on Water Supply Reservoirs Guidelines – Volume 2 Legislative Framework (to be released)

What was apparent after following up consultation meetings with Department of Communication and the Arts regarding their proposed legislative amendments, was that there was little available data highlighting the impacts of telecommunication facilities on reservoirs that have been referred to the Telecommunications Industry Ombudsman (TIO) for action. This is despite various organisations, LWUs and water authorities who have/are experiencing issues jeopardising their operations, worker's safety and public health.

Unfortunately, one cannot say the "system is broken" to manage Telco's communication facilities on reservoirs unless there's legitimate attempts to use the system. The NSW Water Directorate's *Third Party Infrastructure on Water Supply Reservoirs Guidelines (Parts 1&2)* attempt to educate and promote the various legislative instruments ("the system") that are currently available for LWUs to use, and to bring balance back for a mutually sustainable arrangement between LWUs infrastructure and Telcos.

2.0 LEGISLATIVE FRAMEWORK

The current Commonwealth telecommunication legislation was introduced when Telstra was privatised in the late 1990s, and when the various state legislation for public health, water quality, workers safety was (perhaps) not as developed as it is now.

The *Telecommunication Act 1997 Cth* (Telco Act) provides substantial powers and immunities for Telcos to access, install and operate communication facilities on private property, especially if the facility is categorised as Low Impact under the *Telecommunications (Low-impact Facilities) Determination 1997* (i.e. the *Determination*). There are other supporting legislative instruments that Telco's must adhere to, such as *Telecommunications Code of Practice 1997* (i.e. the Code), *Telecommunications Regulations 2001*, and various Telco Industry Standards and Industry Codes registered with Australian Communication and Media Authority (ACMA). These are also explained in NSW WD's guidelines.

If the facility cannot be categorised as Low Impact under the *Determination*, the Telco must obtain development consent through State planning processes (which includes Local Government planning approvals). This gives LWUs opportunity to stipulate consent conditions to ensure the Telco's facility is compatible with LWU's essential operations and governance requirements.

Consent conditions should address the needs/requirements of the LWU:

1. Site access
2. Installation and maintenance activities
3. Water quality contamination
4. Work health and safety
5. Lease/licence agreements

However, if the facility is categorised as Low Impact under the *Determination*, then there's no need for the Telco to obtain development consent through State or local government planning processes. This is the area of greatest concern for LWUs, as many of their reservoirs, towers, tanks are considered candidates to host Low Impact communication facilities.

__Figure 1:__ ***Example of a Low Impact Facility posing risks to water supply operations and public health***

This paper highlights various potential grounds to raise objections initiated from Telcos' Land Activity Notices (LANs) with respect to installing or maintaining communications facilities under the *Determination*. Submitting objections is the mechanism to begin meaningful discussion / negotiations with Telcos.

3.0 WHAT ARE LOW IMPACT FACILITIES?

Low impact Facilities are facilities which are considered to have a low visual impact because of their size and location. At the time the Telco Act was drafted, they were less likely to raise significant planning, heritage, or environmental concerns.

The NSW Water Directorate guidelines - "*Third Party Infrastructure on Water Supply Reservoirs Guidelines, Part 2"* help to explain what is or not a Low Impact facility under the *Determination*. In particular, "public utility structure" is specifically mentioned in Part 7 of the Schedule of *the Determination* with only limited conditions relating to noise and percentage volume of space being utilised. In other words, water supply reservoirs may be considered as a Low Impact facility more often than not.

There are stringent procedural requirements for:

1) Telcos to access and install communication equipment on Low Impact facilities sites in the legislation,
2) Strict timeframes for Land owners to object and negotiate with Telco and refer matters to the Telecommunication Industry Ombudsman (TIO). The process often begins with the Telco issuing a Land Access and Activity Notice (LAAN).

It's very important for LWUs to immediately review a Telco's proposal to establish a Low Impact facility under the *Determination*, and to be prepared to lodge an objection on legitimate grounds and within certain timeframes. The onus is on the LWU to identify noncompliance and lodge an objection, and failure to do this is interpreted as accepting the Telco's proposal on prima facie. This enabling the Telco to carry out activities stipulated in the LAAN. This is explained further below.

4.0 LAND ACCESS AND ACTIVITY NOTICE AND OBJECTION PROCESSES FOR LOW IMPACT FACILITIES

Schedule 3 of the *Telecommunications Act 1997* (the *Telco Act*) and the *Telecommunications Code of Practice 1997* (the *Telco Code*) set out a process (the "Land Access Process") that allows the Telco to install Low-Impact Facilities without the consent of the Land owner and without obtaining State, Territory or local government approvals.

The objection process may not be successful in stopping the Telco's proposed activity but is an effective mechanism to have constructive dialogue with the Telco to attempt to address issues and concerns of both parties to sustainably co-exist. It also provides the mechanism for the Telco to make reasonable efforts to enter into an agreement with LWUs if a Telco's activities are likely to affect the operations of a public utility.

The *Telco Code* (Clause 4.24) outlines the Land Access and Activity and Objection process for new facilities, and similar processes are outlined for Inspection of Land (clause 2.31) and Maintenance of Facilities (clause 6.23) with different timeframes.

The process for new installations[2] is outlined below:

1. Typically, Telcos will issue a LAAN at least 10 business days before commencing works. To raise/discuss any concerns/issues with the Telco, the Land Owner is expected to lodge an objection at least 5 business days before commencing works.

2. Both Land owner and Telco have 20 business days (i.e. Consultation period) commencing when the Telco receives the Objection to resolve the Objection. During this period, the Telco must make "reasonable efforts" to resolve the Objection commencing within the first 5 business days of the Consultation period.

3. If the Land Owner and Telco cannot resolve the Land Owner's objection by agreement by the end of the Consultation Period, the Telco must issue a "End of Consultation Notice" within 5 business days from the end of the Consultation Period to the Land Owner indicating whether the Telco is making any changes to the original LAAN to address the Land Owner's objection.

4. If the Land Owner is not satisfied with End of Consultation Notice, the Land Owner can write to the Telco and ask the Telco for refer the matter to the Telecommunications Industry Ombudsman (TIO) within 5 business days after receiving the End of Consultation Notice. If this step is not carried out, the Telco will be able to carry out the activity stipulated in the LAAN.

   Referral to the TIO

5. If the Telco wishes to proceed with their activity after receiving the TIO referral request from the Land Owner, they are required to prepare a referral brief and send it to the TIO as soon as practical. Unfortunately, the *Code* does not specify a timeframe for the Telco to refer the Objection to the TIO, however, if the Telco wishes to proceed with the proposed activities despite the Objection, the referral should occur promptly and preferably within 20 business days from when the Telco received the Land owner's request to refer[2].

If the objection complies with the relevant clauses of the Telco Code, a Telco is only able to engage in the land entry activity in the following situations.

- The objection is resolved by an agreement between the Telco and Objector.
- A request to refer the objection to the TIO is not received by the Telco within 9 business days for the inspection of land, or 5 business days for the installation or maintenance of a Low Impact Facility provided in the Telco Code. Accordingly, time periods are critical.
- The TIO deals with the objection without giving any direction to the Telco and informs the Telco in writing of that outcome.
- The TIO gives a direction to the Telco.

The TIO will review the information provided in the Telco's referral brief and will invite both parties to provide any other information/documents that may be relevant.

It may be appropriate for the Land owner to seek professional legal assistance to collate and respond to any TIO request for information. There are no provisions in the Land Access Process that allow the Carrier or Land owner to appeal decisions made by the TIO by a Court except in limited circumstances. Again, legal advice should be sought if this is being considered.

5.0 VALID GROUNDS FOR AN OBJECTION

Fortunately, Telcos must comply with many conditions that are contained within Division 5 of Schedule 3 to the *Telco Act*, and the *Telco Code*. LWUs can utilise the objection process as a powerful mechanism to negotiate with Telcos, rather than accepting a notification of their planned installation or maintenance of facilities under the *Telco Act*.

NSW Water Directorate's guideline (Part 2)[4] summarises the legislative requirements that Telcos must comply with. These include:

- Telcos to adopt best practice, often with reference to the various industry codes registered by Australian Communication and Media Authority (ACMA) - Clauses 2.11(1), 4.11(1) and 6.11(1) of the *Telco Code*
- Telcos to abide by laws governing noise applicable under State laws - Clauses 2.12, 4.12 and 6.12 of the *Telco Code*

- Telcos must take all reasonable steps to ensure that they cause as little detriment, inconvenience, and as little damage as practicable - Clause 8 of Schedule 3 to the *Telco Act*
- Telcos must take all reasonable steps to ensure that the land is restored to a condition that is similar to that which existed before the activity began - Clause 9 of Schedule 3 to the *Telco Act*
- Telcos must take all reasonable steps (under Clause 10 of Schedule 3 to the Telco Act) to:
    - Act in accordance with good engineering practice.
    - To protect the safety of persons and property.
    - Ensure that the activity interferes as little as practicable with:
        - the operations of a public utility;
        - public roads and paths;
        - the movement of traffic; and
        - the use of land.
    - Protect the environment.
- Telcos must make reasonable efforts to enter into an agreement with a public utility, where it is to engage in an activity that is likely to affect that public utility's operations. The agreement must provide the way the Carrier will engage in the: inspection or land; or installation of; or maintenance of a facility - Clause 11(1) of Schedule 3 to the *Telco Act* and clause 2.6, clause 4.6 and clause 6.6 of the *Telco Code*
- Telcos must give notice to owner of land before engaging in any activities involved with entering land - Clause 17 of Schedule 3 to the Telco. Warning…this clause as many exceptions
- Telcos to give notice to owner of land for any tree lopping - Clause 18 of Schedule 3 to the *Telco Act*
- Telcos must give 10 days' written notice to road authorities and utility authorities before engaging in any of the following activities (Clause 19(1) of Schedule 3 to the Telco Act. Warning…Telcos can often use the exception to maintain adequate levels of service):
    - Closing, diverting or narrowing a bridge.
    - Installing a facility on, over or under a bridge.
    - Altering the position of a water, sewerage, or gas main or pipe.
    - Altering the position of an electricity cable or wire.
- Telcos must ensure that there is reasonable passage for persons, vehicles and vessels when installing facilities over a road, bridge, path, or navigable water. The Telco must install the facility is such a way that satisfies 'reasonable passage' - Clause 20 of Schedule 3 to the Telco Act

6.0 CONCLUSION:

It's believed that poor corporate posturing by Telcos (perhaps more so by their contractors and sub-contractors) have enabled them to "work the system" to their advantage to minimise their costs to establish Low Impact facilities on reservoirs. This has caused great concern and expense to LWUs.

As highlighted above, there are substantial grounds for LWUs to hold Telco's (and their agents) to account. Objections raised by LWUs from a Telco's LAAN are essential to begin dialogue with the Telco about their installation, and to establish a more sustainable approach to both parties' legislative requirements.

It's hoped that if the industry is more educated and motivated to exercise their rights under the same telecommunication legislation, the risk to LWU's operations, staff, water quality and public health can be better managed.

NSW Water Directorate is interested to receive information from LWUs so the newly formed working committee comprising of NSW Water Directorate, Qld Water Directorate and WSAA can collate information and highlight any legislative deficiencies to the Department of Communication and the Arts.

7.0 CITED REFERENCES

Department of Communication & Arts (Media Release 12 October 2017: https://www.communications.gov.au/departmental-news/5g-enabling-future-economy

Telecommunications Industry Ombudsman – Guidelines on the Installation and Maintenance of Low-Impact Facilities (10 April 2015): https://www.tio.com.au/publications/guidelines

Third Party Infrastructure on Water Supply Reservoirs Guidelines – Volume 1 (June 2017), NSW & Qld Water Directorate, Aqualift and Murray Thompson Water Services Pty Ltd: Obtained via NSW Water Directorate

Third Party Infrastructure on Water Supply Reservoirs Guidelines – Volume 2 (to be released), NSW Water Directorate: Obtained via NSW Water Directorate

8.0 OTHER USEFUL REFERENCES

Telecommunications Act 1997 (Volume 1 and 2):
https://www.legislation.gov.au/Details/C2017C00357

Telecommunications Code of Practice 1997:
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FILTER 'FOLLIES' – HOW AND WHERE TO FIND THEM

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12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

FILTER 'FOLLIES' – HOW AND WHERE TO FIND THEM

Adrian Cameron – *Water Engineer*, Tamworth Regional Council

ABSTRACT

July 2016 was an exciting time for the Tamworth Region. The recently 'enlarged' Chaffey Dam was filling up fast. No sooner had the construction contractors finished then the rains came – eventually filling the dam. With a capacity increase from 60GL to a 'full' 100GL – this provided the Tamworth Region with greater water supply security. However, the water treatment operations staffs were struggling during this period treating the 'changed' Peel River Raw Water supply.

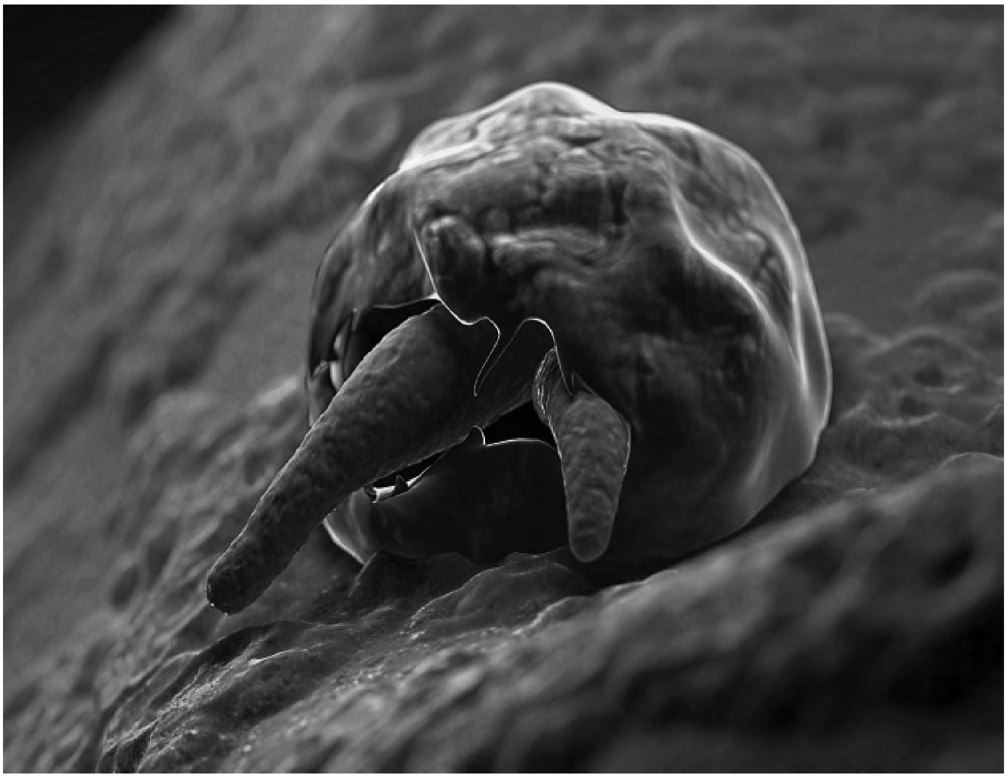
For example, water supplied from Chaffey Dam is quite high in pH and alkalinity and now with a bigger dam to fill it was not contributing to flood flows downstream. This changed the water chemical characteristics leading to a lighter floc formation and consequently the Clarifiers were not able to 'settle' this fine floc as well. This was leading to settled water turbidity more than 3 NTU when usually it would be less than 1.8 NTU. The filters were removing the extra floc but were experiencing turbidity breakthrough on drain down for backwash. The operators either had to drain the filters to waste or manually drain filters very slowly leading to many 'after hours' work by the employees.

During this period there were major concerns that filtered water turbidity levels would breach the Critical Control Point limit. However, research indicated that media filters should be able to treat settled water with turbidity greater than 3 NTU. There was definitely a problem! What was wrong with the filters? What was the fix and who would know? How long since the filters had been refurbished?

1.0 INTRODUCTION

The Calala Water Treatment Plant (CWTP) was originally commissioned in 1980 with augmentation in 1992. It has a theoretical capacity of 80 megalitres per day. The CWTP currently supplies 40 000 people of Tamworth and Moonbi-Kootingal. The filters at the CWTP are part of a multiple-barrier treatment process designed to remove particles, including water-borne pathogens oocysts such as *Cryptosporidium* and *Giardia,* from potable water. *Cryptosporidium* and *Giardia* are present in raw water and can cause gastrointestinal illness in humans. As pathogenic oocysts are highly resistant to chlorine disinfection, their removal relies upon effective sedimentation and filtration processes. Contamination of *Cryptosporidium* within the water system can occur if turbidity breakthrough occurs. If it is significant enough where water can no longer be guaranteed to be safe from these organisms, it may require a boil water notice to be issued for all affected customers. This would be a disaster for public relations and community health risks (not just from waterborne illness but also potentially scalding incidents). The filters need to be operating well or there is the chance pathogens could infiltrate the Tamworth community.

The current staff at the treatment plant had not been involved in filter refurbishments and as the filters had always performed well there was an element of 'out of sight, out of mind' with them. Outside assistance was required.



<u>Figure 1:</u> ***What we need to remove - Cryptosporidium (nasty little buggers)***

2.0 CONSULTATION WITH EXPERTS

Initial consultation about the filters at the CWTP was with Hunter H2O and the filter investigations methods were taken from the 'bible' of filter repair the WIOA journal *Practical Guide to the operation and Optimisation of Media Filters.*

Recommended actions from these sources to ascertain the condition of filters included checks on:

- Filter bed appearance

This is visual observation of the bed for uniformity and media depth. When in service, filters may lose media which reduces their ability to produce clean water and hold particles. Uneven and lumpy beds are signs of problems with mudballs.

- Air scour pattern

This should be established evenly and gently across the entire filter. Violent eruptions or disjointed appearance is cause for concern as this indicates blocked or missing nozzles.

- Underdrain pressure

This is important as high underdrain pressures in a plenum type arrangement can rupture the floor and lead to total failure of the filter. High pressure in the underdrain is generally due to sand that has migrated to the underdrain blocking the nozzles and laterals.

- Underdrain leaks

These are the result of excessive underdrain pressure. Leaks in the underdrain indicate the plenum floor is starting to lift. This will relieve excessive pressures to some extent but also indicates the structural integrity of the Plenum underfloor is failing.

- Dirty water treatment

A filter's ability to maintain good water quality is tested vigorously when the treatment plant is dealing with 'dirty' water. Filter problems during this time can become especially evident.

- Looking for turbidity breakthrough on backwash drain down evident as dirty water in the baths

When filter breakthrough occurs, the process can no longer be guaranteed to form an effective barrier to pathogens such as Cryptosporidium and may compromise the effectiveness of chlorine disinfection.

2.1 Filter Investigation

Consultations recommended the best way to observe a filter is to complete a manual backwash and take notes. As part of the investigation process, pressure gauges linked to SCADA were also installed into the backwash and air scour line respectively to monitor underdrain pressures.

Results of the filter investigations at the CWTP

- Some filters had a considerable quantity of mud-balls

A lot of these mud-balls were located at the inlet end of the filters and this zone of the bed typically appeared to be less agitated during backwashing than the remainder of the bed. This indicated blockages of laterals/nozzles in this area. Air and backwash velocities in the remainder of the bed may be excessive, which can result in media intermixing and migration of sand to nozzle depths.

- Floating filter nozzles in cells

When nozzles are missing from the plenum floor filter bed, sand will migrate into the underdrains of the filter. This leads to additional nozzles in those cells also being blocked and then the underdrains being over-pressurised. As these issues continue to worsen, the risk of significant over-pressure increases. This could eventually lead to a failure of the underdrain system. This will lead to complete failure of the filter.

- Significant quantities of sand were observed in some of the filtered water chambers

This indicates that there has been migration of sand from the filters into the underdrains.

- In some filters air can be observed to bubble up along the concrete edge at the washout channel during the backwash

This is a sign that excessive pressures have resulted in lifting of this section of the floor and complete failure of the underdrain may be imminent. Photos were taken during checks for future reference with filter 2 air scour pictured in figure 2 below

Figure 2: ***Air scour pattern-Filter 2 leaks evident along the drain and 1/3 media not agitated.***

2.2 Filter Observations

There were obviously some big issues with the filters at Calala! There needed be some way to prioritise refurbishment. Several key parameters were used, and each given a ‘score’ to help develop a prioritisation.

Table 1: ***Filter ratings of performance issues***

	Filter bed appearance	Air scour pattern	Under drain pressure	Under drain leaks	Dirty water treatment	Total score
Filter 2	10	8	6	10	10	44
Filter 11	8	6	10	0	9	33
Filter 12	7	4	9	2	9	31
Filter 8	5	4	6	7	8	30
Filter 7	4	4	9	2	8	27
Filter 10	5	4	6	7	2	24
Filter 5	5	6	5	5	1	22
Filter 6	5	3	6	3	4	21
Filter 3	4	4	4	5	3	20
Filter 4	4	4	4	0	3	15
Filter 9	0	0	6	0	9	15
Filter 1	2	2	4	0	2	12

Filter 2 was in a very bad condition and could no longer be guaranteed to form an effective barrier to pathogens such as Cryptosporidium. This filter was taken offline.

Filters 11, 12 and 7 had very high underdrain pressure and these high pressures indicated a large amount of sand had migrated to the underfloor. These filters needed remedial action urgently before the complete failure of the underdrain. All filters were showing at least some signs of performance problems.

2.3 Refurbishment

Consultation for the filter refurbishment was with the team from Water Treatment Australia. Research was completed into the Tamworth Council records with the previous media configurations for the filters at Calala and rosette information being obtained. This really demonstrated the importance of good record keeping as some employees who had been involved in filter refurbishment had moved on and others who were still at Council had forgotten some details as the filters had last been refurbished nearly 15 years before.

Number 2 filter was taken offline, and the media removed with a large vacuum truck. When this was completed it was noted the filter bed which was quite shallow to begin with had lost quite a significant amount of media. This would have been compromising the filters' ability to remove particles. The 1200 rosettes were removed with damaged threads repaired. This process is pictured below in figure 3.

Figure 3: ***Labour intensive rosette removal. Many nozzles were broken and threads damaged***

Due to wear, all the nozzles were replaced with Water Treatment Australia fabricating replacements. They had the existing mould specifications (being the original nozzle suppliers back in 1979 when the water plant was commissioned).

The underdrain cleaning presented a problem as the only access was a 350mm diameter inlet pipe. WHS laws are much tighter now than 15 years ago when the smallest guy was sent in the hole with a dustpan and a brush. Cleaning the laterals was achieved with an air and water blaster made up to poke through the rosette holes and blasting the sand into the plenum. That cleaned the laterals but now what about the plenum?

After various ideas were suggested including boring large holes in the top of the plenum to let an operator in – a vacuum excavator was used with some pool cleaning poles and a vacuum cleaner end cleaning from the outside through the 350mm pipe. Air leaks along the underdrain were also repaired at this time. The new media configuration was provided by Water Treatment Australia and the filter media was sourced from James Cummings. Water Treatment Australia provided initial advice on the new media install and to date another 3 filters have been refurbished with 8 more to go.

3.0 CONCLUSION

It is great to complete filter refurbishments in-house thus letting operators get a good idea of how things work. Such problem-solving skills give a sense of ownership to the stakeholders and all involved in the process. Also filters lose some of their apparent black magic.

Understanding what to look for will result in recognising that filters are underperforming. These signs will be quite evident! Due to the length of time that is often between filter refurbishments it is important to record the information for future use. For over 15 years there could be many staff changes with people moving on and even for those who are still on staff the finer details could be forgotten during that length of time.

Consultation will be required with people who work day-to-day with filters as they have up-to-date information and can advise on media configurations and repairs as required.

4.0 ACKNOWLEDGEMENTS

I would like to acknowledge the following: my employer Tamworth Regional Council for giving me the opportunity to operate in an Engineering role while I am completing my Engineering Degree; Craig Jakubowski from Hunter H20; the team from Water Treatment Australia; Calala Water Plant operators and the Council fitters led by Norm Priestly for helping provide solutions to many of the ‘problems’.

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MBR OPERATION AND OPTIMISATION AT CAMDEN HAVEN WWTP

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MBR OPERATION AND OPTIMISATION AT CAMDEN HAVEN WWTP

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ABSTRACT

This paper explores the operation and optimisation of the Membrane Bioreactor (MBR) plant at the Camden Haven Wastewater Treatment Plant over the past six years. MBR's are a new wastewater treatment process that combines the activated sludge process with a membrane filtration process. MBR's provide several benefits over conventional bioreactor/clarification systems, including reduced footprint, higher quality effluent/permeate and complete bacteria removal.

This was the first MBR plant to be commissioned within the Port Macquarie Hastings Council Sewerage Scheme, and hence provided many challenges due to a lack of experience and familiarity with the recently developed process. One of the major issues with the plant that is explored in this report was severe membrane fouling caused by poor aeration sequences and cleaning frequencies. Through the methods outlined in this report, the team have successfully optimised the MBR treatment process and have improved the longevity of the membranes in doing so.

1.0 INTRODUCTION

1.1 Camden Haven Sewage Treatment Plant

Port Macquarie Hastings Council operates and maintains five sewerage schemes and treatment plants throughout the local government area from Dunbogan in the south, Port Macquarie to the north and to Wauchope in the west. This paper will focus on the optimisation of the MBR Plant at Camden Haven Wastewater Treatment Plant.

Camden Haven Wastewater Treatment Plant is located on the Mid North Coast of NSW and services the Camden Haven region. The plant has a dry weather flow of 2 ML/day, and in periods of heavy rain, can receive over 10 ML/day. The plant consists of 4 MBR trains with each being able to draw 20 L/s permeate with a capacity to ramp up to 32 L/s in wet weather. The plant has a capacity of 15,000 EP (equivalent persons).

__Figure 1__: ***Membrane Bioreactors at the Camden Haven Treatment Plant***

The permeate water from the membrane filtration is held in a storage tank and used either as a resource to backwash the membranes or it is discharged into the ocean (3kms away) after first being disinfected by UV lamps and chlorine dosing. According to our discharge licence with the EPA, phosphorus levels in the discharge must be less than 1 mg/L. To ensure this occurs, aluminium sulfate (alum) is dosed as a chemical flocculent before the MBR's. On contact with water, alum forms a fluffy precipitate (aluminium hydroxide) which binds with any phosphorus in the sewage to form an insoluble aluminium phosphate compound. As a result, the phosphorus can no longer be used as a food source for algae and will be easily removed by the membranes.

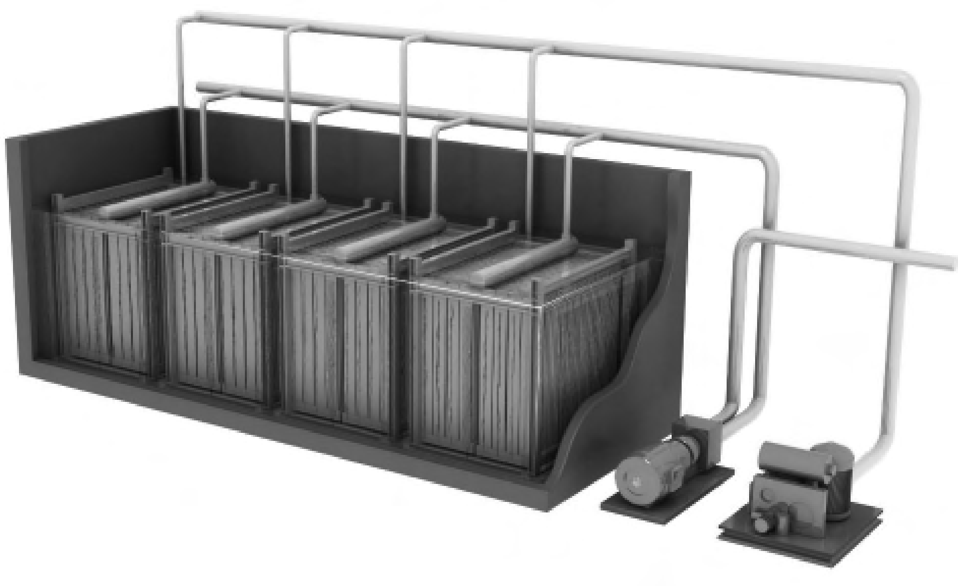
Other chemical dosing at the plant includes caustic dosing as a pH adjustment (to protect membranes), as well as sodium hypochlorite and citric acid for the Clean-In-Place (CIP) of the membranes.

1.2 Membrane Bioreactors (MBR)

A membrane bioreactor (MBR) is a state of the art treatment process that involves the combination of a membrane process such as ultrafiltration with a biological wastewater treatment process, the activated sludge process.

The activated sludge process concentrates the naturally occurring bacteria in sewage to remove the organic waste in the sewage and to reduce the nutrient load prior to discharge of the treated effluent. This is done through a combination of aerobic and anaerobic conditions, manipulated using aerators. The aerators introduce oxygen to the sewage and allow for bacteria to live. The bacteria then feed on the ammonia in the sewage and convert it to nitrites and then nitrates (nitrification). Once all the free oxygen is gone (aerators are turned off), the bacteria attack the nitrate ions to obtain oxygen to survive. This then forms nitrogen gas (N_2) which escapes to the atmosphere (denitrification).

The membrane filters are submerged in the activated sludge and provide some physical barrier filtering solids down to 0.2 microns out, which not only removes all solid particles but also removes pathogens such as bacteria and protozoa.



<u>Figure 2</u>: Schematic of a Membrane Bioreactor

1.3 Advantages of MBR's

MBR's effectively simplify the wastewater treatment process by combining the biological conversion process with the separation process. Conventional activated sludge processes require an aeration tank followed by a clarification process, as shown in Figure 3.

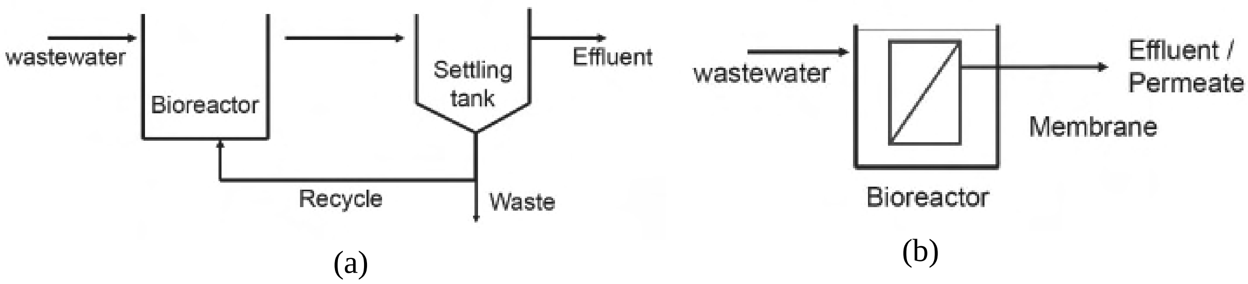


Figure 3: ***Conventional Activated Sludge Process (a) & Membrane Bioreactor (b)***

Some of the advantages of MBR's over the conventional process include:

- Significantly less footprint (size of plant)
- All biomass and virtually all other suspended solids retained by the membrane
- Effluent suspended solid concentration <1mg/L compared to 5-20 mg/L for clarifier effluent
- Excellent and consistent effluent quality
- Solids loss commonly observed in clarifiers is prevented
- Most of pathogens (and most viruses) removed
- High degree of automation
- Reduced quantity of chemicals needed for phosphorus reduction
- Eliminate the need for secondary clarification

2.0 DISCUSSION

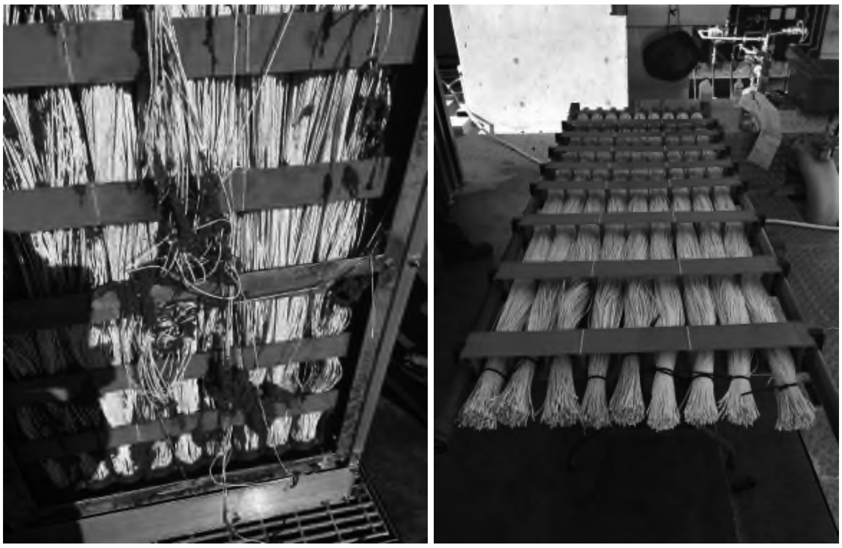
Since the commissioning of the MBR's 6 years ago, there has been many challenges that have been presented. Due to a lack of experience and understanding of how these issues were occurring, we were required to learn during the process.

2.1 Excessive Membrane Fouling

The MBR's at the Dunbogan Treatment Plant were operated under a constant flux mode, with the Trans-Membrane Pressure (TMP) used as an indicator of membrane fouling status. Therefore, the permeate pumps are run at a variable speed to achieve a desired flow rate set point (and hence have a constant flux). Over time, the TMP of the membranes all began to rise and under FMAX (wet weather flow – 32 L/s), the permeate pumps would consistently shutdown due to a low flow shutdown alarm. The permeate flow could not be maintained for 20 minutes under the wet weather flow.

The initial strategy to fix this issue was to increase the frequency of the CIP cleans, from 12 monthly to monthly. However, this did not fix the problem, with the same issues still occurring.

To gain a better understanding of what was occurring, it was decided that we would pull one of the membrane trains out and inspect their condition. Upon inspecting the membrane condition, extreme alum sludge cake fouling was discovered throughout all the fibre strands. This was the clear cause of the inability to maintain a constant permeate flow. Each of the 52 individual cassettes were pulled out and cleaned by hand and low-pressure water. This was an extremely time consuming process, with each cassette taking approximately 2 hours to clean. Figure 4 shows the extremely fouled membranes before and after the clean by hand.



(a) **(b)**

Figure 4: ***Membrane Fouling Before (a) and After (b) Clean***

Figure 5: ***Membrane Fingertip Cleaning Process***

After cleaning the membranes, they were placed in a water bath and low-pressure air was pumped into the membranes to see if there were any holes within the membrane strands. Any large holes in the fibre were removed, glued and retested in the water bath before being placed back in the train.

Additionally, we found that the air inlet and outlet pipes were also blocked with alum sludge reducing the amount of aeration the MBR would receive. Due to this lack of aeration, the membrane strands were not being agitated enough to break free any built-up rag or fouling.

After cleaning and retesting the air-lines, the membrane trains were placed back into position. As an initial test, the MBR was filled with permeate water to ensure there was no major problems. After this, the membranes were subjected to a citric acid clean and a sodium hypochlorite clean.

During the time taken for this clean, we performed a large amount of analysis using the SCADA computer system. Trends in process variables and parameters were created and potential solutions noted. From this analysis, it was discovered that in the programming, the aeration sequence in the MBR when the plant was in standby was set for only 5 minutes every hour. This would not provide enough agitation to remove built-up materials from the membranes. The initial solution to the issue was to increase this aeration frequency, creating a 10 minute aeration period followed by only 10 minutes without aeration when in standby and during normal filtration. During times of FMAX (wet weather flow), the aeration times were extended such that there was continuous aeration.

Additionally, the implementation of a short reverse permeate flow to backwash the membranes was introduced. During normal filtration, 20 seconds of reverse permeate flow would be used after 380 seconds of filtration. After 300 seconds of FMAX filtration, there would be 60 seconds of reverse permeate flow. This was done as a method to further decrease the fouling of the membranes.

To try and make the membrane filtration a continuous process, the speed of the permeate pumps were coded such that they would ramp up and down based on the bioreactor tank level (tank upstream of the MBR's). This ensured that the MBR's would not experience as many periods of being in standby mode. Additionally, as a method to remove entrained air within the membranes, a de-aeration cycle was introduced such that a reverse air flow would pass through the membranes after 10 aeration cycles.

2.2 Results of Optimisation

After recommissioning the MBR's and implementing the above changes, the TMP and membrane resistance of each train were back to normal values. There were no issues evident and after a month it was decided to pull out Train 2 and inspect the condition of the membranes. It was found to be completely clear of Alum sludge and it was evident that the changes made through the control systems had made a drastic change to the process of filtering mixed liquor.

Figure 6: Membranes after One Month of Recommissioning

By implementing the above procedures, the permeate pumps are now operating at slower speeds (since the membranes are not as fouled) and are currently providing higher quality permeate results. The continuation of the more frequent citric acid cleans (monthly) will also aid in maintaining clean membranes and implementing extended soaks of a minimum of 3 hours has further decreased the potential for membrane fouling. Additionally, an automatic citric clean will be implemented after a significant rain event (periods of FMAX). The continuation of daily Sodium Hypochlorite cleans to remove biological matter from the membranes is also essential.

3.0 CONCLUSION

Membrane Bioreactors are an extremely promising treatment process that provides many benefits when compared to traditional bioreactor/sedimentation processes, including reduced footprint, higher quality effluent/permeate and complete bacteria removal. Due to MBR's being such a new technology, we have learnt that operational issues will arise but can be used as a learning opportunity to further improve the process. As further advancements and discoveries into the maintenance and operation of MBR's become available, an increased understanding will be available and capital/operating costs will continue to decline, resulting in the process itself becoming more optimised.

4.0 ACKNOWLEDGEMENTS

Many thanks to our fitters and sewer attendants for taking on the dirty job of cleaning the membranes for over a month, and Alan Butler (Water and Sewer Process Engineer) for assistance with this project.

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LENNOX HEAD DUAL RETICULATED RECYCLED WATER SCHEME – 12 MONTHS OF OPERATION

Paper Presented by:

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12th Annual WIOA
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11 & 12 April, 2018

LENNOX HEAD DUAL RETICULATED RECYCLED WATER SCHEME – 12 MONTHS OF OPERATION

Thomas Lees, *Treatment Plant Process Engineer,* Ballina Shire Council

ABSTRACT

Ballina Shire Council launched its Lennox Head Dual Urban Reticulated Recycled Water Scheme in July 2016.

This article intends to review the process leading to and following this event. Identifying the issues experienced within the first twelve months of operations and prior decisions made that contributed to the smooth implementation of the scheme.

1.0 INTRODUCTION

Lennox Head is located approximately 20km south of Byron Bay situated on New South Wale's picturesque far north coast. During the early 1980's the town received reticulated sewer with the accompanying treatment plant (plant) constructed as a twin 4,000 EP Intermittent Decant Extended Aeration (IDEA) or "Bathurst Box" design, which included an ocean outfall discharging at the low tide mark of Boulders Beach. Constant population growth meant that by the early 1990's the capacity was increased with the installation of an additional 10,000 EP IDEA with ultra-violet disinfection pre-treatment added to the original ocean outfall.

1.1 Recycled Water Inception

During Council's master planning phase of the early 2000's, expansion of the existing ocean outfall was initially identified; however due to public resistance to this proposal (Boulders Beach being a popular surfing beach) and a community priority for better environmental outcomes, Council adopted a master plan that advocated the creation of two dual urban reticulated recycled water scheme in 2003.

This master plan specified 80% water reuse within the Shire by 2026, with all future developments in Lennox Head and Ballina being built to accept dual urban reticulated recycled water as defined by the Australian Guidelines for Water Recycling (AGWR). In terms of the effects on the individual dwellings attached to the scheme, this meant that the laundry cold water washing machine tap, all toilet cisterns and all but one external taps were plumbed to the recycled water main through a separate recycled water meter.

2.0 DISCUSSION

The resulting recycled water schemes identified as part of the 2003 master plan (Ballina Recycled Water Scheme [not covered in this article] and the Lennox Head Recycled Water Scheme) were by far Ballina Shire Council's largest capital works project and at project completion the schemes will supply approximately 7,200 houses with dual urban reticulated recycled water from two discrete recycled water treatment plants (Ballina and Lennox).

2.1 Treatment Plant Configuration

To meet the water quality requirements specified by the AGRW for dual urban reticulated recycled water (Table 1), a major upgrade of the existing Lennox Head WWTP was required. These works focused on the addition of a separate recycled water process train parallel to the existing ocean outfall stream. This was an important feature of the Lennox Head Treatment Plant design; allowing the balance between plant inflow and recycled water demand to be discharged through the existing ocean outfall.

<u>Table 1:</u> ***AGWR log reduction values for prescribed uses***

Pathogen		Protozoa and Helminths	Viruses	Bacteria
Indicators		Cryptosporidium	Rotavirus	Campylobacter
LRV per Use	Commercial food crops	4.8	6.1	5
	Dual Reticulation	4.9	6.3	5.1
	Fire Fighting	5.1	6.5	5.3
Log Reduction Requirement		**5.1**	**6.5**	**5.3**

The Lennox Head recycled water process train design consists of an ultra-filtration module (Pall Aria™ AP6) followed by ultra-violet disinfection (Trojan UVFIT™ 18AL40) and chlorine disinfection through sodium hypochlorite addition (125kL Chlorine Contact Tank). The Plant operates at a peak instantaneous flow of 40 L/s, with the log reduction performance listed in Table 2.

<u>Table 2:</u> ***Claimed log reduction values for the Lennox Head Recycled Water Treatment Train***

Pathogen		Protozoa and Helminths	Viruses	Bacteria
Indicators		Cryptosporidium	Rotavirus	Campylobacter
Claimed LRV	Ultra-Filtration Module	4.0	4.0	4.0
	Ultra-Violet Disinfection	2.0	-	-
	Chlorination	-	3.0	3.0
Total Log Reduction Claimed		**6.0**	**7.0**	**7.0**
System Redundancy		*0.9*	*0.5*	*1.7*

The implementation of a Hazard Analysis Critical Control Point (HACCP) approach is suggested in the AGWR as a suitable risk management approach to ensuring continuous adherence to the required log reduction values (Table 2).

Ballina Shire Council invested significant time and effort streamlining the critical control points and parameters to determine the fewest parameters still able to ensure safe production (Table 3). This is because there needs to be a balance between;

- too few critical control parameters, the plant performance cannot be ensured, and
- too many, the process may become unreliable and prevented from operating unnecessarily.

<u>Table 3:</u> ***Critical Control Points, Parameters and Values for the Lennox Head Recycled Water Treatment Train***

Critical Control Point	**Parameter**	**Critical Value**	**Shutdown Timer**	**Measurement Frequency**
Ultra-Filtration Module	Turbidity	>0.15 NTU	5 seconds	Continuous
	Trans-membrane Pressure	>250 kPa	5 seconds	Continuous
Ultra-Violet Disinfection	Dose	<33.6 mJ/cm^2	30 seconds	Continuous
	Flow	>40 L/s	30 seconds	Continuous
Chlorine Contact Tank Outlet	Free Chlorine	<0.65 mg/L	1,800 seconds	Continuous

All control parameters that were identified as non-critical but still required to operate the plant were categories as quality control parameters and are listed below (Table 4).

<u>Table 4:</u> ***Quality Control Points, Parameters and Values for the Lennox Head Recycled Water Treatment Train***

Quality Control Point	**Parameter**	**Quality Value**	**Quality Timer**	**Measurement Frequency**
Ultra-Filtration Module	Direct Integrity Test	>7.63 kPa/5min	N/A	Daily
	Flow	>40 L/s	30 seconds	Continuous
	Temperature	>40 °C	30 seconds	Continuous
Ultra-Violet Disinfection	Transmittance	<60 %	30 seconds	Continuous
	Lamp Age	>12,000 hours	N/A	Continuous
	Lamp Failure	>2 lamps	N/A	Continuous
Chlorine Contact Tank Inlet	pH	>9 pH units	1,800 seconds	Continuous

2.2 Section 60 Application and Pre-Launch Activities

Though Council had existing Recycled Water Schemes operating (agricultural reuse and sporting fields), the higher exposure risks associated with dual urban reticulation meant a complete redevelopment of Council's accompanying systems and policies.

This included the creation of a new Recycled Water Management System in keeping with the twelve elements outlined by the AGWR, an Incident Management Plan and the implementation of an 88E Positive Covenant, requiring all new dwellings in dual reticulated areas to make plumbing provision for recycled water to be approved by Council.

Consistent with an equivalent drinking water process the AGWR supports a "risk-based framework" for managing schemes and systems. The biggest risk for any Dual Reticulated Recycled Water Schemes is the cross-connections between drinking water and recycled water, either within the reticulation or more likely within individual dwellings.

Satisfactorily managing this risk is one of the biggest ongoing operational challenges faced by operators of these schemes. Ballina Shire Council addresses this risk through several complimenting strategies consisting of;

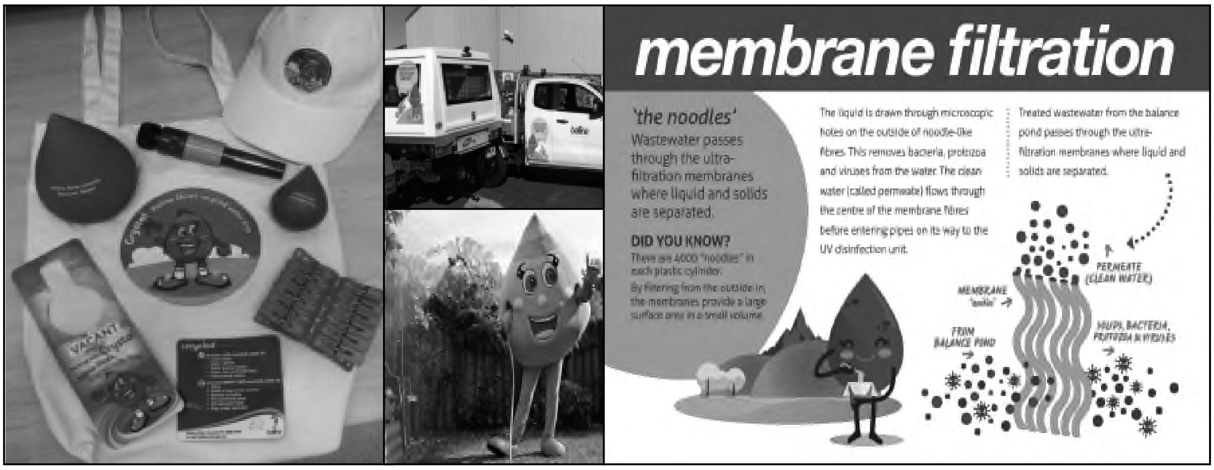
- regulator plumbing audits (pre-occupancy certificate, every 5 years and upon sale of property),
- quarterly pressure testing of both recycled and drinking water mains in dual reticulated areas, and
- meeting Australian Drinking Water Guideline (ADWG) requirements on the recycled water.

N.B. Ballina Shire Council does not allow the use of recycled water outside of its approved uses, but instead treats the water to this level to mitigate risks associate scheme cross-connections.

Prior to launch Council also developed a communication strategy to ensure all key stakeholders were aware of the acceptable uses for dual urban reticulated recycled water. This was especially critical as at the time in far northern NSW there were no comparable schemes. This meant that required consumer behaviours were not well understood.

Council addressed this through the following methods;

- Supplying new occupants with information packs (figure 1),
- Supply of factsheets to key stakeholders,
- Development of a Ballina Water website,
- Installation of treatment plant tour signage and promotion of community group, university and local school tours, and
- Development of FAQs for front line staff



<u>Figure 1:</u> ***left) recycled water information pack for all new occupants, top middle) Council vehicle livery promoting recycled water, middle bottom middle) Crystal – Ballina Shire Council's recycled water mascot and right) is example of the treatment plant tour signage.***

2.3 Launch and Go Live

The commencement of supply for the scheme was scheduled for July 1 2016. This date was chosen as it nicely coincided with; a new billing quarter (recycled water is charged in Ballina Shire Council at 80% of the drinking water tariff), Section 60(c) approval and completion of all outstanding plumbing audits.

Commencement began with the removal of cross connections that had fed drinking water into recycled water mains. Barring a couple of minor issues, within a couple of days all eligible dwellings were connected to the live scheme.

2.4 Transitioning to Business as Usual

The transition from launch to business as usual operations has gone relatively smoothly. That said, there have been several water quality issues Council has been managing over the first 12 months:

Free Chlorine and Trihalomethanes (THMs)**;** due to relatively few connections to the scheme at launch (approximately 700 dwellings or 10% final utilisation) and elevated Dissolved Organic Carbon (DOC) concentrations found in the recycled water, managing free chlorine residuals has been the biggest issue with the scheme so far.

Some parts of the reticulation currently have hydraulic retention times more than 7 days. This is contrasted with Council's self-imposed requirements to meet ADWG requirements especially the 0.25 mg/L for THMs (chlorination by-products), therefore maintaining free chlorine has been a balancing act between re-chlorination (in Reservoirs) and routine flushing (predominantly in underutilised parts of the reticulation).

Hardness**;** has also been another area of interest for Council. This is mostly due to the softness of the existing drinking water supply, typically 30-60 mg$CaCO_3$/L. Even though the recycled water is only moderately hard at 80-110 mg$CaCO_3$/L, the contrast is noticeable enough for some residences to complaint about white streaks left on glass. Council has managed this through promotion of hand drying rather than evaporation when using recycled water for window cleaning.

Demand Management**;** even though approximately 700 dwellings were connected to the scheme at launch, the vast majority of demand comes from local sporting fields, especially the East Ballina Golf Course. This means that the demand on the scheme is still very weather dependent, ranging from <50 kL/d to 2.5 ML/day depending on rainfall.

This is expected to stabilise over the coming years as more dwellings are connected to the scheme.

3.0 CONCLUSION

The first 12 months of the Lennox Head Recycled Water Scheme was a reasonably smooth transition from pre-launch to business as usual operations.

The biggest factors in this success have been down to;

- Effective management of the cross connection risk through 88E covenant on scheme dwellings, regular plumbing audits and high water quality requirements,
- Streamlined HACCP approach allowing for only five critical control parameters, and
- Supply redundancy through drinking water top up facilities within the scheme to guarantee supply.

Issues still being managed with the scheme into the future are;

- Maintaining desired free chlorine residues within the reticulation, and
- Demand management / demand stabilisation.

4.0 ACKNOWLEDGEMENTS

To all the members of this recycled water project, weather from the very beginning to the present, as mentioned above this process has been the culmination of fifteen years of work across all departments of Council and to date has been a resounding success.

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TO BURST OR NOT TO BURST? REPLACEMENT OF 225MM SEWER MAIN IN MOREE

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12th Annual WIOA
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TO BURST OR NOT TO BURST? REPLACEMENT OF 225MM SEWER MAIN IN MOREE

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ABSTRACT

Moree Plains Shire Council (MPSC) conducted routine inspections of its sewer network in early 2016. During that inspection, Council identified that one of its DN225 concrete sewer mains had partially collapsed. The original line had been laid in 1950. The main, located in an older, built-up part of Moree was approximately 6 metres deep and serviced 14 houses.

Council collaborated with pipeline and infrastructure renewals specialist Interflow P/L, to develop a cost-effective rehabilitation solution that would not interrupt services to residents.

The rehabilitation consisted of installation of 140m of DN150 PVC in a high line including connection to affected properties, and then bursting 125m of DN225 and replacing with DN250 PE100 pipe to improve service to customers upstream of the damaged main.

1.0 INTRODUCTION

MPSC employed Sewer Services to do a condition assessment of 25km sewer main in Moree. A condition assessment report submitted by Sewer Services pointed out that the 225mm diameter concrete sewer main in Heber Lane had two collapsed pipe sections and two joint dislocations. The total length of affected sewer main was around 125m with three manholes (MH) which are 5.5-5.7m deep with 14 household 150mm sewer connections.

During conditional assessment the CCTV camera couldn’t pass through 5 spots and only around 25% of the area recorded the rest of the pipe line condition is unknown because camera couldn’t pass through 5 spots while trying from both upstream and downstream direction. Various options including spot fixing excavation, pipe bursting, robotic repairs and relining were considered. The repairs or replacement of the sewer main need to be done quickly as possible to restore Sewer services to normal.

2.0 DISCUSSION

Due to the space limitations and economic benefits, trenchless options including spiral relining, CIPP Lining and slip lining were considered. Relining options require known host condition and a minimum anulus to pull through the liner. Where host pipes have sections that are not visible or collapsed a combination of point repair techniques can be utilised.

Robotic repair and relining options were selected as a possible scope of works which would include removing pipe pieces from collapsed section of pipeline with Hydraulic Milling Robots, Install Point Liner patch repair over the collapsed sections of pipeline and reline Structural Liners along with pre-lining preparation of collapse repair using Hydraulic Milling Robots and Point Lining System provides a quick trenchless solution to the rehabilitation of sewer pipelines while avoiding inconvenience.

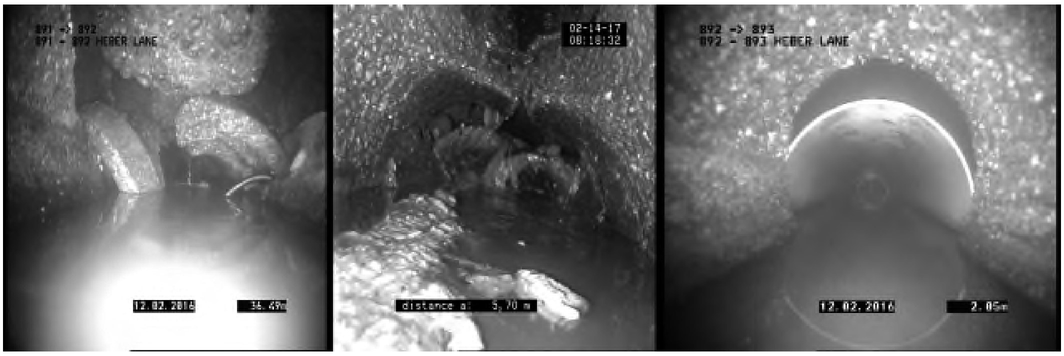

Figure 1: ***Heber Lane DN225 concrete sewer mains before rehabilitation***

2.1 Robotics Repair and Liner Patch Repair and Reline

If the pipe line is stable robotic pipeline repair equipment is ideally suited for the cutting, grinding and milling of intrusions, encrustations, and even completely clear blocked sewers as the equipment can cut through most materials, including concrete.

Spot relining or fiberglass patch repair is a cost-effective technique widely used in trenchless rehabilitation for both point repair as well as, to prepare damaged pipes for relining. Glass fibre matting is impregnated with a fast curing resin and installed using an inflatable packer for an easy and cost-effective solution.

After the robotics repair work on site and further CCTV inspection between each MH found further collapses and the pipe repairs couldn't be done because of the severity of the damage.

2.2 Pipe Bursting with Shallow Rider Main to Pick Up the House Connections

On further reviewing the CCTV footage and due to the significant number of collapses it was decided that the previously discussed trenchless techniques would be unsuitable and that pipe bursting or an open trench excavation may be the only choices for rehabilitation of the existing pipe.

The pipe bursting option reduces surface damage and restoration as well as less disturbance to business and residents when it is compared to traditional open cut construction. During pipe bursting the house hold connections are usually excavated upon prior and a temporary connection setup. When the burst main is installed the existing junctions are destroyed and this prior process allows services to be reconnected with the minimum amount of impact.

With each of the house junctions at Heber Lane connecting into a main 5.5 to 5.7m deep and with 14 households in total, the level of excavation would be almost as significant as open trenching and relaying the entire 130m length. Because of these considerations a shallower highline in PVC was prosed to pick up the house service connections and carry waste to the manhole via an internal dropper.

2.3 Pipe Bursting

Pipe bursting is a well-established method for trenchless replacement of worn out and undersized sewer mains.

It can be done either as a pneumatic, hydraulic expansion or static pull method for fracturing of an old pipe and displacement of the fragments outwards while a new pipe is drawn in to replace the old pipe (ERDC of US Army Corps of Engineers, 2001).

Moree plains used pneumatic method for pipe bursting to replace approximately 130m of an old broken pipe between three manholes along Heber Lane. The replaced sewer pipe was located at a depth of 5.5m with a fall of 200mm over the length of the pipe replacement with a 5.7m depth at the exist manhole.

Typically, pipe bursting is carried out by insertion of a conically shaped tool (bursting head) into the old pipe. The expansion fins/blades on the bursting head fracture the old pipe and forces the fragments into the surrounding soil. The diameter of the bursting head is larger than the inside diameter of the old pipe and slightly larger than the outside diameter of the new pipe, to reduce friction on the new pipe and to provide space for manoeuvring. The bursting head is connected to the new pipe, while its front end is pulled by a cable connected to a winch. The bursting head and the new pipe are inserted from the insertion manhole and the cable is pulled from the reception manhole.

__Figure.2:__ ***Pipe Bursting head setup at Heber Lane***

Thermoplastic pipe systems that are joined by thermal butt-fusion are currently the most popular for use in pipe bursting applications. These systems provide a monolithic pipe length, with fully restrained, gasket less joints that have the same material properties as the pipe itself. When compared to the pipe, these joints are characterized by excellent pull force capability, full pressure rating, and zero leakage potential. There are two thermoplastic materials currently offered with this joining system; High Density Polyethylene (HDPE) pipe and Fusible Polyvinylchloride Pipe (FPVCP). Both systems are generally assembled from lengths of pipe (typically 12m long) shipped to the project site. These lengths are joined into the required strings of pipe for each pipe bursting run required. The pipe is then inserted as a monolithic length through an insertion pit and through the alignment to complete the burst.

2.4 Launching Pits and Receiving Pits and Manhole Preparation

The insertion pit must be large enough to allow the pipe to be inserted. For continuous pipes, this means that the pipe must be able to be fed from the surface into the existing pipe alignment without overstressing the pipe in bending.

The purpose of a receiving pit is to simply pull the pipe, access the new pipe end and retrieve all associated tooling and equipment. Manhole modifications must be made to receive the new pipe and pipe bursting tool. In most cases it will require either partial or complete removal of the manhole invert as well as the removal of some of the sidewalls.

On completion of the pipe burst, the manhole invert and connection to the new pipe must then be rebuilt.

2.5 Equipment Installation

When chain or wire rope/cable are used to pull the bursting tool through the pipe, the winch or hydraulic powered ram is placed into a reception pit, and the chain, cable or wire rope is pulled through the pipe and attached to the front of the bursting unit in an insertion pit. When rigid pulling rods are used instead, they are inserted from the reception pit through the existing pipe until the pipe insertion point is reached. The rods are then attached to the bursting head, and pulled through the existing pipe

2.6 Bursting Operation

The bursting of the old pipe should be performed as a continuous action if the replacement pipe is continuous. It is not desired to stop a pipe bursting operation once it is underway as the annulus begins to relax and close in around the newly installed pipe. Working hours and local ordinances should also be considered prior to the start of work.

<u>Figure 3:</u> ***Pipe Bursting with Shallow Rider Main in Heber lane***

2.7 Reconnection of Services

Service connections can be reconnected to the sewer main by various methods. In Heber lane project due to the depth of sewer we opted for Shallow rider main to pick up the house connections terminating with a dropper into the downstream manhole, this saved excavating 5.5 meters x 14 household connections.

2.8 Dilapidation Report

Considering Moree’s reactive soil types are susceptible to expansion and contraction with varying soil moisture content, buildings are prone to have cracks because of the movement of soils. To avoid insurance claims, dilapidation surveys of the nearby residences and outbuildings, and the provision of vibration monitoring equipment and analysis during the project. The specific purpose of these reports will be to provide an accurate visual record of defects and damage found in or on the properties before and after the sewer replacement has been completed. These reports will be based on a visual inspection, no core drilling, testing or structural sampling is done. The internal areas, structures external facades and all yard area improvements/structures are inspected. Reporting on current defects to these structures which include settlement, cracking and any obvious areas of deterioration of cladding, render brickwork and concrete etc.

Dilapidation Report

1. 8 Structures were identified for Dilapidation Reports which was situated close to the sewer main.
2. Prior to Pipe Bursting works visual inspection done for identified structures on November 15, 2017.
3. Final inspection done on 26th January 2018, upon completion of visual inspection, no additional damage was identified for all 8 structures.
4. These findings agreed with the Vibration Report that there was no potential for any cosmetic damage to light framed residential buildings.

2.9 Construction Vibration Monitoring During Pipe Bursting

The vibration monitoring was carried out continuously for the duration of the works, from the commencement of the bursting of the old pipe at the entry point manhole until the bursting head was extracted at the exit manhole. The monitoring location was shifted along Heber Lane to track the progress of the bursting operation.

The highest vibration levels recorded (along the Y axis in line with the movement of the pneumatic hammer) were between 6 and 8 mm/s at frequency of 43 to 47 Hz. These ground vibration levels are well within the ground vibration criteria from the German Standard DIN 4150-3:1999, which is the most conservative criteria for potential cosmetic damage to buildings. The same criteria under British Standard BS 7385-2:1993 is 50mm/s at 40Hz and above.

The ground vibration during pipe bursting was subjectively perceptible by a person standing immediately above where the bursting head was traversing through the ground. It is possible that some vibration would have transferred into the buildings causing minor presentable vibration. This would have been short duration transient vibration which may have caused some rattling of kitchen utensils but would have no potential for any cosmetic damage to light framed residential buildings. The vibration levels throughout the pipe bursting process along Heber Lane have remained at levels which are unlikely to cause cosmetic or structural damage to light framed residential buildings.

3.0 Pipe Bursting V's Open Cut Replacement & Other Rehabilitation Methods

Open cut replacement may be a preferred option of pipe renewal when the pipeline is shallow, and the trenching does not create inconvenience. However, under many conditions, pipe bursting has substantial advantages over the open cut replacements. It is (1) much faster, (2) more efficient, (3) often cheaper, (4) more environmentally friendly, and (5) less disruptive to surface features than open cut. Pipe bursting usually produces less ground disturbance than open replacement. In open cuts, there is stress relief in the ground as the trench is dug. The main advantage of pipe bursting over other trenchless rehabilitation methods, such as cured-in-place (CIP) pipe, fold-and-form (FF) pipe, slip lining, etc., is the ability to upsize service lines.

4.0 CONCLUSION

Pipe bursting is a mature, proven technology for trenchless replacement of pipes.
As the life cycle of the existing underground infrastructure expires and failures occur at an alarming rate, pipe bursting is one of the methods that will be used to effectively

provide long term service for critical utilities that are essential to public life and health. As the only trenchless method that can increase the size of an existing pipe, pipe bursting is suited well to a growing need for additional capacity whether it be in the sewer, water, gas, or other utility market sectors.

Pipe bursting may be the only choice for trenchless improvement of an existing pipe in very poor structural condition or if other rehabilitation methods are rejected as unsuitable. If the chain, cable or pulling rods can be inserted from receiving point to insertion point, the line can usually be pipe burst, unless other issues prevent the application.

With an increased public awareness and limited funding available for critical infrastructure rehabilitation, it is necessary that we utilize methods that offer reduced social disruption and reduced environmental impact while preparing for future capacity needs. As with any successful construction project, pipe bursting projects require good pre-planning, careful observation of job progress and the monitoring of key variables during construction. This will result in a good installation providing additional capacity and services to the owner and community for a multitude of years.

5.0 ACKNOWLEDGEMENTS

We are highly indebted to Interflow for their guidance and providing necessary information regarding the project & also for their support in completing the project.

Our thanks and appreciations also go to our colleagues in Water and Sewer department in Moree Plains Shire Council for their support in completing the project.

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Dilapidation Report Moree Plains Shire Council Heber Lane Sewer Bursting January 2018

WE'VE BOUGHT A DRONE, NOW WHAT? ASSET SURVEILLANCE USING DRONES

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12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

WE'VE BOUGHT A DRONE, NOW WHAT? ASSET SURVEILLANCE USING DRONES

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Rob Curtis, *General Manager*, The Ripper Aviation Academy

ABSTRACT

The presence of drones is well and truly established in both Australia and throughout the world. These highly capable and readily available machines have created a whole new way of looking at and discovering new purposes. Operators within the water industry are likely to cross paths with a drone (also known as RPA or Remotely Piloted Aircraft) sooner rather than later and in many cases, already have. In the hands of a water industry professional, drones can be a powerful tool, that can be used for a range of applications. Operating drones is becoming increasingly simple, however there are many key milestones to consider ensuring their use is safe and legal. This paper will discuss understanding and navigating those milestones, along with some insights on how drones are being used for water asset and infrastructure inspections. The paper will also discuss methods for reporting the findings effectively and making best use of the products drones are able to produce.

1.0 INTRODUCTION

Drones – they are often in the media and have a huge presence in today's marketplace. The number of drones operating within Australia is estimated to be in the millions and continues to rise. Demand across a range of age groups has been observed, with the ability to obtain and fly a drone now easier than ever. Along with the increased simplicity and availability, there has been significant increases in capability. As such, there are several factors relating to safety, compliance and training that need to be considered prior to using a drone within a work-based environment. Proper consideration of these factors will pay dividends in terms of getting the most from the technology, whilst ensuring the operations are conducted in a manner that is both safe, legal and cost effective.

In Australia, the use of drones is regulated by the Civil Aviation Safety Authority (CASA). Within CASA, there is a Remotely Piloted Aircraft Systems (RPAS) division who sponsor, promote and enforce the regulations relating to drones. This division has been faced with a range of unique and complex challenges in terms of managing airspace, addressing public concerns and enforcing regulations, all whilst facilitating the opportunities this emerging technology presents.

It is suggested that the ideal person to operate a drone for an inspection is someone who knows what they are looking at. In terms of water asset inspections, observations thus far suggest that it is much easier to train a water industry professional to be a drone pilot, than it is to train a drone pilot how to be a water industry professional!

2.0 DISCUSSION

2.1 Types of Drones

The Civil Aviation Safety Authority (CASA), identify drone types based on their weight class as follows:

Size Rating	Weight
Micro	gross weight of 100 g or less
Very small	gross weight of more than 100 g and less than 2 kg
Small	gross weight of at least 2 kg and less than 25 kg
Medium	gross weight of at least 25 kg and less than or equal to 150 kg (or, for airships, an envelope of 100m or less)
Large	gross weight greater than 150 kg (or, for airships, more than a 100m envelope)

In addition to weight classes, drones are also grouped up into the following categories:

- Multi-rotor
- Helicopter
- Aeroplane (fixed wing)
- Airship


2.2 Sub-2kg Commercial Operations

Currently, an individual and/or organisation is legally able to fly a drone up to 2kg in weight (micro and very small) without any form of training or certification. This extends to both recreational and commercial use, provided the pilot and/or organisation informs CASA of their intent to operate and adheres to the standard operating conditions. A summary of the standard operating conditions are as follows and further details will be found on the website www.droneflyer.com.au :

1. Only fly during the day and keep your drone within visual line-of-sight;
2. Not fly higher than 120m (400ft);
3. Must keep your RPA at least 30m away from other people;
4. Must not fly over or near an area affecting public safety or where emergency operations are underway (without prior approval);
5. You must only fly one RPA at a time;
6. You must not fly over or above people;
7. You must keep your RPA at least 5.5km away from controlled aerodromes; and
8. You must not operate your RPA in a way that creates a hazard to another aircraft, person or property.

Using drones commercially has gained significant momentum, with an increasing number of individuals and organisations taking advantage of CASA's sub-2kg commercial regulations.
This is primarily due to the capabilities and characteristics of the sub 2kg aircraft, combined with the minimal training and administration required to start operating. The simplicity and low cost of a sub-2kg aircraft have seen them emerge as a 'tool of the trade' for most situations. Many organisations are seeing the benefits of equipping staff with a drone as it can be employed easily and to good effect, assisting with work commitments. It is important to recognise that these capabilities also present risk, at both the individual and organisational levels. These risks arise from their significant capabilities and include intruding into airspace operated by manned aircraft, inflicting significant injury to people, damage to property, breaching privacy and causing general concern amongst members of the public.

2.3 Training

General / Sub-2kg Training

Whilst no training is required to fly sub-2kg aircraft commercially, many individuals and organisations are seeing the benefits in seeking out some form of instruction. Despite the perceived simplicity, operating a drone safely, effectively and within the standard operating conditions can be daunting and needs to be addressed prior to use in the work place. A lack of operator and/or organisational confidence often results in newly purchased drones being grounded, never to exit the box. Worst case, a lack of knowledge or skills can easily result in injury, damage to property or a regulatory breach. A basic training package or drone familiarisation course can reduce these risks and ensure the drone is 'value adding' to asset inspections.

A number of training options are available and usually encompass 1-2 days. This type of training does not result in any formal licence or qualification but aims to equip the operator with the knowledge and skills to operate effectively and in a manner that is both safe and legal. An additional benefit of seeking this type of training is to form an important control in risk management strategies and may also enable the user to be eligible for some sub-2kg insurance policies currently available. Usually, training of this type is priced between $500-$1500.

The Remote Pilot Licence (RePL)

Commercial use of a drone over 2kg in weight requires a formal certification known as the Remote Pilot Licence (RePL). This is issued by CASA and like a motor vehicle licence, has a number of upgrades and endorsements available. Achieving this qualification usually encompasses 5 days of theoretical and practical based training and is priced between $2000-$3000 per person. Generally, this will see the candidate awarded a sub-7kg RePL in the multi-rotor category and the licence allows less restrictive operating conditions and eligibility to apply for certain exceptions.

The Aeronautical Radio Operator Certificate (AROC)

This certificate enables the operator to transmit on an air band radio. Doing so without this qualification is illegal. The ability to use an air band radio is advantageous for deconflicting RPAS operations with other air traffic. Additionally, there are some instances where the use of an air band radio is mandatory e.g. when operating an RPAS in controlled airspace. This qualification is often packaged with the RePL however can be delivered independently. This qualification is usually priced between $300 - $500.

2.4 Using the Drone – Sub-2kg Commercial Example

Identifying and purchasing sub-2kg drone/s is arguably the easiest part of integrating drones into an organisation. Other ancillary equipment is also required to support the operation with the need for extra batteries, protective cases, and electronic tablets.

Prior to using your sub 2-kg in commercial operations, it is mandatory for the organisation to inform CASA of their 'intent to operate'. This is a simple process, achieved by obtaining an Aviation Reference Number (ARN) by filling out CASA Form 1162 (see CASA website for details). An ARN can be obtained for both individuals and organisations.

Once an ARN has been obtained, CASA needs to be informed of their intent to operate via the online notification form. This allows the user to input whether the intended operations will be conducted by an individual, or on behalf of an organisation. The form also requires the user to outline which areas or states/territory they intend to operate in. Once submitted, CASA will acknowledge the request and process within 5 business days. When approval has been received, the individual or organisation must wait a further 5 business days before commencing operations. CASA recommend using this time to conduct familiarisation training, plan their operations and review risk management strategies.

Once these milestones have been achieved, flying is then permitted to take place within the standard operating conditions. Some considerations when operating include:

1. Flight areas. There are two components to checking whether drones can be flown within an operating area. One relates to the airspace, the other relates to seeking the landowner's approval, from which the drone will be operating. Airspace must be checked and deemed to be within an area that does not breach the standard operating conditions. There are several ways to check this however the most effective method is via the 'Can I Fly There' application, released by CASA. This tool provides a graphical representation of the area, along with amplifying information about the location (Figure 1).

2. Flight hazards. Hazards likely to affect drone operations should be identified prior to operating, with measures put in place to control the risk. Common hazards include powerlines and other obstructions, other personnel, birds and adverse weather conditions. These should be included in SWMS and/or standing risk management documents and be re-assessed again on-site in the form of a JSA or similar. Figure 2 is an example of a pre-flight plan documentation.

3. Pre-flight briefing. Discussing the flight plan and broad intentions of the inspection with personnel in the vicinity of flight operations, including any emergency or standby procedures as required. It is at this time that special consideration needs to be taken for any changing weather conditions or how the local environment settings can impact on the intentions of the flight (such as prevailing wind, fog, or rain).

4. Public liaison. Being aware of other people or animals in the operating area is imperative to consider and should be identified during the initial risk assessment. Good public relations prior to launching the drone saves a lot of hassles later.

If a tank or other asset must be inspected and is close by to houses or businesses, a quick door knock and conversation with residents will most likely result in favourable outcomes. The offer of a few images of their own premises while in the air, generally persuades even the most reluctant person within the area.

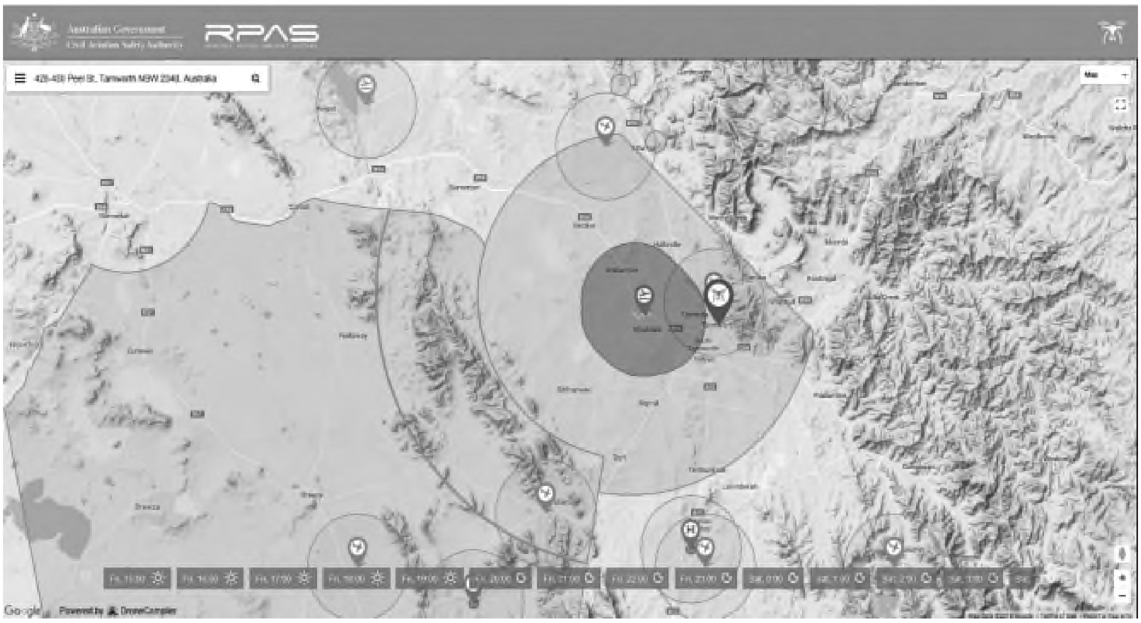

Figure 1: ***Example of area map showing flight restrictions***

RPA Operations (must be completed prior to take off):	
Obstructions identified (trees, powerlines, structures)	Yes / No / NA
Flight plan and inspection requirements determined	Yes / No / NA
Weather conditions suitable for RPA operations	Yes / No / NA
Local population / residents advised of RPA operations as required	Yes / No / NA
RPA operations authorised by Site Supervisor and CRP (if required)	Yes / No / NA
Comments:	

Figure 2: ***Example of a pre-flight check list***

2.5 Drone Use and Inspections

Councils may use a drone in a variety of situations where it is not safe or practical to place a person into the immediate local area. These may include flood monitoring (such as checking levee banks), dam surveys (sediment ingress or algae outbreaks), following river systems to check on unauthorised ingress from adjacent properties, or daily/weekly images of construction projects.

Performing regular asset inspections is important in the water industry, and while this has been addressed in other technical papers, it takes a few additional skills to become effective and relevant. Before launching a drone, prior consideration and planning on what the inspection is to achieve, what information needs to be collected and how will you display this information, is essential to get the best out of the technology available.

Aspects to think about include:

1. Defining the inspection area and content – The first requirement is to have a good understanding of the assets under inspection and planning of what you want to achieve from this inspection.

Is it to gain evidence of problems/issues, identify extent of or impact areas, or any other need identified? Prepare a scope (at least in your head) of what you think you will be looking at, knowing that you may need to alter this once the inspection begins.

2. What information is going to be captured? Is it going to be an onscreen assessment (with relevant people onsite), GPS coordinates of area, video, or photos? Good photography is a skillset required as images should be relevant to the evidence uncovered and they should make sense to others who were not present at the inspection. They need to 'tell a story' which is accurate, clearly identifiable and not misleading.

3. How is the information going to be reported/stored and shared with those relevant? Preparing a report from the data gathered will assist with the information sharing and can ensure that the photos don't just sit in a file somewhere never to be seen again. If an inspection template is prepared with key information points (Date/time/area of interest/key findings/recommended future actions etc), then this can also hold the file path where the original photos are stored. Using an asset priority rating system, will also enable a quick reference guide as to how good/bad the asset was at the time of the inspection. This also allows a method of prioritising the findings against previous inspections.

4. When inspecting the same asset on a regular basis, it is recommended to take the relevant images from the same position, angle and perspective, to allow accurate comparisons to be made.

3.0 CONCLUSION

Buying a drone is a simple process these days and CASA's sub-2kg regulations provide great flexibility for organisations wanting to introduce them to their business. Most may be aware of the responsibilities however don't know where to start, often finding themselves saying "so we've bought a drone, now what?". While official training is not essential it is recommended to ensure that risks and potential liability are managed, and all due care is taken. Training ensures operators are both confident and competent to achieve the most from the technology, whilst flying in a manner that is both safe and legal.

When conducting inspections, prior preparation is imperative and will ensure that you have considered all the pre-flight requirements and checks. An understanding of what you are going to be looking at, what information needs to be gathered and what data to collect, will assist with the exercise. If there is a need to conduct multiple inspections of various assets, then consideration of how best to report the findings, will ensure maximum use of the photos and that the time and effort are 'value adding' to the process.

TROUBLESHOOTING AND OPTIMISING DISSOLVED AIR FLOTATION AT BINGARA WTP

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Hunter H_2O

12th Annual WIOA
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Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

TROUBLESHOOTING AND OPTIMISING DISSOLVED AIR FLOTATION AT BINGARA WTP

Michael Carter, *Experienced Process Engineer,* Hunter H_2O

ABSTRACT

Raw water quality changes can impact all WTPs, however, a DAF plant can specifically be impacted due to its reliance on the attraction between floc and bubble. In mid to late 2017 operators at Bingara WTP encountered issues at the WTP with variable WTP performance due to unprecedented raw water quality changes.

Operational support was provided by Hunter H_2O through assistance with troubleshooting and identification of the likely cause for the WTP issues that were impacting the overall performance and treated water quality. DAF jar testing was successfully used to identify the likely cause of the issue and identify potential solutions in a rapid and effective manner. It was discovered that a suspected change in the characteristics of the raw water was impacting the strength and hydrophobicity of the Alum floc. This combined with the normal operational sequences at the WTP, resulted in floc detaching from the bubbles and impacting DAF subnatant quality at regular intervals. DAF jar testing was used to quickly determine that a polymer was required to improve the physical characteristics, increase the hydrophobicity of the floc and improve overall DAF performance, while use of a standard sedimentation jar test failed to optimise these conditions.

1.0 INTRODUCTION

1.1 Water Treatment Plant Overview

The Bingara Water Treatment Plant (WTP) was commissioned in 2011, with a design capacity of 35 L/s. The WTP is a fixed flow plant that typically operates at 35 L/s during the day shift or if required to meet demand. The current conventional treatment process consists of raw water pumping from an in-river infiltration wet well prior to Aluminium Sulphate (Alum) coagulation, pH correction using Sodium Hydroxide, flocculation followed by Dissolved Air Flotation (DAF). The DAF subnatant is dosed with chlorine prior to gravitating to two oxide coated dual media gravity filters to assist with manganese removal. Filtered water is then balanced and pumped to the treated water storage where it is dosed with chlorine for disinfection. Treated water is then intermittently pumped to the town reservoirs at regular intervals.

The WTP is a ‘run of river’ plant drawing raw water from the Gwydir River. The Gwydir River catchment sources water from many minor creeks and tributaries, however much of the flow come from Lake Copeton. Lake Copeton is a large dam used to supply irrigators through bulk releases of water throughout the year. Hence the Bingara WTP has the challenge of having to receive varying water quality throughout the year which are not only influenced by rainfall events but also frequent bulk water releases.

1.2 Strange Occurrences

During the few months preceding June 2017, Bingara WTP operators encountered unprecedented issues at the WTP with variable WTP performance.

The issues observed at the WTP by operators were concerned with difficulties achieving the target water quality objectives, in terms of turbidity and true colour. In addition, during this period the DAF subnatant and corresponding plant performance would deteriorate with the DAF subnatant (usually ~1.5 NTU) increasing at times from 2.5 NTU to 10 NTU within a matter of minutes.

Operators had noticed a 'chalky white' appearance in the river water during low river levels. Subsequent bulk water releases masked this appearance via increases in the raw water turbidity. This apparent change in the raw water quality had occurred approximately in June 2017 which coincided with the WTP struggling to produce acceptable water quality. Issues at the WTP were first noticed when the settled water above the filters became murky at times. Hunter H_2O was therefore engaged by Gwydir Shire Council to provide operational assistance with troubleshooting and rectification of the issues.

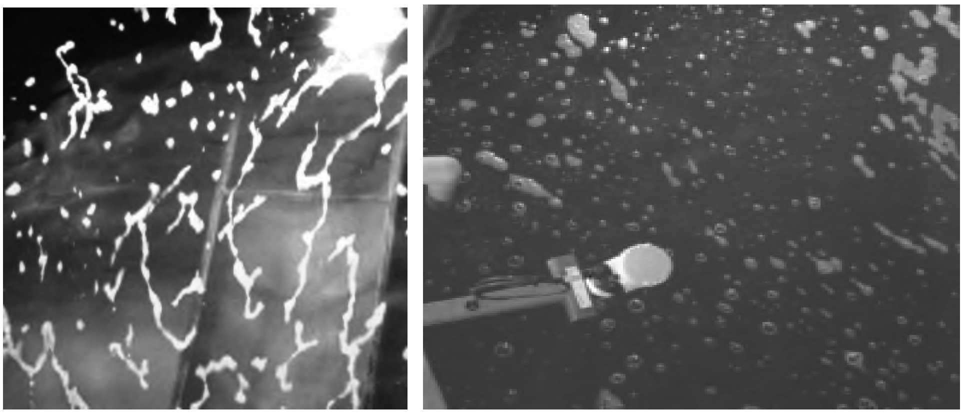


Figure 1: ***Clear water (left) and murky water (right) above the filters at Bingara WTP.***

2.0 DISCUSSION

2.1 Initial Observations

Hunter H_2O arrived onsite, in late October 2017, at Bingara WTP equipped with a troubleshooting kit consisting of a DAF jar tester, water quality analysers and equipment. The plant conditions and raw water conditions were recorded when onsite (Table 1).

Table 1: ***WTP and raw water conditions***

Parameter	Value	Units
Alum dose (as 100% product)	75	mg/L
Raw water turbidity	13	NTU
Raw water true colour	90	HU
Raw water pH	7.3	-
Raw water alkalinity	66	mg/L as $CaCO_3$
Coagulation pH	6.5	-
Coagulation alkalinity	25	mg/L as $CaCO_3$
Filtered water turbidity	1.24	NTU
Filtered water true colour	15	HU

During the troubleshooting process, many variables were examined to determine where the root cause may be for the plant performance issues that were being experienced. During observations of the operation of the WTP, the flocculation tank appeared to contain many small floc, while the DAF saturated water looked good being white and milky. DAF sludge was observed on the surface of the DAF system meaning floc was being floated (Figure 2), however, the DAF subnatant turbidity was still high measuring 3.7 NTU.

Figure 2: ***DAF float***

It was initially thought that the cold water temperature (~16°C) may have been impacting flocculation efficiency. Therefore, the flocculation time was checked, and a plan was created to reduce the WTP flow.

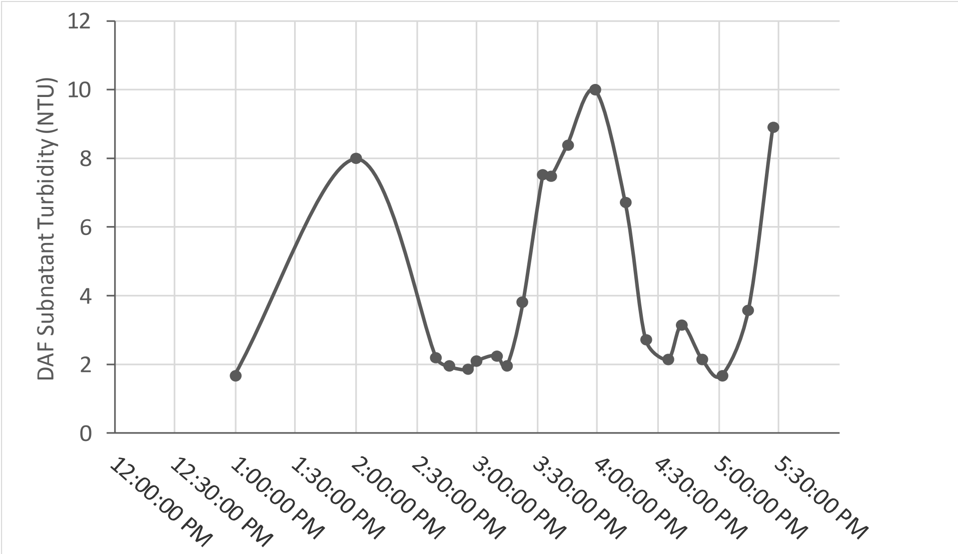
The WTP flowrate was decreased from 35 L/s to approximately 26 L/s and chemical dose rates checked. The flowrate was reduced to increase the flocculation time from 24 to 33 minutes and the DAF recycle ratio from 12.8 to 18.4%. These changes resulted in an almost immediate marginal improvement in DAF subnatant turbidity measuring 2.5 NTU. However, as there was no online DAF subnatant turbidity monitoring it was later noticed that the same unusual phenomenon of DAF subnatant quality deterioration had occurred with a later measurement reading 7.5 NTU even though there were no apparent changes to the raw water quality or process.

A sample was collected from the floc tank and put on the DAF jar tester. The floc was very weak and had broken apart very easily even with very gentle sample collection techniques. Even following addition flocculation time to allow the floc to grow back to the original size prior to sample collection, the DAF subnatant turbidity was found to be within 2.3 – 3.5 NTU across three sample jars. This simple jar test indicated that the floc was very fragile and could easily be broken apart, while also indicating the likely improvement that the WTP DAF might see at the reduced plant flowrate.

A DAF subnatant turbidity of 2.3 NTU was ok, but not what we hoped for and would expect from a well working DAF system. Following not much further improvement at the lower plant flowrates, the flow was increased to 35 L/s again. In addition, the increased demand during the impending summer would mean that the WTP cannot operate at lower flowrates, therefore a solution was needed that worked under the maximum plant flow.

2.2 Discovery of The Root Cause

A DAF jar test was performed to confirm the alum dose rate and determined that a reduction in dose provided a marginally improved DAF subnatant quality and filtered water quality. Meanwhile the WTP DAF subnatant was measured at regular intervals as the previous measurements at various points throughout the day indicated that the DAF subnatant turbidity may have been fluctuating up and down. The DAF subnatant was measured every 5-20 minutes as seen in Figure 3.



<u>Figure 3:</u> ***WTP DAF subnatant turbidity fluctuations.***

It was found that there was a consistent cycle of the DAF subnatant turbidity increasing and decreasing in an unnatural manner. Therefore, the following factors were investigated one by one through site investigations, measurements, review of SCADA trendlines and jar testing to see which factor might be affecting the DAF performance in this way:

- Raw water flowrate and pH changes
- Alum dose rate and coagulation pH changes
- DAF recycle rate, saturation vessel pressure changes and bubble rise rate (time taken for the micro bubbles to rise to the top of a jar)
- DAF sludge pump and clear water pump operation

Strangely enough the only parameter that aligned with the cyclic nature of the DAF performance changes was the clear water pump operation. The SCADA trend of the clear water pump operation indicated that during every pump start the DAF subnatant turbidity would immediately increase which aligned perfectly with the frequency of the DAF subnatant turbidity fluctuations.

It was then observed that upon the clear water pump starts there was a significant jolt in the plant pipework due to water hammer which could be felt at the DAF tank itself. A theory was then formed that the mechanical vibration might be enough to detach the floc from the bubbles if the hydrophobicity of the floc was poor. It was then thought that if a change in the raw water organic characteristics, or some other change in raw water quality, was affecting the alum floc hydrophobicity then either a different coagulation pH, alternative coagulants such as Aluminium Chlorohydrate (ACH) and Polyaluminium Chloride (PACl), or the addition of a polymer may be required.

A jar testing plan was then devised for the next day.

2.3 Troubleshooting via DAF Jar Testing

The objective of the onsite and office based jar testing was to identify the following for Bingara WTP:

- Onsite jar testing:
  - Determination of the optimum alum dose and coagulation pH;
  - Assessment of alternative coagulants such as ACH and PACl;
  - Assessment of flocculant aid polymer dosing.
- Hunter H_2O Office based jar testing:
  - Polymer type, charge and dose optimisation;
  - Preferred delay time between alum dosing and polymer dosing;
  - DAF recycle rate optimisation.

The jar tests aimed to achieve the following targets:

- DAF subnatant turbidity: <2 NTU or lower (preferably <1 NTU);
- Filtered turbidity: < 0.15 NTU; and Filtered true colour: < 5 HU.

2.4 Jar Testing Findings

The relevant key findings from the onsite jar testing investigation were:

- Surprisingly a larger floc was formed at the lower Alum dose rates, which using a sedimentation jar test resulted in better performance, however, alum dosing alone did not produce readily floatable flocs (i.e., DAF subnatant water quality). The best DAF subnatant achieved was only 2.86 NTU.
- The DAF subnatant turbidity (i.e. flotation performance) was very sensitive to alum dose while the filtered water turbidity was not as sensitive.
- Of the three coagulants trialled, PACl performed marginally better than ACH while ACH performed better than Alum in terms of DAF subnatant turbidity (Figure 4). Both ACH and PACl were more forgiving over a wider dose range (Figure 4). However filtered water turbidity was similar to that achieved with both Alum and ACH dosing while filtered water true colour was the lowest of the three coagulants tested.
- Alum combined with polymer performed better than Alum alone, ACH alone and PACl alone in terms of DAF subnatant turbidity (Figure 4), filtered water turbidity and true colour.
- The floc size was dramatically increased when polymer dosing, compared to all previous jar tests.

Further office based jar tests identified the following:

- All six differently charged polymers resulted in improved DAF subnatant turbidity compared to no polymer dosing.
- A cationic or non-ionic polymer was more suitable.
- Polymer dose rates seemed to have an impact on filtered water true colour with a lower dose (0.1 mg/L) resulting in better colour removal.
- A delay between alum dosing and polymer dosing of between 30 – 300 seconds resulted in lower DAF subnatant turbidites.

Some of the results above are presented in Figure 4 and compared on an equivalent Al_2O_3 dose rate basis.

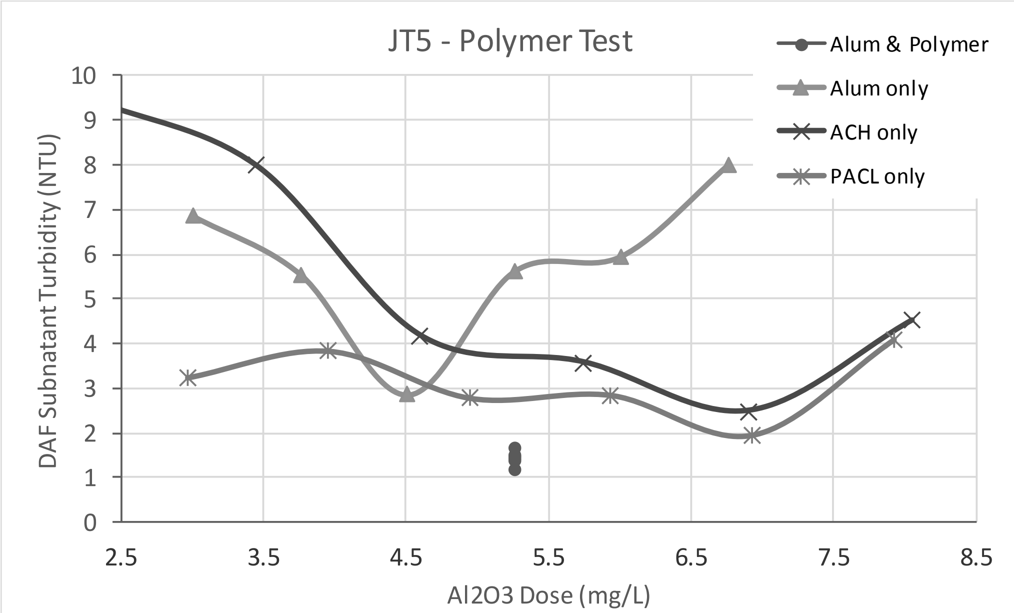


Figure 4: ***Jar Test DAF Subnatant turbidity as a function of Al_2O_3 dose rate comparing Alum, ACH, PACl and alum + polymer.***

3.0 CONCLUSION

DAF performance can be impacted by changes in raw water quality due to its reliance on the attraction between floc and bubble. It was discovered that a suspected change in the characteristics of the raw water was impacting the strength and hydrophobicity of the Alum floc. Thus, impacting DAF subnatant turbidity at regular intervals due to floc detaching from the bubbles following pump starts.

DAF jar testing was successfully used to troubleshoot and identify the likely cause of the issue and identify potential solutions in a rapid and effective manner. The DAF jar testing investigations quickly determined that a polymer was required to improve the physical characteristics, increase the hydrophobicity of the floc and improve overall DAF performance, while use of a standard sedimentation jar test failed to identify these issues.

Hunter H_2O is continuing to work closely with Gwydir Shire Council by undertaking a full-scale trial with polymer being applied on the full scale WTP. If the full-scale trial results confirm the promising results collected from the jar testing investigations, then Hunter H_2O will assist Gwydir Shire Council with a permanent dosing system upgrades.

4.0 ACKNOWLEDGEMENTS

Thank you to the operator at Bingara WTP, Rupert Wall, for supporting and assisting throughout the troubleshooting process and running the current full-scale trial.

Special thanks to Andrew Cooper of Gwydir Shire Council for engaging me in this project and for his assistance with preparing this paper.

Also thank you to my colleagues, Paul Thompson, Chris Conway, Dr Yaode Yan and Nathan Dick for assistance during the onsite investigations, reviewing the peculiar findings, performing additional jar tests and setting up the full-scale polymer trial.

Runner up for the Best Operator Paper at the
80th Annual WIOA Victorian Water Industry Operations Conference,
Bendigo, 2017

YACKANDANDAH ENERGY STORAGE PROJECT

Paper Presented by:

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Author:

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North East Water

12th Annual WIOA
NSW Water Industry Operations Conference and Exhibition
Tamworth Regional Entertainment & Conference Centre,
11 & 12 April, 2018

YACKANDANDAH ENERGY STORAGE PROJECT

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

ABSTRACT

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

Along the journey North East Water have also partnered with SPAusnet to test energy storage through a mini grid pilot program that will see a sewerage pump station being powered by local housing that will collect solar energy for the batteries to run the station.

Both these projects are helping North East Water meet its carbon pledge of a 50% reduction in carbon emissions by 2025.

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

1.0 INTRODUCTION

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

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

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

This paper will review the progress of the 'Energy Storage' project.

The energy storage project was chosen as it represented three opportunities that could inform the water industry.

Those opportunities were:

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

2.0 THE PROJECT

Early in the project it was identified that a site for this trial needed to be a small water or waste water treatment plant (around 1 ML/d) for risk management purposes.

By selecting a smaller plant, contingency energy or water supply could be supplied if issues with the storage unit were to arise.
It was also helpful if the project could capture community support to promote the project as a positive outcome, and not an argument around climate change verses capital expenditure.

After several sites were investigated, the township of Yackandandah was selected as it had the right sized Water Treatment Plant (WTP), and a community group focused on renewable energy outcomes.

The community group known as TRY or Totally Renewable Yackandandah had set themselves a goal of being 100% renewable by 2022.

The Yackandandah WTP covered the aspects associated with risk, including the ability to cart water if required.

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

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

2.1 First Step - Energy Reduction

The first step to understanding what the project might look like, North East Water first had to assess the energy profile of the plant. This allowed NEW to understand the energy requirements to have sufficient renewable energy and storage to run the WTP "off grid".

It was initially identified through profiling the energy consumption that the WTPs energy use was highly variable showing large spikes during the plants operation as shown in Figure 2.

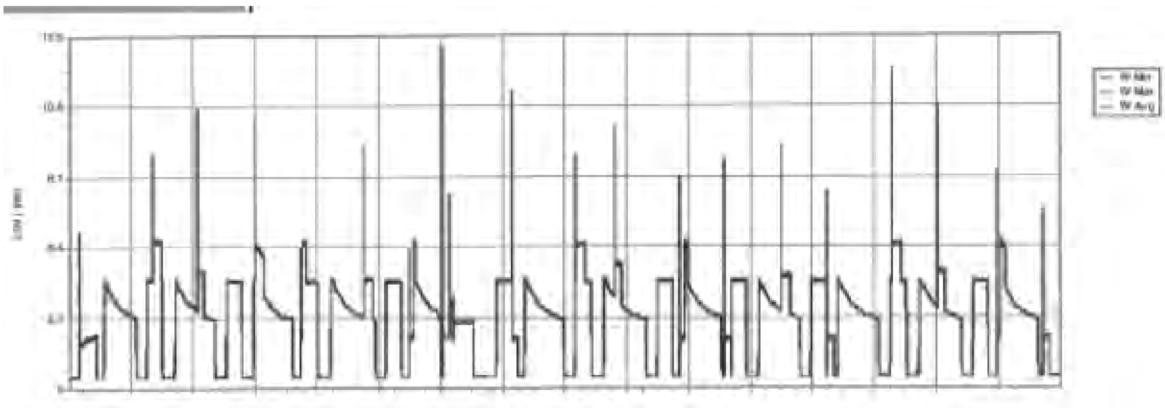


Figure 2: ***Yackandandah WTP energy use***

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

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

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

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

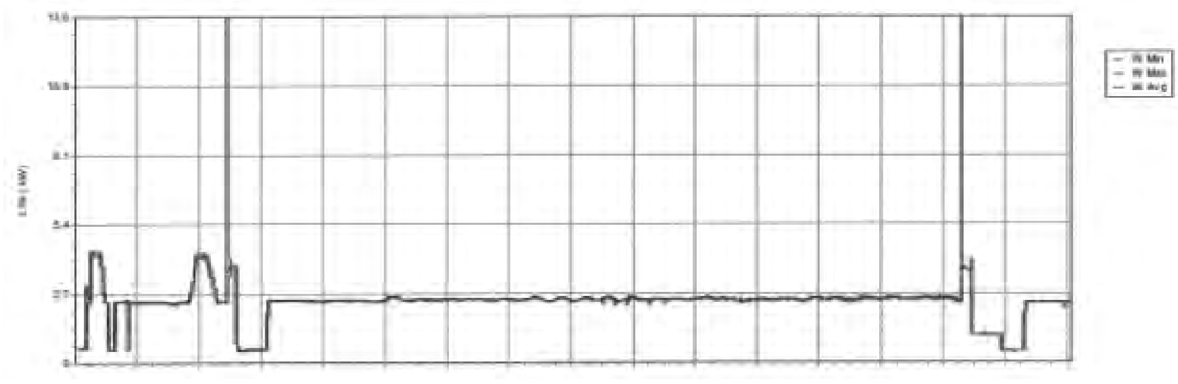


Figure 3: ***Yackandandah WTP energy use after optimisation***

2.2 Community Engagement

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

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

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

This connection then saw SPAusnet (Energy network provider), the community and North East Waters network provider coordinate to introduce a mini grid installation. By having the key partnerships with TRY other parties have expressed interest and now wanting to get involved. Further projects are now being investigated to help reach the 2022 target.

2.3 The Installation

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

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

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

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

The installation consists of a solar photovoltaic array of 140 panels situated at the top of the WTP storage, with a DC powerline down to the plat with 24 lithium ion sulphite batteries and inverter combinations inside a weatherproof switchboard (see Figure 4).

The value of the Lithium Ion batteries North East Water is installing is that the footprint is small enough to fit into the current site.

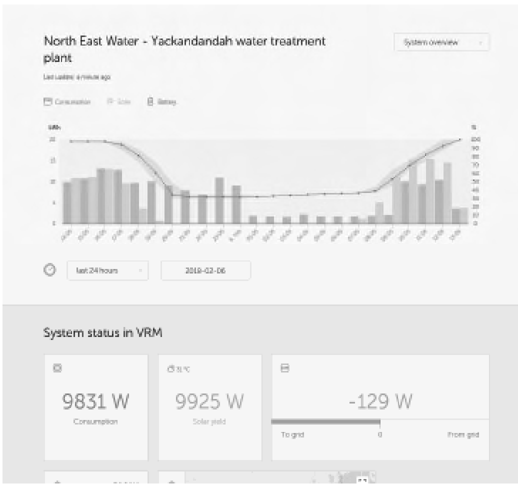
The generated solar power feeds the plant while the WTP is running, the excess energy tops up the batteries at the same time or when the plant is idle. When the solar panels no longer generate the plant will switch over to the battery supply. The batteries also can top up on cheaper off-peak power then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

<u>Figure 4:</u> ***Weatherproof switchboard***

3.0 CONCLUSION

The plant has been in operation since October 2017 and has resulted in the following learnings:

1. The value of energy optimisation before the plant is designed and built to ensure cost efficiencies
2. Better utilisation of the clear water storage tank as a battery can optimise solar generation instead of battery consumption (see Figure 5)
    a. Figure 5 is an example of where plant run is called while not generating solar power resulting in draw down of the battery and corresponding grid draw
3. The size of the solar and battery is correct but only if the plant is run off solar during the day and the ancillary plant power is run from the battery at night
4. North East Water have gained extensive learnings into power storage for other sites within the Corporation through this project



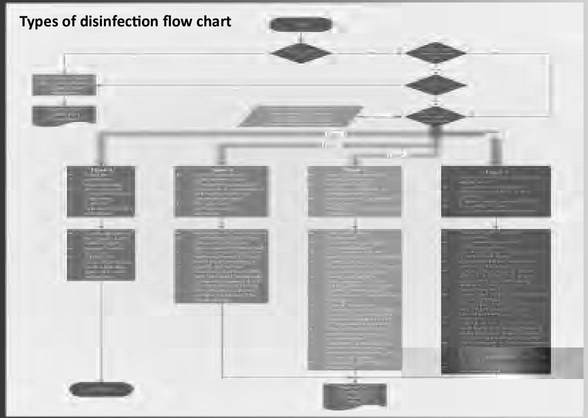
<u>Figure 5:</u> ***Daily plant tracking of solar and battery generation***

Along with all these learnings, the biggest highlight for North East Water has been the community support and partnership with the 'TRY' group who have been strong advocates for our business and the project.

POSTER PAPERS SUBMITTED FOR JUDGING:

Judging from 1.10pm on Thursday, 12 April 2018

- **Mr Wes Trotter** *(Kempsey Regional Council)*
  - "Hat Head STP Modifications"
- **Mr Danny Roberts** *(Port Macquarie Hastings Council)*
  - "Water Mains Disinfection – Keeping up with Development and Growth"
- **Mr John Lawton** ***(****Moree Plains Shire Council)*
  - "CCTV Investigation and Assessment of Sewer Rising Main Assets"



WATER MAINS DISINFECTION

Keeping up with development and growth

By Danny Roberts
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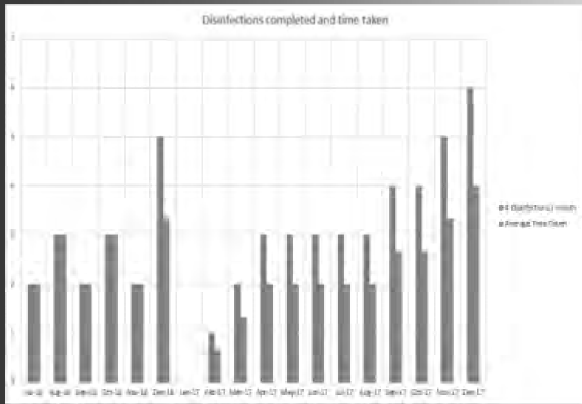
PORT MACQUARIE HASTINGS



Disinfection of new water mains has become a full time job for our Water Process Team. This is due to increased development in the Port Macquarie area.

Our processes and methodology to complete disinfections have been reviewed and updated to drive efficiency and meet the increased demand.

Review outcomes -

- Streamlined planning procedures
- Development of disinfection task calculator
- Revised operating practice, SWMS & SOP documents
- Higher target chlorine residuals to achieve effective 'KILL'
- Reduced task time / higher target residual reduced CT

Example of hydrant de-chlorination unit using ascorbic acid

Example of hydrant to hydrant dose for mixing and injection

Example of hydrant de-chlorination using mats & ascorbic acid

CCTV INVESTIGATION AND ASSESSMENT OF SEWER RISING MAIN ASSETS

Moree Plains SHIRE

OVERVIEW

- Rising mains convey sewage under pressure from a pumping station to a point of discharge such as a gravity sewer or a sewage treatment works.
- Rising mains are very difficult to inspect, as they are under pressure and frequently cannot be taken out of service.
- In a rising main there may be very limited, or even no access into the pipe.
- Rising mains often contain bends that may be difficult for testing and inspection equipment to navigate through.

POSSIBLE CAUSES

- In a rising main, condition assessment should ideally identify and quantify defects in the pipe wall, before they extend through the wall and cause a leak.
- These defects can be caused by a variety of factors and may occur at isolated sections along the pipe

PROBLEMS CAUSED

- The probability of pollution incidents arising from any failure is significant because the sewage is transported under pressure.
- It is often difficult to set up by-pass arrangements for rising mains, especially during wet weather events, and it can be difficult to carry out repairs.

SOLUTIONS

- Two trials are currently in progress
- Installed two new manholes in rising mains, cut 0.5m section of rising main and corrected with 0.5m of vacuum suction hose clamped with 150mm travis clamp/ 2nd trail connected with T Flange blanked off one end and connected with spigot flange couplet and connected back to main
- The clamped suction/ T flange hose acts as an inspection portal for pipe cleaning, CCTV condition assessment and future rehabilitation and maintenance works.

By John Lawton E: john.lawton@mpsc.nsw.gov.au P (02) 6757 3222

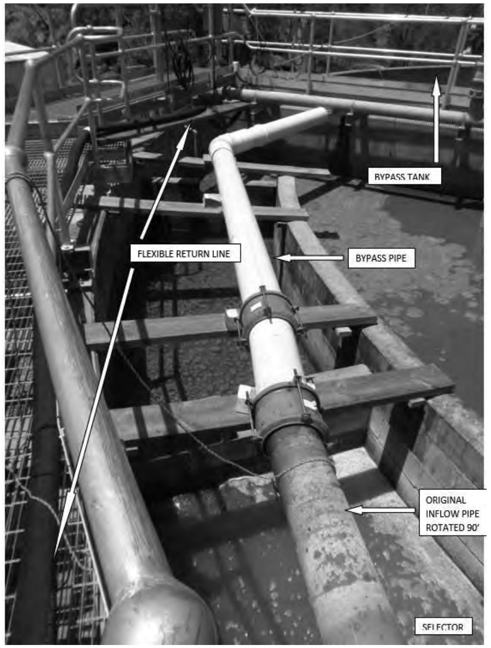
Hat Head STP Modifications

Full Plant Trial

After a lot of discussions it was decided that a full time diversion would be put in place without any actuated valving and a pump returning the diverted inflow from the bypass tank (old #2 aerated sludge tank). To control the process , once the decant has finished and the plant resumes its treatment phase the pump will resume normal operation and empty the storage tank into the selector. The pipe work for the diversion was already on hand at the plant. It was previously used for the installation of new Aquablade air diffusers. A second hand submersible sewer pump was sourced from the spare pump shed. This pump had a floor stand already fitted which placed the bottom of the volute about 160mm above the floor of the bypass tank (#2 sludge tank) and had a flow rate of approximately 10-12L/sec, which made it ideal for the job. The pump can be lifted to remove chokes (which is unlikely) via a gantry and hand winch. A flexible3"fuel delivery hose was used to transport the pumped liquid into the selector exiting via a short tailpipe.

The Issues

During holiday seasons and peak summer months the population of the small village of Hat Head increases dramatically. With this increase, the sewage treatment process traditionally struggled to cope with the increased daily inflow above 125KL/day. This was due to the short circuiting of incoming flow during the settle-decant period of the process. The plant displayed the ability to treat higher flows by reducing ammonia to acceptable limits and settling well. However during the settling/decant phase inflow would disturb the sludge blanket, causing an increase in turbidity and ammonia. During peak holiday flow periods the volume of inflow during the settle/decant phase (which has a duration of around 80 minutes) could approach 20KL. This figure represents about 33% of the current weekday diurnal flow



Trial Results and Augmentation

The plant failed two licence samples in January 2014 while we were optimising the process. As a result a winning combination was found whereby the plant produced clear, compliant effluent, decant after decant, regardless of time of day. It was found the bypass tank level was crucial to accept peak daytime flows.

From the successful trials an augmentation design was created. The design included a permanent influent line to the bypass tank with provision to bypass straight to the selector, two dry mount pumps capable of 14l\s @0.5m tank level, a bypass return line to the selector, level sensors, flow meter, automation and associated chemical dosing lines were upgraded while works were being completed. Before the augmentation was started the process team decided to upgrade the platforms, walkways and all working at heights and associated safety equipment.

Author: Wesley Trotter– Process Engineer, Kempsey Shire Council Ph: 02 6566 3328 Email: wes.trotter@kempsey.nsw.gov.au

Acknowledgements: I would like to thank Kempsey Shire Council and the Sewer Process Team especially Mick Short and Elissa Burgin for their committed and valuable work during the trialling, design, construction and commissioning phases of the augmentation.