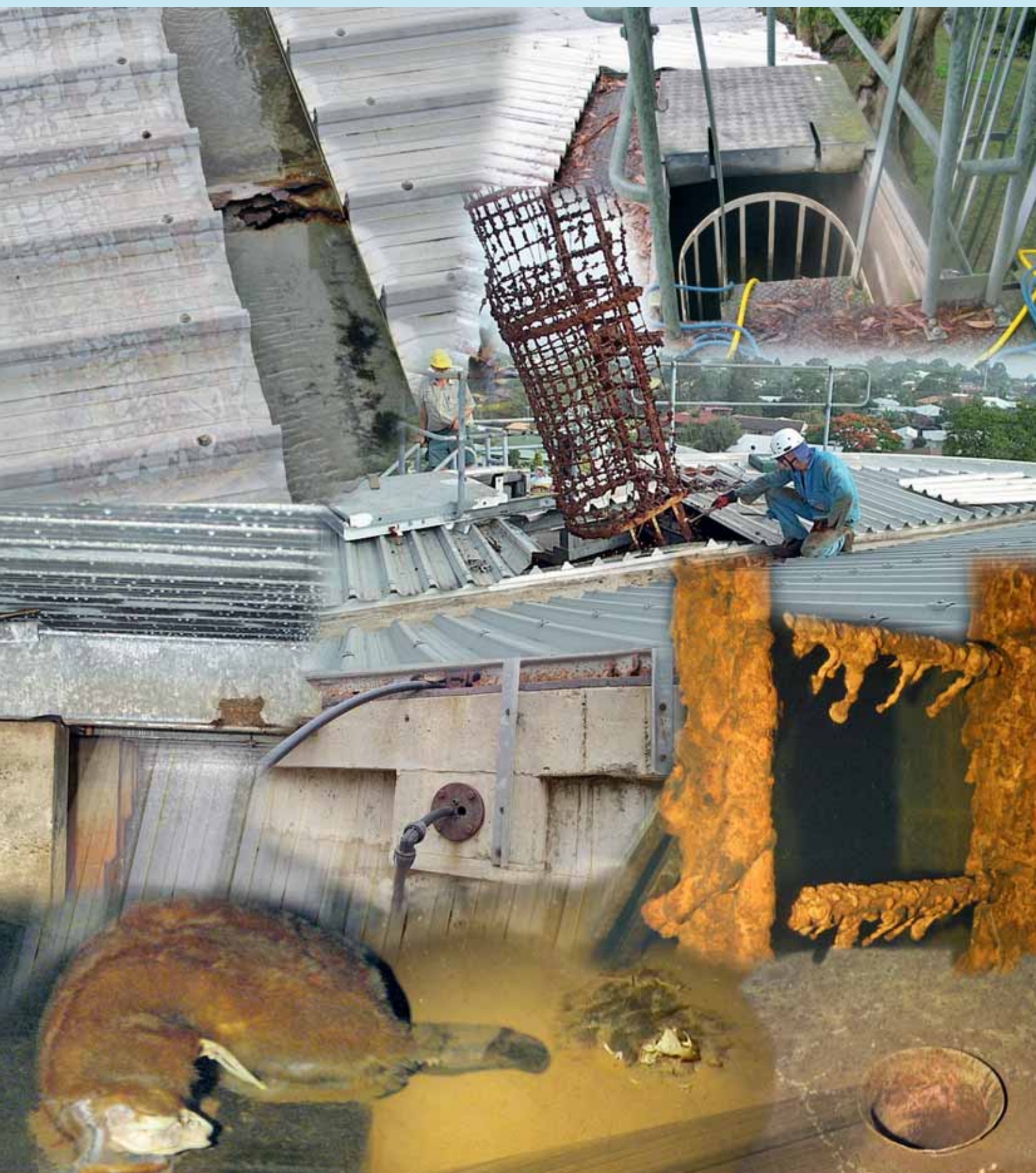


# WATERWORKS



OFFICIAL JOURNAL OF THE WATER INDUSTRY OPERATORS ASSOCIATION

December 2008



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## CONTENTS

Editorial - Filter Training Needed for STP Operators??	3
Letters to the Editor	4
Recycled Water Colour Woes	7
Cleaning Diffusers at Edgeworth WWTW	10
Bright Filtration Shines	13
Kwatye Prize Report: Sewer Blockages and Tree Roots	15
Sewer Response Unit (SRU)	18
Kawana STP Upgrade Sorted	20

# FILTER TRAINING NEEDED FOR STP OPERATORS??

Recycled water is certainly topical at the moment. Hardly a newspaper, water industry magazine or conference passes without significant reference to recycling be it for third pipe use for toilet flushing, beneficial reuse on community sports fields or indirect potable use.

To meet the requirements for recycling, many STPs are being retrofitted with media filters, BUT are the operators similarly being "retrofitted" with training for media filter operation and in some cases coagulation, flocculation and clarifier operation. All too often, training is boxed according to the role the operator fulfils, so wastewater operators complete waste treatment courses and water treatment operators complete water treatment courses.

Filters are built at STPs but the operators aren't trained on how to operate them. Unfortunately, as a result, many STP media filters become blinded and perform well below their optimum. Two examples show the extent of the problem. In one media filter at an STP, the damage to the filter

was so extensive that when the filter inlet valve was closed and the filter outlet valve opened there was no drop in the level of water in the filter. At another plant, 90% of filter coal media had been lost and the remaining 10% was badly contaminated with mud balls to the extent that this remaining media needed to be removed. If nothing else this would represent a significant cost to the utilities to "fix" the filters. The cost of operator training pales into insignificance against the cost of refurbishment that may cost between \$20,000 and \$30,000 per filter.

Recognise that if a new element or process is added to a plant a check needs to be made to ensure the operators are able to operate that element. Failure to operate it well may lead to not meeting the requirements for a particular class of recycled water or worse, many \$10,000s to refurbish trashed filters.

**Peter Mosse**  
**December 2008**

## HOW GOOD IS YOUR TREATED WATER STORAGE???

Our cover this month is a montage of photographs taken on, beside or in various treated water storages across our country. The photographs have been kindly provided by Dave Barry of Aqualift Pacific. Clearly, many of our treated water storages leave a lot to be desired in ensuring the safety of our drinking water. International events like Gideon, Missouri in 1993 where in a town of 1100 people, 600 people became ill and 7 died due to poor maintenance of a treated water storage and contamination with bird droppings should bring home the message loud and clear. More recently in Australia, Cairns Regional Council issued a boil water alert in Port Douglas and surrounding areas as a result of *E coli* being present in 7 of 12 treated water reservoirs. In an interview on the ABC PM program, Cairns Regional Council Manager of Regional Waste and Water stated that "some of the reservoirs do have small holes and gaps and things in the roofs where this contamination could be coming in through lizards, cockroaches and frogs and who knows what else. We

will be moving to clog up those holes as best we can." Not sure about the accuracy of the implied microbiology however the suspected cause was clear, storages with gaps in them. In a recent event in the UK (reported in *Health Stream* September 2008) a single dead rabbit in a storage resulted in a boil water alert for 250,000 people in England. The event has been linked to several illnesses from a species of *Cryptosporidium* previously thought not to infect humans.

The photos on the front cover show a possum's and a fox's corpse in storages, roofs with holes in and access hatches that allow anything on the roof to easily run into the storage every time it rains. The question needs to be asked, how many people are becoming ill in Australia due to slack maintenance of treated water storages. We know that recontamination of drinking water after it has left a treatment plant is a high risk and yet storages like the ones on the cover are all too common. Isn't it time we cleaned up our act. Imagine seeing storages like this at a dairy factory or brewery?? Why is water different??

Dear Editor,

Morgan WTP in South Australia takes water from the Murray River at Morgan, treats it via a 200 ML/day conventional filtration plant and pumps it to a significant proportion of the state. My role is to provide the required support to a hard working group to ensure this happens.

I began my time with the then government department at the first Water Filtration Plant in this state at Hope Valley in the late seventies as an instrument tradesman, and for much of the time since have been involved in water treatment in one form or another.

During that time I have also been involved in a number of capital projects. It is on this subject and as a response to Peter Mosse's editorial in June 2008 *WaterWorks* that I write this article.

The nature of those projects has varied from a few thousand dollars and a couple of weeks to complete, to more than a million dollars and over a year to complete. My first serious one was where I was asked to design a system that enabled the dosing of copper sulphate into reservoirs without the use of extensive manual labour. I decided to hire a jet boat and inject the copper sulphate into the intake of the jet venturi. Unfortunately I had to spend several weeks in summer traversing the reservoir at high speed. It was a tough job but someone had to do it (and it worked by the way).

Anyone who knows Peter (or has read his editorial) will be aware that he has a very strong allegiance to those folks who operate treatment plants, and has been an advocate for their role in the system for many years. His editorial emphasised the responsibilities of project managers, design engineers and financial administrators, and I would agree with him that on more than the odd occasion some of these folks forget that the whole aim of the exercise is to provide a facility that enables an operator to fulfil his or her responsibility to provide the outcomes required of them.

It is at this point I would like to add to the discussion. I have at times inherited new systems that have had little involvement from the operators. This has been because the attitude from that group (or more often our managers) has been that they do not have the time or inclination to be an integral part of the design and implementation of such systems. Very often we order a horse and get a camel- basically the same sort of beast but hardly compatible. It is my opinion that in these circumstances we have no one to blame but ourselves. I know how difficult it is to

allocate the time needed to make sure we get our horse but it is the only way to achieve the result. It could be argued that not only do we have the right to influence the design and implementation of capital upgrades, but a responsibility.

We recently completed a replacement of our control system, right down to the variable speed drives and PLC's. By nature, this was the type of project that needed involvement from the end users throughout the process, and I was very fortunate to have a manager that recognised the fact that this involvement was not an optional extra. I was also lucky enough to have a group of colleagues that were prepared to take up the slack to enable me to commit to such a large project. There were many occasions where I had to argue long and hard to get what we considered a basic requirement, and I must say that as long as it was a logical argument, we managed to get the support of the project managers. I would not wish to imply that this process was an adversarial one, because it was in fact the exact opposite. At the risk of sounding corny, I have to say that I enjoyed the whole affair, and have nothing but praise for all of those involved, including the contractors. We all worked together as a team and the result reflected that fact.

I am not naïve enough to suggest that this will always be the case, but I can assure the reader that it is possible to end up with a project that meets all of the criteria as far as time, cost and functionality is concerned but can also be enjoyable for all those connected with it.

**John Knoblauch**  
**Morgan WFP Senior Operator**  
**SA Water**

Dear Editor,

We have just finished off cleaning some tanks for a client that must (but doesn't deserve to) remain nameless!!!

Dead rabbits, snakes, frogs, birds .... all the normal kinds of stuff. The same stuff we identified in our reports from 6 years ago... and nothing has been done in that time to fix the obvious problems!

I mentioned it to one of the operators (who incidentally has never heard of WIOA either), and this was his answer..."a bitta shit never hurt anyone" actually there where a few 'c' words in there as well, but you get my drift...

THERE IS MORE WORK TO GO, before we 'hang up the gloves' I reckon!!!!

## Water Safety: finding the balance

Clean, safe drinking water. This should be our industry standard.

Yet safety has long been focused on the personnel working in our various water industries with little attention being given to the safety of the actual product.

Most organisations have developed safety protocols, staff resources and working equipment to address personnel safety. All of these areas are driven by Work Cover guidelines, media coverage and legal actions.

Most training courses focus on personnel safety: confined spaces and working at heights to name but a few.

But have we gotten the balance wrong?

Has personnel safety been given a priority only because there are more resources and information available on the subject?

Is it easier to focus on personnel safety because "everyone else is doing it"?

Do we really need to send personnel on yearly training courses in say confined spaces, when the subject matter is fairly easy to understand? Why are we allowing training organisations to nominate yearly re-certification periods when there is no legal requirement within the Australian Standards to do so?

We don't require yearly re-certification in driving a motor vehicle, yet this is where the large majority of work place and private accidents occur: on our way to and from our work environment.

So the question needs to be asked: why aren't we focussing more of the training budget into those areas that have potential to cause harm to a LARGE GROUP of personnel at any one time, that is, our water consuming customers?

We have previously suggested 'Water Cover' as well as Work Cover. We need an organisation that records water quality incidents, administers a system to respond to problems as they occur and one that educates the workers and public alike of their respective rights and responsibilities when it comes to consuming the product.

Why not develop some training courses in 'water contamination identification'? Give our operators the 'tools' to identify the real risks facing our industry?

There has been a lot of media attention given lately, to bottled water, asking why use 'oil driven, disposable packaging' when tap water is fine. Well, I for one can tell you that in a lot of cases 'tap water' is NOT FINE, and it is only the lack of media attention and no formalised system

of recording and publishing the 'near misses' that is fuelling the impression that 'all is well'.

Work Cover has had no hesitation in telling us that "we are constantly at risk in the home and at the workplace" and everyone is beginning to believe it. But is it really true? Have we lost our natural common sense and become too reliant upon their systems, their training and constant media reminders in order to survive?

Isn't it time to shift the focus slightly to something that may have a significant impact on everyone's safety one day?

WATER. The most important thing to life as we know it, yet also the most misunderstood, misrepresented, and undervalued product of our time!

**Dave Barry**  
**Aqualift Pacific**

Dear Editor,

The June edition of *WaterWorks* canvassed the establishment of a WaterCover authority to ensure water is stored in a high

quality, hygienic environment. There are standards in Australia for the storage of potable water, specifically ASNZS4020, and architects and engineering designers by and large place a high value on the manner by which water is stored.

However, the requirement for tendering projects begins the erosion of standards. The construction industry is encouraged to respond with the cheapest possible tender in order to win the project. Our community relies on and expects the highest possible quality and safety standards when it comes to water supply. The tender process is by and large a good one – it is designed to protect the community through process transparency. But it does have a downside when quality is a prime consideration.

Consider this example in a regional community. The local authority draws up plans to store 10 mega-litres for the town water supply. Despite the rhetoric about long term viability and sustainability, the council wants to spend as little as possible. The least expensive option is to simply excavate a shallow dam in a nearby field and line it with plastic so the water doesn't

become mud. A barbed wire fence will be required to reduce the risk of contamination. This then forms the basis for further alternative comparisons once the tender process has started.

An alternative to the dam would be of course to build a 10 mega-litre tank, of a type approved for water storage, with a sealed roof. The cost of this is however considered beyond the budget. But why? It is worth considering the following:

- A properly installed and approved tank will reduce water evaporation to zero. The average annual evaporation rate in many parts of regional Australia exceeds the average annual rainfall rate by about 3650 mm in the north and 200 mm in the south. A tank with a sealed roof will not only eliminate evaporation, it will keep the water cooler, require less chlorine purification, and keep it free of decaying animal matter, insects, and other contaminants.
- If the tank is properly sealed from light, the risk of algae and micro-bacteriological contamination is reduced to an insignificant value.

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- Consequently, the need for regular and high dosages of chlorine is reduced markedly.
- Furthermore, the sealed tank reduces the risk of wilful or accidental contamination of the water and in most circumstances; the tank would not require a security fence around it.
- A tank built on tank stands approximately 500mm from the ground would offer ease of inspection and close to zero maintenance.
- Some GRP tanks such as the ones my company supplies can offer up to an eight times safety factor. An earth dam is always at risk of breaking its banks, of the liner splitting turning the water to mud, and is exposed to risk of wilful damage.
- Unlike a dam, a tank provides ease of inlet and outlet attachments and maintenance.

Outcome: The initial cost of the tank (rather than the long term cost) might be double the budget for an earth dam. It is consequently rejected by Council as too expensive. This short term solution is hardly the outcome the community deserves.

Consider another scenario becoming prevalent in today's cities. A large high-rise building is managed not by the owners, but by a management firm that has won the bid to manage the building for a certain number of years. While quality will no doubt be part of the winning bid's pitch, the reality is that the owner will almost always look to the final figure, that is, how much will this cost per year? From the date of engagement, the building managers look to reduce costs below the budgeted figure and hence make a profit. Increasingly, the site facility manager is paid a small retainer with bonuses for performance. The performance criteria are of course bringing the maintenance contract in under budget. The more the savings, the more the bonus. Quality and sustainability should be the prime considerations, not savings. Risk and future maintenance issues are put aside to meet budget for the year. Outcome: The corroding and leaking tank in the plant room is patched up and not replaced for another year, at risk of bursting and damaging expensive plant and mission critical equipment such as servers and



impairing the facility with loss of water. For this, the facility manager is rewarded with a bonus. Does this makes sense?

Readers will be familiar with these tales and no doubt have a few of their own. In both scenarios, water quality has not been the prime consideration. Water testing is rare. Many tanks are not approved for potable water but are installed none-the-less. Inspection of valuable water tanks and equipment is rarely a designated person's responsibility. Tanks in buildings and outdoors are often to be found with other equipment stored on the roof or even work and welding benches immediately alongside with little regard for the structural integrity of the tank.

Damage to a tank by other parties is rarely notified unless it immediately leaks. When the tank supplier is called in, detail is sketchy or none-existent and yet expectations of warranty repairs are raised.

*WaterWorks'* concern for WaterCover makes sense. Adding to the article's list of considerations:

- Tanks should be clearly specified in tenders and suppliers not permitted to quote lesser quality substitute products.

Only water quality approved tanks should be specified.

- All tanks required for 10 years use or more, should be externally reinforced. Today's tank technology is highly advanced and materials used in the construction of the tank allow them to be made without any steel or metal touching the water. This safeguards the water quality as well as removing the risk of corrosion which can lead to leaking and rupture. Importantly, externally reinforced tanks can be inspected without the need for internal examination and adjustments can be readily made from the outside.
- Internal ladders and other critical components should be uPVC or GRP, or rubber coated.
- Ideally, all tanks should be completely sealed from light, dust and insects and built with drain outlets at the lowest point of the tank so that tank flushing is complete.
- Manhole covers should be locked at all times.
- All tanks should be subjected to materials testing at Australia's registered labs.

Many elements could be added to the list. The point made by *WaterWorks* in June is that water is too valuable a commodity and our health is too great to risk. WaterCover will be the next step if we as an industry fail to raise the bar.

**Robert DeBelle**  
General Manager  
Dematec Water

Dear Editor,

Just read your article in *WaterWorks* June edition on "It's just not good enough".

It was a great article and very true, in fact from the pictures in the article we have the same membrane plant and the same problems.

Just wondering if you can forward my contact details to the operators at this plant and maybe we could use each other when we get stuck on a problem.

THANKS

**Michelle Pankhurst**  
Water Treatment Plant Operator

# RECYCLED WATER COLOUR WOES

*Yolanda Sztarr*

*Winner of Iwaki Pumps Australia Prize for Best Paper Overall at the WIOA NSW Engineers & Operators Conference, Newcastle, April 2008*

Melbourne Water and the Melbourne retail water authorities have identified colour as an emerging critical quality parameter, especially for water reuse.

Recycled water is supplied by Melbourne Water through the Eastern Irrigation Scheme which recycles ~3.5% of the treated effluent from the Eastern Treatment Plant (ETP). Reclaimed water is treated with ultra-filtration to meet Class A irrigation quality, then distributed as recycled water to over 60 locations for horticulture, recreational, industrial and non-potable residential use. South East Water Limited (SEWL) also supplies reclaimed water from its own treatment plants, treated to Class C quality, for uses including agriculture and irrigation of a golf course.

Unfortunately, some customers receiving recycled water have complained about its quality, especially the staining of toilet bowls that are flushed with recycled water. Whilst such complaints may appear trivial, especially when water resources are becoming increasingly constrained, these customers are likely to stop using the recycled water entirely. In this way, colour can present an aesthetic barrier to customer acceptance, and failure to address colour issues may compromise the success of projects that reuse or recycle water.

Colour in recycled water obviously arises from the wastewater received and how it is treated; but the contribution of individual trade waste customers and domestic customers to the resultant water quality is not well understood.

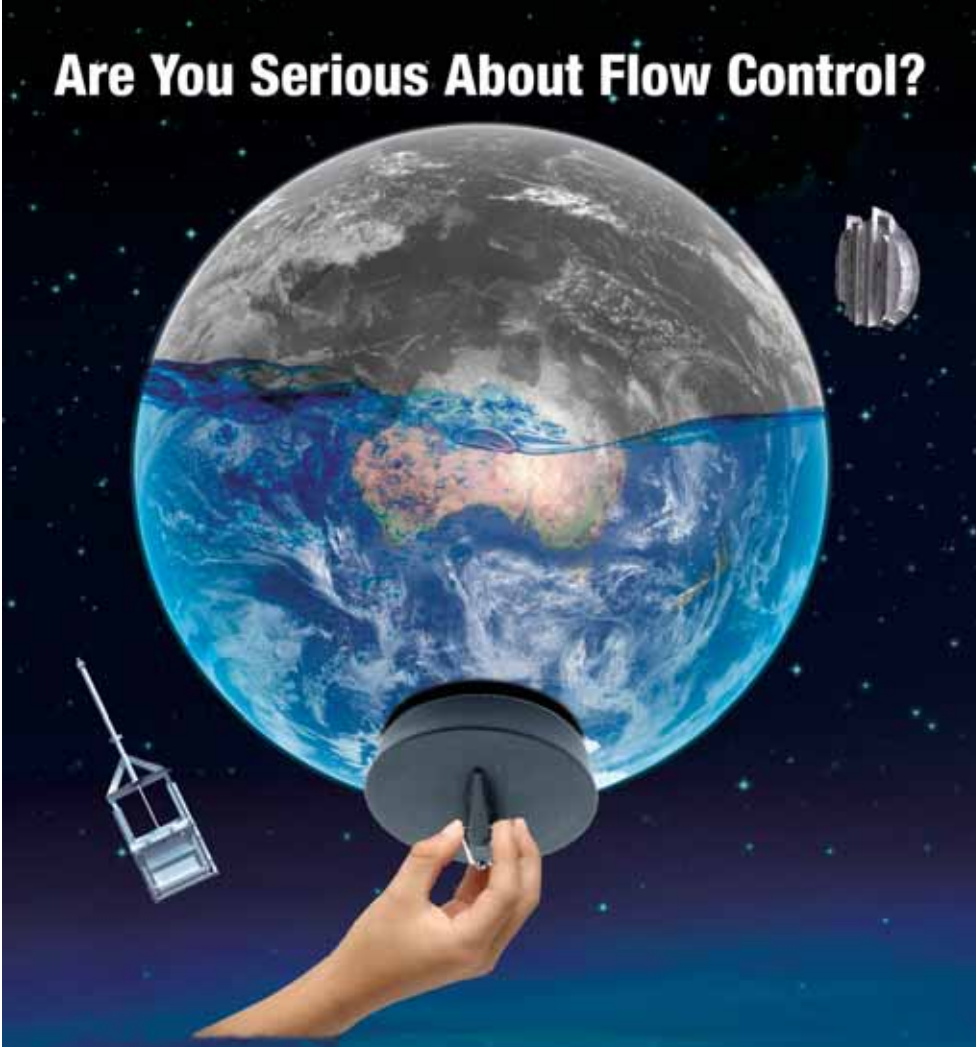
Colour in waste water is typically due to coloured minerals and dyes, humic and fulvic acids and iron. Coloured minerals and dyes can be found in any colour of the rainbow. Humic and fulvic acids originate from the breakdown of organic matter. Humic acids are dark brown to black in colour and fulvic acids are light yellow to yellow-brown in colour. Humic acids are typically associated with wastewater from the pulp and paper industry. Iron in water supply is well known for causing reddish-brown staining at concentrations above 0.3 mg/L. Iron bacteria, which cause reddish-brown

slimes, often colonise biofilms when waters contain high concentrations of iron. Iron in trade waste can arise from iron-based flocculants used in water and wastewater treatment. Other metals known to cause colour staining include copper (blue-green) and manganese (brownish-black). Iron and manganese stains are not normally removed by soaps and detergents, in fact the use of chlorine

bleach and brighteners common in many washing powders can intensify such stains.

## True and Apparent Colour

In the water industry a distinction is made between true colour and apparent colour. Apparent colour is measured on a sample without any filtration and includes absorption of light due to coloured materials and any turbidity in the water.



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Even a slight turbidity causes the measured colour to be noticeably higher than the same sample without turbidity. True colour is measured after filtration and measures the absorption of specific wavelengths of light by coloured substances without any interference from turbidity.

While there are guidelines for colour in potable water of 15 Pt Co, there are no similar guideline value for colour in recycled water.

As an example, treated effluent leaving ETP typically has colour that varies from 40 - 160 Pt-Co units. This means that even after further treatment, the colour of recycled water delivered in the Eastern Treatment Scheme will far exceed the colour of most drinking water supplies.

## What About Trade Waste Standards for Colour?

Unlike many trade waste quality parameters, colour discharges do not present a risk to the safety of sewer works or to the integrity of sewer assets. This may partly explain why there is no consistent compliance standard for colour in trade waste. Trade waste standards for colour differ widely and often refer to different methods for measuring colour.

Some examples of the wide variety of acceptance standards applied by Water Authorities in Australia include:

- "The Customer must not discharge trade waste containing colour greater than 9 Adams-Nickerson units, determined from the most pronounced colour obtained from a sample adjusted to a pH of not less than 7.0 and no greater and than 8.0 following biological treatment by an activated sludge process." [SEWL]
- "No visible colour when the waste is diluted to the equivalent dilution afforded by domestic sewage flow." [Various NSW Shire Councils, e.g. Bega Valley and Wyong]
- "No colour visible after 100 dilutions; colour must be biodegradable" [Power and Water, Northern Territory]
- "The colour is not to exceed, at a pH of 8.0, 300 platinum/cobalt units or 9 Adams-Nickerson units, or the equivalent per cent light transmission as determined by a procedure acceptable to the Engineer" [City of Devonport, Tasmania]
- "The assessment of colour in a trade waste shall be on a filtered sample of waste discharged to the sewer; and the trade waste shall have a colour not exceeding 300 True Colour units." [Goulburn Valley Water, Victoria]

- "The limit for colour shall be 300 ADMI units within the range of 6.0 to 10.0 relative to distilled water; and all determinations of the Colour of a waste shall be made after the sample of such waste has been adjusted to a pH that gives the most pronounced Colour within the pH range of 7.0 to 8.0." [North East Region Water Authority, Victoria]
- "The Colour of the wastes when measured on the Platinum Cobalt scale shall not exceed 1000." [Gippsland Water, Victoria]
- "Limited such as not to give any discernible colour in treatment works discharge." [Cairns Water]
- "No waste shall have colour or colouring substance that causes the discharge to be coloured to the extent that it impairs wastewater treatment processes or compromises the final effluent discharge consent." [Wellington City Council, New Zealand]

The author is unaware of any water authority that charges its customers for the colour discharged although some water authorities do manage colour as a compliance issue, e.g. where waste is received from the pulp and paper industry (Gippsland Water).

## So How is Colour Measured?

There are a wide variety of colour analysis techniques available, but as demonstrated by the diversity of acceptance standards used, there is no universal method to classify coloured wastewaters. There are essentially two recognised approaches to measuring colour:

- **Visual comparison methods** – The colour of a sample is determined by

comparison to a standard colour. The standard is typically either a colour wheel or a set of calibrated concentrations of a known substance. These methods can be used for true colour and apparent colour.

- **Spectrophotometric methods** – Spectrophotometric methods are usually only suitable for true colour measurements because otherwise the presence of turbidity interferes with the analysis. A spectrophotometer is used to measure how much light is transmitted through the sample (the % transmittance value) at a number of known wavelengths of light. The results are then used as inputs into various algorithms, which should be defined in the test method.

Some of the most common methods are described below.

## Apparent Colour Test

The sample is not filtered prior to analysis. Colour is determined by visual comparison of the sample with known dilutions of a coloured Platinum-Cobalt stock solution, and the results are reported in Pt/Co units. This test is most suited to water samples which are clear to light yellow liquids, and is especially suited to sources of potable water supply. This test is used extensively in the water industry but is also used for clear oils, chemicals and petrochemicals such as glycerine, plasticisers, solvents, carbon tetrachloride and petroleum spirits.

Trade waste samples often contain colouration from a variety of other sources, and test may not be well suited. The presence of turbidity also makes it harder to see through the sample to make the visual comparison. For these reasons the test is often unable to be applied to trade waste samples.

## True Colour Test

For the true colour test, the sample is filtered, using a 0.45 micron filter, to remove suspended matter which contributes to apparent colour. The test is then carried out in the same manner as the apparent colour test.

Note that the Platinum-Cobalt scale is often referred to as APHA Colour or Hazen Colour and can be reported in either Pt/Co or HU. APHA is the American Public Health Association, which publishes the standard methods on this test. Dr A Hazen is credited with originally describing this test in 1892.

For highly coloured samples dilution is necessary. The dilution factor may be as much as 0.5 mL per 100 mL. The option to dilute samples also means that many samples with colours different from yellow

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can often be tested by using a sufficiently diluted (low colour) sample. However, the results should be interpreted with caution, especially if the original sample was not suitable for the apparent colour test.

The colour value of water can be pH-dependent and invariably increases as the pH of the water is raised. For this reason, samples submitted for analysis are often pH adjusted (usually to a more neutral pH) prior to colour analysis. Alternatively, some tests report the colour value at the natural pH of the sample and at a standard adjusted pH.

True colour is usually less than the apparent colour. However, some recent results received from a consultant laboratory showed the opposite. The laboratory confirmed these results and gave the explanation that when samples have a cloudy appearance to them, this can in effect add a "whiteness" to the colour which can cause a lessening of the apparent colour. Such "unexpected" results may be more likely to occur with trade waste samples, which can contain different types of colours than supply waters.

## ADMI Colour Test and AN42 Colour Test

For these true colour tests, the sample is filtered using a 0.45 micron filter. The transmittance values are measured using a spectrophotometer at 10 different wavelengths (the standard tests recommend using either 10 or 30 wavelengths). The transmittance values are used to calculate both the ADMI and the AN42 test. (ADMI is the abbreviation for American Dye Manufacturers' Institute Colour, which developed this standard test.) The two calculations are different and result in different values. A "colour difference value" can also be calculated as the difference between the two.

According to one contract laboratory the ADMI colour value obtained is typically ~26 times the reported AN42 value however another laboratory uses a standard relationship to check equipment calibration based on the difference between the two methods. At 300 ADMI, the ADMI colour value obtained is ~34 times the AN42 value.

Confused yet??? There is more!

The ADMI and AN42 tests are reported to overcome the limitations of the Pt-Co colour range because they are based on a large number of wavelengths across the visible light spectrum. These types of colour tests are often used in manufacturing to check that a consistent product quality is being made, for example that the colour of orange juice has not varied outside a specified quality range. However,

interpreting the results for trade waste can become more difficult because the colour difference value only reports one type of colour information. There may be significant variation within and between trade waste discharges, and other mixing and chemical interactions that influence colour value.

## Colour Biodegradability Test

The colour biodegradability test has been developed by Ecowise Environmental, in consultation with SEWL. It is a different approach to measuring colour because it attempts to simulate the type of biological degradation that would occur during standard treatment at a wastewater treatment plant. This type of test is not available at all laboratories.

A common assumption is that coloured discharges from industries such as food manufacturing are likely to be mostly biodegradable. This type of test can check whether such assumptions are valid.

## Conclusions

There is currently no consistent method used in the water industry for measuring colour in trade waste and there is no recognised standard for what colour is acceptable in trade waste or in recycled water. Generally there is a lack of consistent information available on colour in trade waste, which makes it problematic to attempt to manage the colour discharges from individual trade waste customers. Whilst colour does not necessarily present a risk to health and safety, there is an emerging need for Water Authorities to manage colour, especially when customers are supplied with recycled water. Potentially, the costs of managing colour could be recovered, but not unless colour is better understood.

Many customers supplied with recycled water are likely to judge its quality based on aesthetic consideration such as colour. Failure to address colour issues may compromise the success of projects which reuse or recycle water. Tackling this issue will require both the technical management of colour (e.g. source reduction, colour removal and amelioration) and community engagement to develop realistic acceptance standards.

## The Author

At the time of the presentation **Yolanda Sztarr** was a senior technical consultant with the Hatlar Group. She is now a senior consultant with KPMG (ysztarr@kpmg.com.au), helping clients access funding for environmental projects.

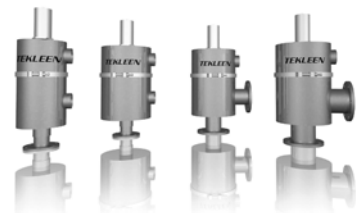
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# CLEANING DIFFUSERS AT EDGEWORTH WWTW

*John Stevens*

*Winner of Actizyme Prize for Best Operator Paper at the  
2nd WIOA NSW Engineers & Operators Conference, Newcastle, April 2008*

Edgeworth Waste Water Treatment Works (WWTW) (Figure 1) situated on the central NSW coast just west of Newcastle services a population of 65,000 people. The plant is an activated sludge plant using the Modified Lutzack Ettinger (MLE) process.

Flow is directed continuously between two bioreactors, which have an anoxic zone and an aerobic zone. Porous polyethylene disc diffusers supply air to the aerobic zones. The diffusers are all Nopon HKL-215 units, which are 215mm in diameter (Figure 2). The porous discs split the supplied air stream into many small bubbles.

There are 1306 diffuser discs in each bioreactor. Each branch of diffusers has a control valve that can be adjusted for flow balancing purposes. The blowers are designed to start automatically to maintain airflow through the diffusers using DO control. The normal operating pressure of the blowers is around 50kPa. The target



Figure 1. Edgeworth WWTW.

DO for the plant of 0.5mg/L is the minimum level needed to maintain adequate treatment.

These diffusers are subject to fouling and deterioration and need to be cleaned periodically. The inner surfaces may become clogged with air borne dust if the blower inlet air filtration system is

defective. The outer surfaces become coated in attached biological and inorganic slimes. There have been some excessive prolonged air outages due to power surges and blackouts and this will have contributed to solids settling on or entering the diffuser openings, adding to the fouling problem. Increased backpressure on the blowers and reduced oxygen transfer (seen in the inability to meet DO set points) are the best indicators of diffuser deterioration. Fouled diffusers lead to blowers being unable to deliver their capacity without either releasing their pressure relief valves or going into surge.

When the diffusers become fouled, backpressures can increase from 50kPa to as high as 65kPa. The increase in backpressure, as well as the low DO levels indicates some degree of diffuser fouling. Daily checks are done on backpressure readings and there is usually a slow increase over a number of months. Figure 3 shows changes in backpressure before and after cleaning.

## Diffuser Cleaning

Acid cleaning and pressure cleaning have been used successfully. Cleaning has been done both after removing the diffusers and while in-situ. Depending on weather conditions, it is possible to take one reactor off line to allow diffusers to be removed and cleaned. However there is a need to be prepared to bring the bioreactor back



Figure 2. Fine bubble diffusers up close and in situ in the reactor.

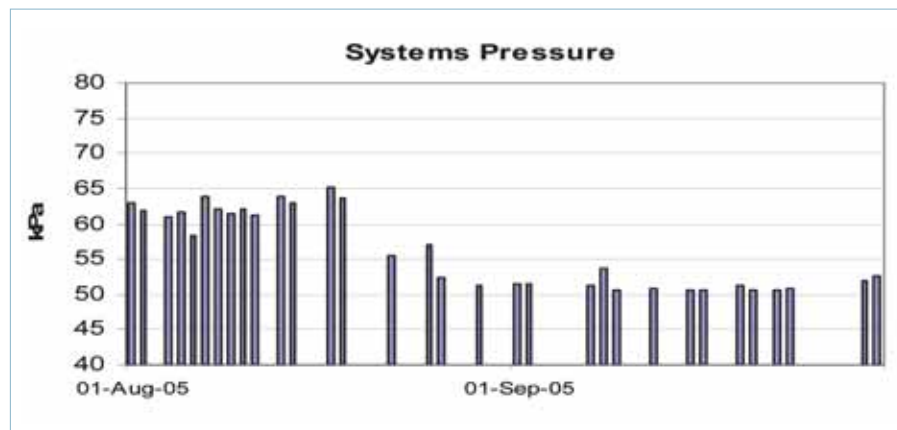


Figure 3. Changes in backpressure before and after diffuser cleaning.

online quickly if heavy rainfall is experienced.

## Pressure Cleaning Diffusers

One method of cleaning the diffusers is to completely drain the bioreactor and progressively remove the diffusers and clean both sides of each diffuser using high pressure water blasting. This would allow the replacing of the internal check valves. This is a time consuming exercise and as previously mentioned, is dependant on weather conditions. Due to the large increase in backpressure and the heavy fouling of diffusers, this method was used in 1999 with great success (Figure 4). Some thought and research was put into alternative methods of pressure cleaning diffusers where down time could be dramatically decreased. It took 2 to 3 weeks to clean diffusers by removing them and pressure cleaning individually. For this reason an attempt was made to clean the diffusers while in-situ. This was done by maintaining air flow through the diffusers and holding the pressure washer at an angle so as not to further lodge accumulated biological and inorganic slimes. This proved



Figure 4. Pressure cleaning of the diffusers in 1999.

very successful and it was decided to use this method to clean the diffusers with a crew following behind replacing the internal check valves.

## Acid Cleaning

This is the preferred cleaning method recommended by the supplier of the diffusers. Testing was undertaken using this method in 2002, when it was suspected that the diffusers were badly fouled. Backpressures were up to 15-20kPa higher than tests done on new diffusers.

A portable injector nozzle was screwed into a socket on the grid downcomer pipe and a portable dosing pump was used. Approximately 7kg of 85% formic acid was dosed into each grid or about 15g per diffuser. While there was some decrease in backpressures of about 5-6 kPa in comparison with predose rates, it was suggested by the diffuser supplier the large increase in backpressures experienced at the plant were due to backflow of mixed liquor into the diffuser pores during the excessive and sometimes prolonged blower shutdowns

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the plant has experienced since the plant was commissioned. It was also possible backpressure increases were being caused by the hardening of the rubber of the internal check valves.

It is not known whether repeated dosages of formic acid would reduce backpressures further but it was thought it may be insufficient to remove significant accumulations of mixed liquor which had deeply penetrated the diffuser pores. Based on these experiences a standardised cleaning method has been developed using pressure washing. The method is described below.

## Cleaning Procedure Used

The following is a description of the cleaning procedure developed over the years for the Edgeworth WWTW.

- Reduce the MLSS in both reactors to approximately 2500 mg/L.
- Pump the contents of bioreactor No 1 to bioreactor No 2. Air valves need to be adjusted at regular intervals to maintain aeration pattern.
- Pump bioreactor 1 empty and shut off air supply to the bioreactor when the level is approx 200mm above diffusers.
- Using vacuum tankers to remove accumulated sludge and grit from bioreactor floor.
- Crack open valves to supply a small amount of air flow through the diffusers.
- Clean each diffuser trying to ensure sludge/grit is not pushed into diffusers.
- Inspect complete diffuser system and replace any damaged components or pipe work.
- If replacing internal check valves, have a second team following removing only one or two rows of diffusers in case the bioreactor needs to be brought back online quickly due to wet weather. The internal check valves are easily removed using a small screwdriver. Placing the diffuser discs in a solution of dishwashing liquid and water assists in the reseating of the discs on the diffuser body.
- Refill the bioreactor with either clarifier effluent or sewerage to a level of approx 300mm then introduce some air to check for leaks, uneven air pattern or badly seated diffusers.
- When satisfied everything is OK start RAS return pumps and allow sewerage to refill bioreactor.
- MLSS may be pumped from the other bioreactor but we found this unnecessary as readjusting wasting can equalize MLSS.

While cleaning by removing each diffuser and high pressure water blasting is successful, the extra down time is of concern. By cleaning diffusers in-situ using the above procedure this down time can be significantly reduced from almost 3 weeks down to 5 days. There is not much cost saving in reducing the time. The main benefit is the reduced risk to the process. In particular, the sludge age is halved causing reduced nitrification and less stable sludge. Also as the MLSS is greater with one tank, there is a risk of rising sludge blanket in the clarifiers as well as the hydraulic problems splitting evenly to each clarifier.

## Author

**John Stevens** ([john.stevens@hunterwater.com.au](mailto:john.stevens@hunterwater.com.au)) is a Wastewater Treatment Plant Operator with Hunter Water.

# BRIGHT FILTRATION SHINES

*Brian Scobie, Rex Humphreys and Jason Mullins*

*Winner of the Actizyme prize for best paper by an Operator at the 2008 Victorian Conference*

Bright is a sub-alpine tourist town located in North East Victoria. Water for the town is taken directly from the Ovens River and disinfected with chlorine, there being no other treatment.

Historically, the water quality has met the Australian Drinking Water Guidelines turbidity standard, however since the 2003 and more recent 2006/07 bushfires the water quality has declined, particularly after rainfall. Turbidity levels consistently exceed 5 NTU. Prior to the fires, elevated turbidity events due to rainfall in the catchment could be managed via the town's treated water storages and a small secondary supply. Typically, elevated turbidity would not be sustained, and would reduce to approximately 1-2 NTU, which was deemed suitable for potable supply.

Figure 1 shows monthly turbidity data from the Ovens River. The graph highlights both an increase in average turbidity levels and frequency of high turbidity events in recent years.

During February 2008, significant rainfall in the catchment (> 100mm) resulted in sustained dirty water, triggering North East Water (NEW) to implement a Boil Water Notice. River turbidities did not fall below 5 NTU for weeks after the rainfall. Ongoing Boil Water Notices and numerous customer complaints led to NEW deciding to implement temporary filtration at Bright. A permanent facility

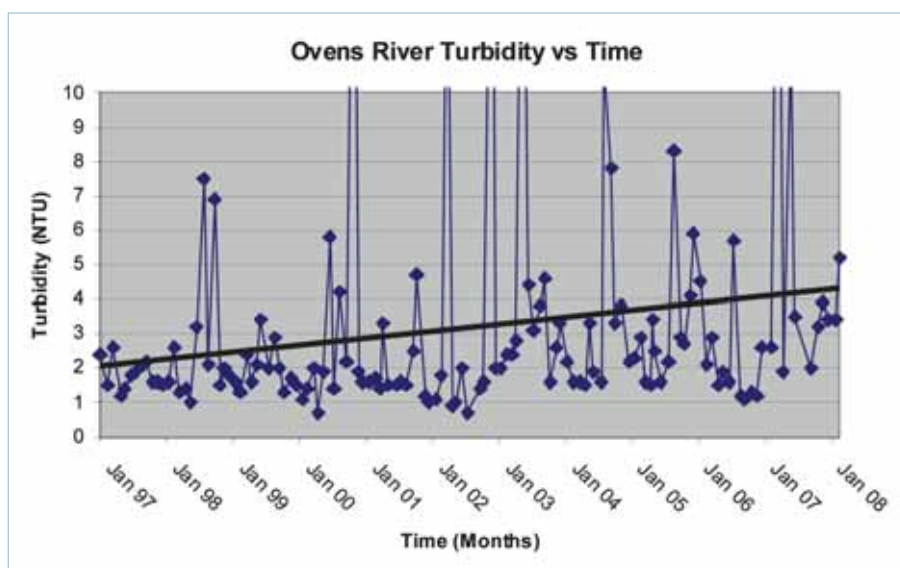


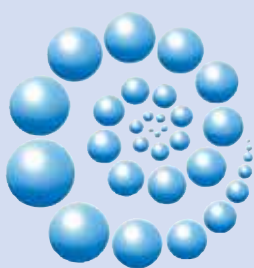
Figure 1. Ovens river turbidity data since January 1997.

was planned to be installed in 3 to 5 years, however because of the deteriorating water quality, more immediate action was deemed appropriate. A decommissioned package plant was available from another NEW site at Wangaratta.

The aim of the temporary filtration facility was to treat the Ovens River water at Bright to potable standard particularly after storm events when the turbidity can rise for 24 to 48 hours.

The following data was used to design the filtration capabilities:

- Ave Turbidity Range: 2 – 20 NTU
- Peak Turbidity: 50 NTU (24hrs after peak slug)
- Iron: 0.5 – 1.0 mg/l
- Manganese: < 0.05mg/l
- Ave Flow: 1.0 – 2.0 ML/d
- Peak Flow: 3.5 ML/d



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## Site Selection and Planning

The site for the containerised filtration plant was obvious; however it did not belong to NEW. The site is an existing arboretum (tree reserve), which is owned and managed by DSE, and therefore required formal permission to establish the containers on the site. Approval was gained from DSE within three weeks. Local council was also informed, and did not object to the project.

A budget estimate of < \$100,000 was prepared for the project, and endorsed by NEW executive management team. The major items included a raw water pump, pipe work (material & fabrication), electrical components and security fencing. In-house resources from both operations and electrical departments were to be utilised to minimise costs and ensure timely completion.

## Construction

Work started immediately with the construction of a foundation pad. The containers at Wangaratta were dismantled and the existing filter media (DMI-65) removed, leaving only a 350mm support base to assist in the removal of iron and finer particles.

Despite removing the DMI media, each container still weighed in excess of 20 tonne. With winter approaching, potentially restricting access at the arboretum, the containers were quickly transported via side shift transport. The containers were placed onsite with minimal damage to the flora and grounds.

Next, fabrication works were carried out for the connection of backwash, raw and filtered water lines (Figure 2). Control and electrical services were also installed.

Anthracite media was craned onto site placing a 500mm layer in each of the 8 vessels and soaked. Installation of a raw water pump to existing infrastructure was carried out, as well as a static mixer and relevant dosing points.

The cleaning of the existing clear water storage (aka "Frog-hole") was supposed to be a straightforward exercise, however it became quite a challenge. Eight cubic metres of sandstone!!!! This was broken into pieces, and hand bucketed up the



Figure 2. Stainless steel pipe work, fabricated and installed on-site.

embankment. This resulted in an "all hands on deck" approach to achieve this goal.

## Commissioning and Operation

Day 1 of commissioning (1 July 2008) was not ideal, with in excess of 50mm of rain falling and the Ovens River running at over 100 NTU and colour over 200 Pt-Co. And 7°C!!

With electrical staff adjusting PLC programs and operational staff jar testing, checking pump rotations and calibrating instruments, the plant was placed on-line knowing full well that capabilities would be tested to the limit with the challenging raw

water quality. With limited optimisation, the plant was able to reduce turbidity from 140 to 5 NTU, requiring a dose rate of 30ppm (v/v) ACH.

The following day held much more optimism, with raw water quality 15 NTU and 30 Pt-Co. Continued optimisation over the day achieved a filtered water turbidity of 0.5 NTU at a dose of 6ppm (v/v) ACH. This dosage was later reduced to 3ppm (v/v), as the raw water turbidity decreased to 10 NTU.

All automation and control features were tested with slight changes to backwash sequences, and operating parameters were functioning properly.

During the following 48 hours, the filtration plant was producing water with the

following quality parameters:

- Turbidity: < 0.3 NTU
- pH: 6.9
- *sol* Al: 0.01mg/l
- Fe: 0.02 mg/l
- Colour: 0 Pt-Co

The flow rate through the plant was 134kL/hr, with filter runs of 12 - 24hrs, and a filtration rate less than 9.8m/hr. Backwash flow rates were 80.4L/hr with a velocity of 40m/hr with only 3% efficiency losses at this stage.

The fully automated process was essentially commissioned within 2 weeks, including operations staff training. Immediate improvements within the reticulation were observed. The clean water resulted in a reduction of chlorine dose by one third, as well as sustained Cl<sub>2</sub> residuals in the reticulation. Reticulation extremities, and the adjacent towns were recording Cl<sub>2</sub> residuals that were unprecedented.

The decision was then made to lift the Boil Water Notice, which had been in place for approximately 6 months, which was the ultimate goal of the project.

## The Authors

**Brian Scobie** is a Treatment Technician, **Rex Humphreys** (rhumphreys@nerwa.vic.gov.au) a Treatment Specialist, and **Jason Mullins** the Technology Development Manager all with North East Water (Vic).

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# 2007 KWATYE PRIZE REPORT: SEWER BLOCKAGES AND TREE ROOTS

*Graham Thomson*

The aim of my Kwatye project was to examine what strategies the water industry is utilising to improve the reliability of reticulated sewer systems. In particular, to investigate what systems are being used to address blockages due to tree roots and to determine if chemical treatment could be undertaken at Barwon Water within areas where it is currently not utilised.

Site visits to various water businesses were undertaken to meet with operational personnel, discuss what they were doing and determine what particular operational issues they had encountered while tackling tree root blockages.

Figure 1 taken from the National Water Commission 2006/07 National Performance Report, indicates that across Australia 54% to 93% of sewer blockages are due to tree roots.

Table 1 provides a summary of the common sewer blockage cleaning methods used in the water industry.

## Site Visits and Meetings

Part of my project included site visits to discuss methods of controlling sewer blockages with other water utilities and to observe first hand their practices.

These included

- Hunter Water
- Central Highlands Water
- Sydney Water

I also attended a number of meetings and conferences to continue discussions on the topic. One in particular was with the steering committee of the WSAA/CSIRO collaborative sewer blockage project.

## Survey Questionnaire

A survey questionnaire was developed and circulated to eleven organisations to determine their sewer maintenance practices. Nine were returned. The

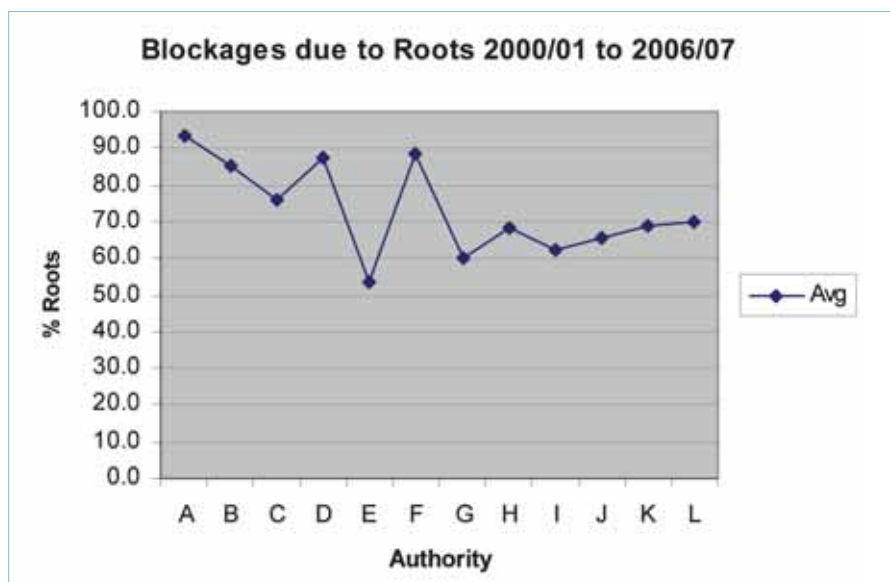


Figure 1. Blockages due to tree roots comparison within Australia.

Table 1. Summary of common methods for clearing sewers.

Method	Description
Rodding	This process uses either a mechanical or manually operated ratchet drive connected to hardened steel rods fitted with a specific head. This type of work is typically undertaken on a reactive basis and is at least a two-stage process, i.e. Stage 1 is with a point type head to "break" the block then Stage 2 is with a cutter type head to clear the pipe.
Jetting	This uses high-pressure water (103 bar to 690 bar) to drive specific heads fitted to the end of a hose. The water used is usually from the reticulation water system, i.e. fireplug. Recent developments have seen the use of recycled water and/or equipment being modified to suit to use "water" from the sewer main itself. The heads fitted are typically for a specific purpose, e.g. removal of rubble or root cutting. This process usually removes material from pipe, e.g. rubble. Some authorities refer to this method as "flooding".
Root Cutting	Similar to jetting using high-pressure water but specific heads are used that enables the equipment to cut the tree roots. Basically two types of heads are used. One where nozzles in the head does the cutting and the other where a hydraulic motor "drives" a cutting head similar to a "hole saw" fitted to an electric drill.
Chemical	In this process a root inhibitor chemical is applied to the reticulation sewer pipes considered to have tree roots present. The chemical historically has been applied via a "foaming" process but other processes have been trialled, e.g. spot spraying in conjunction with closed circuit television (CCTV) equipment. There are two philosophies regarding this method and they involve when and/or if pipes should be root cut.
Dig/Repair	This method is generally restricted to isolated cases and site-specific conditions that require a unique approach to clear a blockage and/or defect. Repairs are normally undertaken as part of a planned program but there are situations where a reactive excavation and repair is required e.g. collapsed pipe, equipment trapped within the sewer pipe.

information confirmed the processes detailed in Table 1 were in use and there was no particular method being exclusively used. It did emerge however that some water businesses currently do not undertake any form of chemical treatment within their sewer system. The main reason for this appears to be related to Occupational Health and Safety (OHS) concerns and the effectiveness of this process.

## Reporting Blockages

The water industry measures the performance of reticulated sewers usually by comparing the number of blockages experienced per 100 kilometres of sewer main or number of blockages per 1000 customers.

One of the interesting things to come out of this project was that in Barwon Water most, if not all, sewer blockages are associated with gravity pipes of  $\leq 300$ mm in diameter (Table 2).

Therefore the proportion of  $\leq 300$  mm diameter gravity pipes in a system difference, may have a big effect on the reported number of blockages. Perhaps the industry could improve its measure of its performance by including only gravity pipes  $\leq 300$  mm.

## Field Trials

At Barwon Water there are areas that currently have a high blockage rate due to tree roots. In some of these catchments the preventative maintenance works undertaken do not include any form of chemical treatment. However it has been found that the current practice of regular root cutting and jetting programs can be both time consuming and potentially less effective than chemical treatment. Previous history of chemical treatment in some areas indicates there is potentially a high risk of disruption to the biological treatment process at particular water reclamation plants. As the plants have a regulated discharge licence, the potential for non-compliance with their operating licence is considered too great. Another reason chemical treatment has not been used is some treatment plants have a proportion of the discharge being used as recycled water and thus there is a

**Table 2.** Comparisons of Blocks/100 km for Barwon Water.

Financial Year	2005/06	2006/07	2007/08
Quantity of Blockages	894	1126	905
Blocks/100 km (all pipes)	40.3	50.6	40.3
Blocks/100 km (Barwon Water Gravity $\leq 300$ mm)	48.1	60.7	48.7

**Table 3.** Comparison of blockages for Anglesea and other Barwon Water towns.

Sewer Blockage Details		Financial Year		
		2005/06	2006/07	2007/08
Total Blocks	All Barwon Water	894	1126	905
	Anglesea	99	76	83
	% Blocks in Anglesea	11.02%	6.74%	9.17%
Blocks/100km	All Barwon Water	40.3	50.6	40.3
	Anglesea	153.5	117.8	128.7

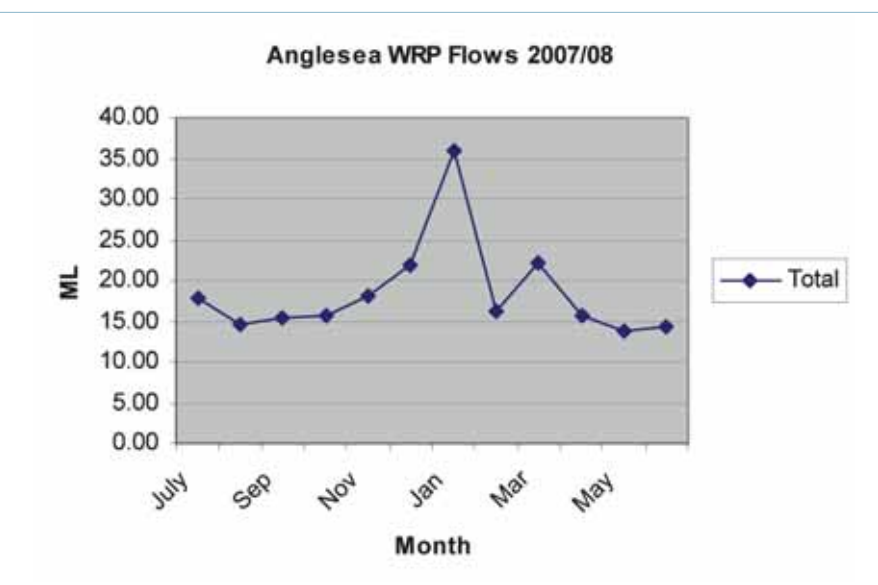


Figure 2. 2007/08 Flows at Anglesea WRP.



A "typical" root mass in a gravity sewer.

possibility of negative impacts on this high profile process.

In order to evaluate if chemical treatment can be used in an area where currently it is not used, a trial was undertaken using strict guidelines and controls in Anglesea. Anglesea is a popular, small coastal beach town west of Geelong in Victoria. Anglesea was selected because there is a higher incidence of blockages there. The reason for this is not known; however, the shallow depth of the gravity sewers and the dense native vegetation are considered to be possible reasons.

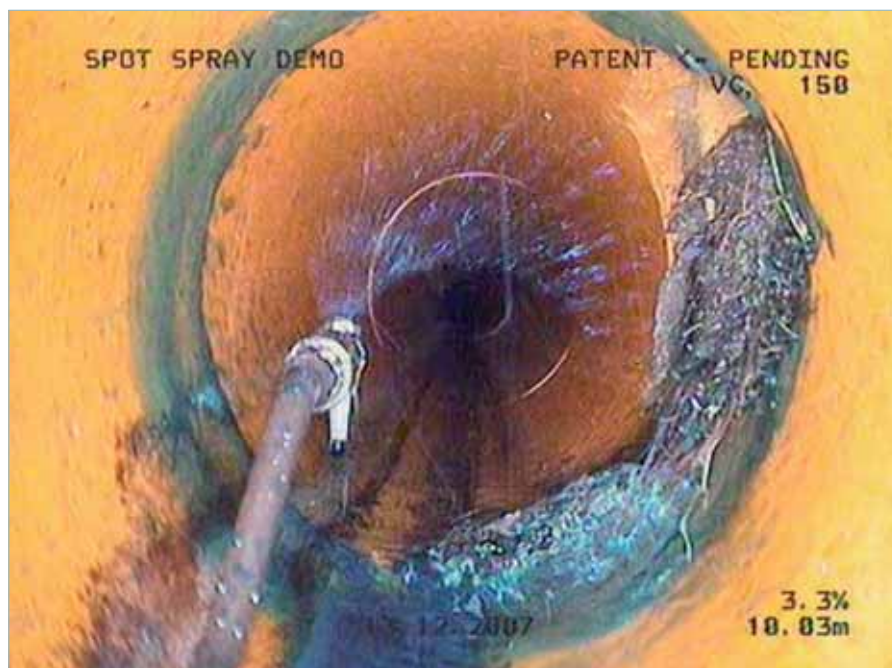
Figure 2 shows the monthly flows during 2007/08 at the Anglesea Water Reclamation Plant (WRP). There is a clear seasonal peak due to the influx of holidaymakers. The increased flows are often associated with increased blockages some of which function adequately at lower flows.

The first step in selecting a chemical treatment involved obtaining sample of the products that might be used by the various contactors. These products were sent to a laboratory for an anaerobic inhibition test. This test provides an indication of the likely toxicity of the chemical to the biological treatment process. The results of this test helped determine the amount of chemical acceptable for use in the trials.

The next step was to select an area within Anglesea where field trials could be undertaken. The design of the Anglesea gravity sewer system provided the ability to select a particular catchment where strict controls and monitoring could be put in place.

Following the successful testing of chemicals in the laboratory, two field trials were undertaken. The two methods used were spot spraying after cutting, and foaming without cutting. The field trials have only recently been completed and the results will be assessed over the next twelve to eighteen months. At regular intervals, the pipes will be checked using CCTV equipment for signs of root growth. Also, for comparison purposes, other pipes where root cutting only has been undertaken are being monitored.

The "new" technique of spot spraying that was carried out has the advantage that it is undertaken in conjunction with CCTV equipment allowing observations to



The "spot spray" set up inside a pipe.

be undertaken on what condition the sewer asset is in at time of application.

### Summary of Developments In the Management of Sewer Blockages

So what are the recent developments in the area of reducing the number of blockages?

1. Chemically treating pipes – two main methods

- (i) Using chemical in conjunction with foam either with cutting or without cutting roots.
- (ii) Spot spraying chemical after cutting done in conjunction with CCTV equipment.

2. Using historical data to plan particular root cutting programs. In some water businesses the analysis includes various weightings for risk and consequence so an overall priority is assigned to a particular pipe.

3. Targeting high-risk pipes with planned works on a time basis, eg all pipes near a water body in an area every six months. The prime driver here is that the consequences will have a huge impact, i.e. overflow to the water body.

4. Equipment has been upgraded to utilise the water directly from the sewer main by recycling through special filters incorporated into the machine. This offers considerable flexibility and an opportunity to save water.

5. There is an increased focus on the rehabilitation of sewer pipes, including the house connection points.

6. By evaluating CCTV footage there are cases where an isolated section of a pipe can be repaired and it will improve the overall performance of a pipe. This is generally referred as a dig/repair or spot repairing and depending on various scenarios can result in an increase in a sewer pipe performance in a cost effective manner. There are circumstances where the repair costs are shared with property owners and/or developers as they are of a mutual benefit or the location of defect is in an area of shared responsibility.

### The Author

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# KAWANA STP UPGRADE SORTED

Stephen Will

*Winner of Actizyme Prize for Best Operator Paper and WITA Prize for Best Paper Overall at the 33rd Qld Water Industry Operations Workshop, Gold Coast, June 2008*

Kawana STP is located on the Sunshine Coast in South East Queensland. The plant was commissioned in 1981 and has undergone 3 upgrades since then. The most recent upgrade in 2005 was undertaken to increase the plant's hydraulic capacity from 58,000 EP to 76,000 EP. A conventional activated sludge plant and a set of IDAL reactors were decommissioned. The major new work involved retrofitting one of two IDAL tanks into a continuous flow bioreactor with the provision of four secondary clarifiers. New inlet works, two new gravity drainage decks and modification of the existing secondary sedimentation tanks for the chlorine disinfection were also included. The retrofitted bioreactor consists of 8 zones (3 anoxic and 5 aerobic), all with varying hydraulic capacity. The first of the anoxic zones caters for the mixed liquor recycle (A recycle), RAS flow from the clarifiers and all raw influent.

Air was originally going to be distributed to the aeration zones by mushroom fine air diffusers used in the previous IDAL system, but this could not be achieved due to the extra structural restraints needed in the bioreactor. Subsequently two OKI submersible aerators were installed in each aeration zone. The OKIs were connected to the existing air distribution pipe work and supplied by three turbine blowers. Butterfly valves controlled the flow to the aerators.

In 2007, two years after the upgrade, the original Caloundra STP was also decommissioned. This flow was redirected to Kawana STP. With the rapid population growth and increased tourism over recent years in the Caloundra region, this has had a clear impact upon the Kawana STP. In less than three years after the 2005 commissioning, the upgraded plant is now fast approaching its design load, even though the forecast for this upgrade was projected to last until 2015.

This paper reports on selected upgrade experiences associated with the

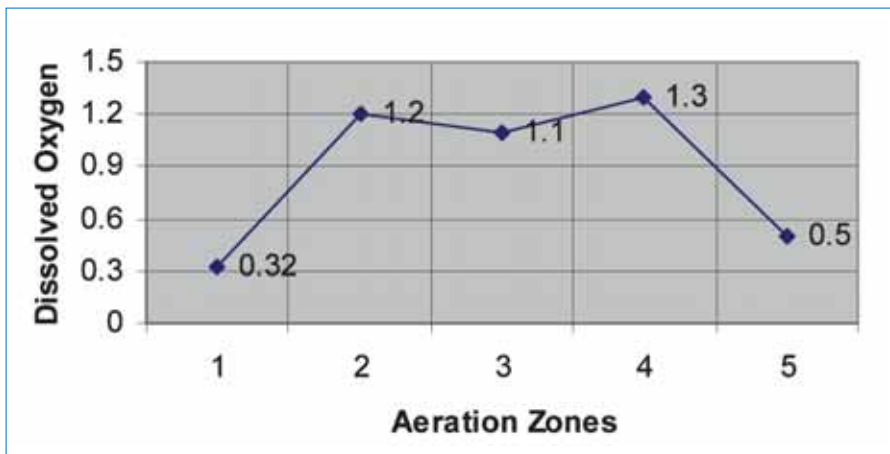


Figure 1. DO levels in the five aerobic zones.

commissioning in 2005 as well as the plant's performance in the first two years of operation after this upgrade and in particular a number of problems encountered.

## 1. Dissolved Oxygen Control In Aeration Zones

### Issue 1: System logic control of butterfly valves

The DO trends for the aeration zones fluctuated greatly. These trends demonstrated the opening/closing positions of the butterfly valves in relation to different oxygen demands in the aeration zones. Originally valve movement was in increments (wait time) of approximately eight minutes, but this was causing considerable lagging of valve position, as opposed to where they should have been due to load demand. This was demonstrated in the trends as valve positioning did not align with oxygen demand. Also confirmed was that the air bubbles were shown to be ineffective at transferring oxygen to mixed liquor.

**Resolved By:** Replacing the aeration control logic with PID loop control system. This was fine tuned by the operator who would relay the field position of butterfly valves to the engineer who configured the relevant PID loop for each of the aeration zones.

**Outcome:** Vast improvement in DO profiles and better control to desired set points. Although not perfect only minor lagging still occurred.

### Issue 2: From VSDs to Direct on Line (DOL) power supply for OKIs

Originally the speed of the OKI aerators was governed by VSDs in relation to load demands. Five out of the ten VSDs have failed due to overheating, with three of these failures being caused by a single power outage. Exposure of the VSDs to direct sunlight was also identified as perhaps contributing to the overheating.

**Resolved By:** Council made a unanimous decision that all OKI aerators that were originally on VSDs, but had failed due to excessive heat, were to be converted to direct on line control. The remaining VSDs were set to 100%.

These changes meant that air flow would be controlled through the air turbine blowers. This decision also took into account observations that the diffused air bubbles when the OKIs were running slow were too large and not effective for the transfer of oxygen.

**Outcome:** All aerators have been operating effectively since the change. As long as the blower pressure is no higher than 46kPa, then the diffused air bubbles

are comparatively small and oxygen uptake by the water is good.

The remaining VSDs were also enclosed in an air conditioned weather proof building to protect the equipment from direct exposure to the sun.

### Issue 3: Set Point In Zone # 5 of the Aeration Reactor

Figure 1 shows the typical DO levels in the aeration zones during the hours from 7am until 3pm. Notice that the DO drops in zone # 5. The DO only reaches the set point of 1.5 in zone # 5 during off peak flow periods. The difficulty achieving set point appears to be due to the large volume of the 5th aerobic zone (Table 1).

## 2. RAS pumps

### Issue 1: Parallel running of pumps per clarifier creating consistent faulting

Each clarifier was set up with two RAS pumps. These were initially run in parallel. This caused consistent faulting out.

**Resolved By:** Running only one pump to achieve daily duty (30Hz) instead of two pumps running in parallel (27Hz). This also allowed the pumps greater velocity and decreased the chance of pump chokes in achieving normal daily flow requirements.

**Outcome:** Successful operation of RAS. The pumps are now only run in parallel when the clarifiers need emptying. This can only take place if the clarifiers are full and the pumps run non-stop during the emptying process.

### Issue 2: Hydraulic noise indicating cavitation is evident

Loud noise was evident during the operation of the RAS pumps.

**Resolved By:** Replacing the 239mm diameter impeller with the smaller 217mm diameter impeller. Tests by Flygt confirmed the likelihood of cavitation to

**Table 1. Volume of aerobic zones.**

Aerobic Zone	Volume (kL)
1	978
2	812
3	1053
4	1269
5	1666

be minimal during single pump operation with the 217mm impeller at around 50Hz. This change offered optimum pump performance.

**Outcome:** Cavitation is now minimal, thanks to constant testing by Flygt. Considering that the pumps have to work with only 500mm of head from the clarifiers and their work also has to be within the plant's flow parameters, the increased speed of the 217mm impeller has overcome excessive cavitation without decreasing the pumps component's life.

### Issue 3: Clogging of pumps via ragging

Blockages occurred because of the low suction velocity, which allows hair and fibres to mat underneath the impeller.

**Resolved By:** Trialling the "relief groove" plate with the addition of the adjustable guide pin "shark tooth", which acts as a straightening vane for flow/rag through the pump housing of the pumps. The guide pins also break up this rag matting and forces it from the centre of the impeller and is then pumped away.

**Outcome:** Ragging is now minimal much to the operator's relief. These pumps have performed extremely well to date.

## 3. Excessive Detention Time In Contact Tanks

Long detention times resulted in growth of bacteria on the walls and bottom of the contact tanks. There was also significant growth of algae on the walls. The long detention times were a result of

retrofitting two large secondary sedimentation tanks. At about 20 ML/day dry weather conditions, the flow of chlorinated effluent has around 3 hours contact time. Lessening detention time and scheduled cleaning was critical to maintaining compliance with the plant's EPA License because effluent quality actually decreased during the upgrade (Table 2).

### Issue 1: Lessening of detention time

**Resolved By:** Inserting a 300mm diameter knife gate valve at 1.5 meter below and adjacent to the final contact tank weir.

**Outcome:** Detention time is approximately 1.8 hours instead of the original 3 hours at low flows. At high flows discharge occurs over the final contact tank weir as originally designed.

### Issue 2: Build up of algae and Pseudomonas type bacteria

**Resolved By:** a) Erecting a 600m<sup>2</sup> shade cloth structure that covered the 1895 kL contact tank. This cost approximately \$45000. b) Building a diversion pipework back to the inlet of the plant for the Schedule Cleaning Program.

**Outcome:** a) A very noticeable difference during the summer months. More OH&S procedures implemented due to the confined space whilst cleaning the contact tanks. Cleaning is scheduled for every four months. b) Diverted pipe work allows cleaning of contact tanks to take place within regular working hours with the assistance of a Sykes pump.

The above upgrade issues faced by the plant have successfully been overcome.

Since augmentation took place, Kawana STP has achieved all of its design capabilities. Three years down the track and the operators are comfortable with the plant's operation to date, although they are continuing to look for ways to improve the plant.

Positive relationships forged during the upgrade with contractors and internal personnel have developed a firm foundation for future works. As another upgrade looms over the horizon it will be good for operators to catch up with old mates!!

## The Author

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**Table 2. Effluent quality before during and after the upgrade.**

Effluent Quality License Release Requirement (DWF)		Before upgrade April 2004		During upgrade April 2005		After upgrade April 2006
		S1	S2	S1	S2	
BOD (mg/L)	<10 (50%)	6	2	16	1	4
Susp. Solids(mg/L)	<15 (80%)	2	1	6	2	2.4
Ammonia N (mg/L)	<10 (50%)	3.50	0.74	6.35	1.28	0.47
E coli (orgs/100 mL)	<150 (Median of 5 samples)	1	41	15	0	13

S1 = Old activated sludge system and S2 = IDAL System Post UV treatment.



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