WATER

Issue 183. March 2014

Smart Planning for Growth – Meeting the Need for an Expanded Wastewater Treatment Plant without Huge Infrastructure Costs

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WATER

On the Cover

Water New Zealand News

Features and Articles

Cover photo: i.stock.com

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Steve Couper

Wastewater in the Year of the Horse

Happy New Year and welcome to 2014 – the Year of the Horse. This first issue of *Water* for 2014 focuses on wastewater treatment plant design. It is fitting, therefore, that this year we celebrate a milestone in the development of wastewater treatment technology. British researchers Edward Arden and William T Lockett, who have been credited with the initial development of activated sludge, published their landmark paper on the subject in May, 1914.

A number of us in this Association have spent our lives working on wastewater treatment plants and processing. As time has gone on, these treatment systems have become more multi-disciplinary in their design, and there has been a slow but sure, continuous improvement in the effluent quality these systems can achieve. But have we moved that far in 100 years? The fundamentals are essentially the same; air, food and bugs in the correct proportions make for effective treatment.

The story of activated sludge began a year or so earlier in 1912. Both Arden and Lockett worked as chemists at the Davyhulme sewerage treatment works in Manchester. They had been looking into improving sewerage purification through aeration for some time.

Their academic, Dr Gilbert John Fowler, had paid a visit to the experimental sewerage purification station at Lawrence in the state of Massachusetts (the Mecca for sewerage purification at the time) and observed experimental work, which involved aerating sewage in bottles. The bottles had become coated in green algae. On returning to Manchester, Fowler suggested to his students that they aerate bottles of wastewater, but to cover the bottles to avoid the growth of algae. During 1913 and 1914, Arden and Lockett aerated wastewater continuously for a number of weeks, and showed that complete nitrification was possible. Lockett then allowed the treated liquid to settle and decanted off the supernatant (in effect), leaving behind the first activated sludge.

Others had undertaken similar experiments but had discarded all of the liquid after the experiment. The Manchester workers added further portions of wastewater and aerated these in contact with the solids. They found that after each aeration period the amount of solids, now termed activated sludge, increased and the period of time required to oxidise the wastewater reduced until it was eventually possible to achieve complete oxidation within 24 hours.

While some may think it sad to spend one's research years aerating sewage, it is interesting that almost all of our modern high-rate treatment systems stem from these experiments. Wastewater treatment is the largest fermentation industry, with in excess of 350 billion litres treated per year in New Zealand alone. The volume treated on the global scale is simply staggering.

Over 1,500 learned papers on activated sludge and associated technologies are now published annually, but we have not moved that far from the fundamental principles learned from those original experiments. The beauty in their discovery, I believe, lay in its simplicity, namely taking what nature does best and enhancing it to do the same job faster for the greedy humans.

Over the years, many incremental enhancements have been made, including improvements to solids and liquid separation and understanding nitrification, as well as total nitrogen and phosphorus removal, to name a few. But what does the future hold? What are we doing today, that will change the course of treatment technologies in the future? Or are our efforts just part of the incremental improvements made over the past century?

Few scientists are now undertaking such fundamental research. Applied research is more common, on enhancements to all of the existing technologies to drive down costs and improve effluent quality. But where are the researchers looking for the next revolutionary idea, the game-changer that provides a step-change to the technology?

The application of membrane technology to activated sludge systems over the past 20 years has arguably provided such a step-change, but while it may have led to substantial improvements in effluent quality, it is still based upon the fundamental principles elucidated a century ago.

In some areas of New Zealand, we struggle to adopt or cannot afford even basic treatment technologies. A number of schemes still discharge to inland and coastal waters with minimal effective treatment. One might have thought that after 100 years of development and enhancements that we would embrace change and provide for a better environment.

In New Zealand, we are far too busy arguing about who will pay, talking up our clean, green image and congratulating ourselves on the ground-breaking resource management legislation we put in place more than two decades ago, to save the environment. Let's face it, it is easier to promise, than deliver.

Perhaps the fundamental shift we need, is a change to how we implement our environmental regulation and the way we deliver our wastewater services.

This year, let us take the reins and steer this horse in a different direction, one that actually delivers superior environmental outcomes for our communities; one that leverages the technological advances of the past to provide a future legacy of infrastructure and outcomes that we can be proud of. If we cannot invest in our future environment in the currently favourable economic climate, when will we be able to? ■

Steve Couper,
President, Water New Zealand

New Members

Water New Zealand welcomes the following new members:

LAURIE VERCOE
HANK STOCKER
RICHARD COLES
STEVEN CORNELIUS
JAMES WORTHINGTON
EOIN NORTON
JASON KOENEN
PAUL ARMSTRONG
NIGEL GOODHUE
DR GREGORY DE COSTA
JOSIAH SIMMONDS
BARRY SAJEANT
PAUL CASEY
RICHARD GRAMSTRUP
ROSS BUDDLE
MATHEW PUGH
STEVEN RANKIN
JENNIFER PAVERD
ERIN PAYNE
SHERYL BARKER
DUNCAN GOWER
SHANE CARTER
DONIQUE WEATHERBURN
TONY MEARNS

Murray Gibb

Water Reform – A Slow Journey

Will current initiatives deliver high quality governance of our water?

It doesn't take a diligent student of public policy to know that for a long time, the current arrangements for governing water in New Zealand haven't been fit for purpose. If the institutions and organisations responsible for managing the resource were appropriate, freshwater quality wouldn't continue to be the number one environmental concern of New Zealanders, we wouldn't be endlessly debating the consequences of irrigating dry land farms and our urban water infrastructure system would be delivering services to agreed standards.

There are perhaps four reasons why it is taking so long to fix water governance.

Firstly, there has been no leadership. Unlike other countries we have had no designated lead agency for water policy.

Secondly, we have been able to take the resource for granted for much longer than other countries because we're water rich. Unlike our cousins across the water, we haven't had decade-long droughts and we haven't faced the prospect of our major cities running out of water.

Our water is also readily accessible, with 30 per cent of annual runoff being above ground and 60 per cent being groundwater. Respectively, that is twice and one hundred times world averages. If we need a new source of water for abstraction, it is usually readily available. Often, it is simply a case of digging a hole in the ground. Furthermore, by international standards we abstract minimal quantities of it.

Thirdly, it has only been over the past couple of decades that the governance of water in New Zealand has been found wanting by the body politic. Intensification of land use, particularly pastoral dairy farming, has tested our first-come-first-served approach to allocating the resource. Concurrently, diffuse sources of nutrient and microbial contamination of our lowland water bodies have increased. Sediment, our number one and most long-standing source of water pollution, never aroused the same levels of public angst. Perhaps we just expect our rivers to go brown after it rains because deforestation, the cause of this pollution, occurred generations ago.

Fourthly, competing and conflicting demands for water use put water governance into the wicked problem basket. Environmentalists and recreational users place different value on the resource than hydro generators and irrigators. That makes it difficult to fix because of incomplete, contradictory, and changing requirements that are often challenging to reconcile.

So much for the impediments, what of the solutions?

Current attempts to improve water quality stem back to 2002, when the then Government started its Sustainable Water programme of action, partially in response to Fish and Games' Dirty Dairying campaign. The aim was to use the instruments available under the Resource Management Act, namely policy statements and environmental standards, to give direction to regional councils. Famously labelled a 'sustainable water programme of inaction', it lasted six years and delivered only one environmental standard (for sources of water for human consumption). This work was never intended to examine the wider deficiencies in the governance of our water.

Three initiatives in 2008 led to a revised approach.

The incoming government signalled a willingness to take a collaborative approach with representative bodies to address water quality and quantity issues. The genesis of this came from the Nordic co-governance model where through a formal framework, government and industry work together on policy.

Arising from its annual conference the Environmental Defence Society proposed a Sustainable Land Use Forum aimed, as the name implied, at sustainable land use.

Water New Zealand convened the Turnbull Group to propose new ways to govern water. The Turnbull Group's blueprint for reform was published in 2009 in a document entitled Governance of Water.

The Government pulled these three strands together in its New Start for Freshwater Policy programme, launched in June 2009. Aimed at improving freshwater management, the programme had three elements. It established the Land and Water Forum, opened discussion between Ministers and the Iwi Leaders Group aimed at resolving high level freshwater issues and set up a concurrent officials work programme.

The Land and Water Forum delivered the first of its three reports in April 2011. The Government responded quickly with a national policy statement on freshwater management, and some funding to accelerate irrigation.

The second and third reports from the Land and Water Forum in 2012 proposed tools and processes for setting and managing limits on water quality and quantity. The Government's response announced late last year was to propose amendments to the national policy statement on freshwater management.

Several other initiatives have been aimed in part at improving existing organisational deficiencies in water governance.

A water directorate has been established in the Ministry for the Environment to coordinate water policy development across government departments. Assigning one central agency with the responsibility to coordinate policy is a common feature of successful water governance arrangements in other jurisdictions. Making the MfE water directorate a permanent feature of ours, would be a useful step forward.

Establishing an infrastructure unit in the Treasury has highlighted the obvious deficiencies in our water infrastructure system.

The Auckland governance reforms provided an opportunity for scale economies to be demonstrated in the delivery of water services. The stunning economic benefits that rationalisation of water services have brought to customers in the region remain largely unsung.

The Better Local Government reform work programme has been given effect through two pieces of legislation, one enacted, the other currently wending its way through Parliament.

Will these initiatives get New Zealanders to where we know we could be with our institutions and organisations governing water? It has been a slow journey so far. Much more is needed to get us there. ■

Murray Gibb
Chief Executive, Water New Zealand

IMPLEMENTING REFORM

Water New Zealand's Annual Conference & Expo

Claudelands, Hamilton | 17–19 September 2014

Water New Zealand's Annual Conference & Expo 2014

The Annual Conference & Expo will again be an industry gathering not to be missed. It remains the largest and broadest conference of its kind held in New Zealand.

The Annual Conference provides the water industry and in particular association members a chance to gather together for three days to catch up with old friends and colleagues, discuss the latest developments and technologies, and debate the issues at the forefront of our sector. It is also a chance to meet new members of the industry and view the new tools and technology in the largest water and wastewater trade exhibition in New Zealand.

We are looking forward to seeing you in Hamilton. Mark the following dates in your diary!

Key Dates

Wednesday 26 March	Call for Abstracts close
Wednesday 28 May	Registrations open
Friday 18 July	Earlybird Registrations close
Monday 28 July	Poster Summaries close

Conference Theme

'Implementing Reform' is the theme of this year's conference.

Over the past year several proposals have been aired for amalgamation of groups of councils, the concept of "shared services" is a live discussion, and there is an active debate on alternative models for managing assets such as water services and roading. Reforms of local government legislation, the introduction of mandatory environmental reporting, and the development of a National Objectives Framework in regard to freshwater are all part of this mix.

In addition new storage projects and the health of our rivers continue to often polarise communities. What will it mean going forward? These issues and others will be explored in September, so come and join us at the Claudelands Event Centre for a varied and challenging programme.

Exhibition

Expo sites are now on sale!

Held for the duration of the Conference, the expo gives delegates and trade visitors the opportunity to meet with leading equipment manufacturers and service providers and see state-of-the-art equipment, technology and services. Over 100 companies take part and the expo sites at this event are extremely popular.

To view further information and to book a site visit **www.waternz.org.nz**

Sponsorship Opportunities

Sponsorship opportunities are available to any member of Water New Zealand wishing to maximise their involvement at the Water New Zealand Annual Conference and Expo. There are a range of sponsorship opportunities available to suit all budgets, with benefits of investment dependent on the level of sponsorship commitment and the type of package.

For further information visit **www.waternz.org.nz** or email waternz@avenues.co.nz

Call for Abstracts – Closes 26 March

The call for abstracts opened on 19 February and will be of interest to the full spectrum of the water industry and can cover a range of topics. The call for abstracts closes on Wednesday 26 March. To submit a paper visit **www.waternz.org.nz**

Poster Summaries

Poster presentations are always a popular component of the Annual Conference. Submissions are open until 28 July. Visit **www.waternz.org.nz** for more information and to submit your poster summary online.

For more information please contact Hannah Smith, *Water New Zealand* – E: hannah.smith@waternz.org.nz or P: +64 4 495 0897

Welcome to the First issue of *WATER* for 2014

WATER is published five times a year, and we welcome contributions of technical and general news items across the spectrum of the water and wastes industry on the following areas:

- Policy and legislation
- Water quality
- Demand management
- Wastewater
- Project news
- Modelling
- Stormwater
- International
- Training
- Trade waste
- Industry news
- Technical topics/papers

The next issue of *WATER* will be published in May. The themes are water reform, infrastructure resilence, rainwater harvesting, and water storage.

Bernadette Stevenson has come on board as Assistant Editor working closely with editor, Robert Brewer, in sourcing articles for WATER. If you have any story ideas, contributions, or photos, please send these to editor@avenues.co.nz

For all advertising matters, contact Noeline Strange on +64 9 528 8009 or +64 27 207 6511, or at n.strange@xtra.co.nz

The deadline for the May issue of *WATER* is Monday 7 April.

Become a *Water New Zealand* Member Today

Start engaging now with other members of the water industry.

Keep up to date with the latest news, events and trends plus get access to event discounts, industry policies and information, and much more.

Join now at
www.waternz.org.nz
or phone +64 4 472 8925

Changed jobs or details? Let us know. Moving jobs doesn't mean you have to resign! Simply let us know your new employer contact details, and your membership will continue uninterrupted.

STORMWATER 2014 CHRISTCHURCH
14 – 16 MAY

REGISTRATION IS NOW OPEN!

TO REGISTER VISIT www.waternz.org.nz

Sponsorship and Trade Exhibition Opportunities

The Stormwater Conference is a prime opportunity to promote your organisation through sponsorship and trade exhibition. With a projected attendance of 250 attendees, the 2014 Stormwater Conference is targeted at the following audiences:

- Regional council and TLA staff
- Professionals from related disciplines
- Procurement managers
- Academia
- Infrastructure providers

If your company is interested in developing or enhancing business relationships with any of these audiences, then an exhibition or sponsorship at the 2014 Stormwater Conference is a great opportunity.

For details on the sponsorship and exhibition opportunities available visit **www.waternz.org.nz** or email waternz@avenues.co.nz

The 2014 Stormwater Conference is to be held at the new Rydges Latimer Hotel in Christchurch from 14 – 16 May 2014

The Conference is on Wednesday 14 and Thursday 15 May. Optional site visits are on Friday 16 May.

The Water New Zealand Stormwater Group in conjunction with the Modelling Group and the Rivers Group have put together a programme of keynote speakers and technical papers which should appeal to anyone interested in stormwater. The record number of abstracts received this year has necessitated a 4th technical stream on both Wednesday and Thursday with optional site visits around Christchurch on the Friday morning. This year the Downer Welcome Function is on the Wednesday night and the Opus Conference Dinner is on the Thursday night.

The programme will have a significant focus on post-earthquake Christchurch with papers on the increase in flood vulnerability, restoration of waterways, and future stormwater risks.

There is also a very good spread of papers from around New Zealand, plus a few from overseas. Subjects include low impact design, river management, landscape planning, stormwater design, consenting and compliance, and modelling.

The draft programme can be viewed on the *Water New Zealand* website www.waternz.org.nz

Keynote Speakers

The programme features keynote addresses including Douglas Howie.

Douglas C. Howie

Douglas is a licensed PE in Washington and Idaho, and an Adjunct Professor in Civil Engineering at St. Martin's University in Lacey, WA teaching surveying and Stormwater Facility Design classes.

Doug manages the Technology Assessment Protocol – Ecology (TAPE) programme where Ecology evaluates emerging storm-water treatment tech-nologies for use in Washington State. Stormwater Utilities across the United States use results from this programme to confirm that they can get adequate treatment from manufactured treatment devices. He is working with the Water Environment Federation to study the potential for a nationwide evaluation programme.

Doug comes to you with more than 30 years' experience in planning, design, construction, and regulation of water related projects. He has worked with stormwater, drinking water, wastewater, and reclaimed water projects throughout his career.

NZTIWF – Diverse Subject Matter, Better Science!

Keynote Speakers

Rod Oram

Rod is an inspiring and well researched journalist/speaker on corporate, economic and political issues. He's a regular broadcaster on radio and television; a columnist for the Sunday Star-Times and has contributed to several regional economic development projects.

Rod Oram has more than 30 years experience as an international financial journalist and has worked in Europe and North America for leading publications such as the Financial Times of London. His career with the Financial Times spanned 18 years as an editor and writer based in London and New York and he has also travelled extensively in North America, Europe, and Asia.

He's an independent operator, broadcaster and an Adjunct Professor in the New Zealand Centre for Innovation and Entrepreneurship at Unitec, Auckland's technology tertiary institution and has contributed to several regional economic development projects.

He's a regular broadcaster on radio and television; a frequent public speaker on business and economic issues and an occasional correspondent for the Financial Times. Rod and his family emigrated from the UK to New Zealand in 1997. (View Rod's full bio on the conference website).

Kevin Rolfe

As a Consultant Chemical Engineer and Environmental Management Specialist, Kevin Rolfe is a specialist in the technical, policy, and social aspects of the environmental consequences of industrial and urban development. He has 40 years of environmental management experience in various capacities, both locally and internationally, and especially in air quality management and related fields.

Kevin is a Chartered Chemical Engineer and a Chartered Scientist with advanced interpretive and analytical skills. Those attributes led in an easy way for him to be closely involved in early advances in environmental science and management in the 1970s. They continue in his current work areas, including Peer Review and Resource Management Act hearings and Commissioner appointments. (View Kevin's full bio on the conference website).

Other Confirmed Speakers Include

Theresa Wilson, Dairy NZ; Paula Southgate, Waikato Regional Council; Steve Couper, AWT and *Water New Zealand* President; Jenni Vernon, Waikato River Authority.

Full details of the conference programme can be found on the conference website.

Pre-Conference Workshop: Resource Consent Consistency Issues

Water New Zealand has run two very successful workshops to canvas the question "Can Greater Consistency be Achieved in Practices Associated with Establishing Compliance with Discharge Consents?" The first workshop was attended by 86 attendees from a wide range of utility owners, managers and advisers, with a few industry representatives. The second workshop was held with the Regional Council Consent Managers Group. Both workshops were very successful and gained agreement that both the process and conditions could and should be improved.

These were the initial stages of a process focussed on national improvements and aimed at gathering facts on areas where efficiencies could be gained; both to protect the environment, and reduce the effort and costs for all parties involved. As a consequence, a number of specific projects have been proposed for collective completion.

This third workshop is focussed on gaining additional comment, feedback and proposed improvements from representatives of trade and industry. The workshop will present and review the work and information gained to-date plus current proposed improvement projects; and provide a discussion forum for trade and industry representatives to give their views and input into the programme of proposed improvements.

Workshop cost: Included in conference registration fee or $150 inc GST for those not attending the conference.

For further information visit the conference website:
www.confer.co.nz/tiwf2014

Water Environment Federation Announces New Executive Director

Dr Eileen O'Neill

The Water Environment Federation (WEF), the not-for-profit technical and educational organisation with 36,000 members representing water quality professionals around the world, formally announced in February that Dr Eileen O'Neill has been named its new Executive Director. O'Neill replaces former Executive Director Jeff Eger who resigned in July 2013. Dr O'Neill has been serving WEF as the Interim Executive Director since Mr Eger's departure and prior to that, she was Deputy Executive Director.

WEF President Sandra Ralston said, "Dr O'Neill is an experienced association executive with strong water sector knowledge based on diverse domestic and international experience."

"She has a proven track record during her 20-plus years with WEF delivering highly successful technical programming, increasing revenues and building partnerships," President Ralston said.

Before becoming Deputy Executive Director in 2011, Dr O'Neill served as the organisation's Chief Technical Officer with responsibility for oversight of WEF's technical, international, and communications programs. In the past several years, she has been involved in creating national and international thought-leadership programming at WEF's annual conference WEFTEC, the world's largest annual water quality conference and exhibition.

Before joining WEF she worked as an academic and environmental consultant in the US and in Europe. She has a Bachelor of Science in Soil Science from the University of Newcastle-upon-Tyne (UK) and a PhD in Soil Science from the University of Aberdeen (UK) and undertook a postdoctoral traineeship in Environmental Toxicology at the University of Wisconsin at Madison.

President Ralston said, "Dr O'Neill has consistently led WEF operations to be more strategic and data-driven, which aligns WEF with industry trends and the changing needs of utilities and global professionals. She has worked for an enhanced and more forward-looking volunteer experience."

"Her sincere appreciation of and partnership with the volunteer leaders is inspiring."

Dr O'Neill said she was honoured by her appointment to the leadership role. "It is especially exciting to serve the water profession and sector in such a time of change and opportunity. The vital role that water services play in communities is becoming increasingly clear and the need for innovative thinking and practices more widely recognised. I have no doubt that the collective talents of our members and volunteer leaders working with WEF's dedicated staff will allow WEF to play a key role in ensuring that the promise of these new approaches is realised."

Leaders of All Kinds Emerge from Water Leadership Institute

The 2013 graduates of the Water Leadership Institute emerged with confidence and a better idea of leadership styles. The programme, developed by the Water Environment Federation (WEF) (Alexandria, Virginia), helps equip a new generation of water professionals with the latest skills and knowledge needed to take on sector challenges.

"There are great water challenges out there, but there are also great opportunities and it's going to take leaders of all kinds and at all levels," said Eileen O'Neill, WEF Executive Director.

Eileen O'Neill, WEF Executive Director, speaks during the 2013 Water Leadership Institute graduation ceremony at WEFTEC (photo courtesy of Oscar Einzig Photography)

Participating has helped Erin Ganley, a Team Leader with Greater Wellington Regional Council (Wellington, New Zealand), meet new people in the sector and learn new ways to handle challenges.

"This course is about influencing the future and providing those in the programme with the skills to do it," Ganley said. "It has opened my eyes to the different ways of approaching a challenge," she added.

In addition, Ganley learned about ways to leverage her skills in the workplace. "You should never stop learning and that learning should not just be technical, but must encompass learning about yourself and how your interactions impact those around you."

"I have developed a greater understanding of myself and in my current role I am able to implement my lessons and help develop others."

Participant Britt Sheinbaum, a Project Manager at WEF, has already applied knowledge of her leadership style to her course work within the institute and her daily life. "You watched everybody's style and how they interact with the group," Sheinbaum said. "I'm a relationship builder." She says it is this knowledge that has helped her recognise personal strengths, determine tasks where she will be the most successful, and delegate tasks suited to others' strengths.

"It teaches you how you can step up in the ways that you excel," said Brittany Burch, participant and project manager at WEF. "You can lead in different ways," she added. Participating helped Burch expand her definition of leadership and confidence and understanding of her personal skills.

"You should never stop learning and that learning should not just be technical, but must encompass learning about yourself and how your interactions impact those around you. I have developed a greater understanding of myself and in my current role I am able to implement my lessons and help develop others."

The opportunity also enables participants to build a network of water professionals that will help them both personally and professionally in the future. "The bonds you make with people and those connections, it's just nice. I got a lot out of it," Burch said.

"I really feel that the connections and networking that we see here will carry forward and will continue to grow this program," said Renee Kayal, WEF Education and Training program director. ■

The Water Leadership Institute class of 2013 graduates and mentors include(back row from left); David Peterson, Dave Robinson, Jeffrey Berlin, Mark Earl, Dempsey Ballou, Amanda Rockler, Madhusudan Joshi, and Maylinn Rosales; middle row from left, Alvin Pilobello, Jason Dreessen, Doug Barder, Robert Johnston, Mark C. Perry, Aren Hansen, Melissa L. Pomales, Kathleen Bates, Uday Khambhammettu, Keli Callahan, Renee Kayal, and Gary Fournier; front row from left, Erin Granley, Amanda Poole, Janet Spencer, Flor Y. Garcia Becerra, Britt Sheinbaum, Ben Klayman, Brittany Burch, and Dale Kocarek (photo courtesy of Oscar Einzig Photography)

On-site Wastewater Training Has Arrived

Hugh Ratsey and Jonathan Mackey – Opus International Consultants

Abstract

The On-site Wastewater (OSW) industry has long advocated the need for training of industry practitioners to a national standard. NZQA-registered unit standards were developed in 2008, but no training provider has previously offered training to assess competence against them. From March 2014, Opus will be offering training with assessment against these unit standards. This provides the industry with the opportunity to adopt a consistent training package nationwide, and in turn provide assurance of practitioner competence. As regional councils and territorial authorities amend their OSW plans, they are encouraged to adopt this training package to underpin their plans.

Keywords

On-site wastewater, Training, National Standard

Introduction

The New Zealand Land Treatment Collective (NZLTC) and the *Water New Zealand* (WaterNZ) Small Wastewater and Natural Systems Special Interest Group (SWANS-SIG) have been advocating the need for On-site Wastewater (OSW) training to a national standard for many years. This was reemphasised during the NZLTC workshop in Rotorua in November 2012, where critical issues facing the on-site wastewater industry were identified. Of these critical issues, accreditation for OSW systems and practitioners such as designers, inspectors and regulators as well as training, were ranked in the top five challenges (NZLTC 2013).

While OSW training has been and continues to be, offered by several providers in New Zealand, these providers have not assessed trainees against a national standard. Therefore, it is unknown whether trainees have attained competence to the level expected by the OSW industry.

In 2008, following extensive industry input, the Level 4 National Certificate in Wastewater Treatment (On-site Domestic Wastewater System Design) qualification was registered on the NZQA framework (NZQA 2013). This qualification comprised six unit standards, from knowledge of wastewater treatment processes and land application systems, site and soil investigations, through to the design of on-site wastewater systems.

Following registration no training provider delivered and assessed against this qualification, so the qualification is scheduled to be removed from the NZQA framework (Yeates 2013). However, the unit standards remain on the framework and will continue to be available providing they are utilised.

Opus Environmental Training Centre (Opus) is an established NZQA registered private training establishment (PTE) with a proven track record in the preparation and delivery of training in a range of disciplines, including wastewater treatment and disposal.

Opus also manages and provides all the administration, financial, marketing, and quality assurance services for the New Zealand Water and Environmental Training Academy (NZWETA). NZWETA is an Opus and WaterNZ joint venture that promotes and develops training for the wider water industry.

Industry Consultation

Opus has undertaken considerable industry consultation to understand the need for OSW training to a national standard. This has included direct contact with regional councils, territorial local authorities and unitary authorities, as well as discussions with on-site wastewater system designers and suppliers, NZLTC, and SWANS-SIG.

There is general agreement that training to a national standard is required, however opinions vary regarding the appropriate length of the training package. While many indicated support for an extensive training package, others indicated that one or two days training would suffice.

A consistent message from industry was a preference for local training delivery, to local conditions and regulations where possible. Industry also indicated a preference for training delivery with relatively short contact time (one to three days), rather than longer duration (week blocks).

"During consultation, the question was raised about how experienced practitioners could be recognised for prior knowledge and experience. This raises an interesting challenge. While many experienced practitioners are suitably qualified and would be good candidates for a streamlined process, any streamlining process needs to identify and up-skill practitioners who are not currently operating at the required level."

During consultation the question was raised about how experienced practitioners could be recognised for prior knowledge and experience. This raises an interesting challenge. While many experienced practitioners are suitably qualified and would be good candidates for a streamlined process, any streamlining process needs to identify and up-skill practitioners who are not currently operating at the required level. Therefore, some form of recognition of prior learning (RPL) is required, but this RPL process must be robust to ensure the scheme retains its credibility.

Current Industry Training Requirements

Currently within New Zealand there is a lack of consistency around what constitutes a person who is deemed competent to undertake design, installation and/or servicing of OSW systems.

Different authorities use terms such as "Suitably Qualified Person" (SQP), "approval", "accreditation" or "certification". For example, the Gisborne District Council has developed a set of minimum performance criteria for "Accredited Site and Soil Evaluators" and "Accredited On-site Wastewater System Designers" (GDC 2012). In the Far North District, a "Suitably Qualified Person" means any person recognised or approved by the Council as being suitably qualified to prepare appropriate reports, designs and assessments for On-site Wastewater Disposal Systems (FNDC 2010). Other authorities have different criteria in place.

This variation in requirements between different authorities has led to uncertainty regarding the competence of practitioners. Where a provider may be "approved", "accredited" or "certified" to practice in one region or district, this does not necessarily allow them to practice nationwide. However, many practitioners are operating throughout multiple districts or regions, and even nationally. It would

"Module one is a three-day module applicable to all practitioners working in the OSW industry, providing an introduction to wastewater treatment processes and land application systems. This provides background knowledge of OSW systems, and is therefore best delivered in a classroom style. Assessment of knowledge-based unit standards is most efficiently done through traditional written tests. It is expected that experienced OSW practitioners would be able to demonstrate their understanding of this background knowledge through an RPL process."

be of benefit to the industry if all authorities adopted consistent training requirements across the country.

An example of such a consistent training package can be seen in Minnesota, USA. This training package supports the Minnesota Pollution Control Agency (MPCA) requirement that all private businesses in Minnesota that design, install, maintain, inspect, and service subsurface sewage treatment systems must be licensed with the MPCA (University of Minnesota 2014). While there is no such legal requirement in New Zealand to drive an OSW training package, the industry is sufficiently large to support such a training package, particularly if the package has widespread support.

Bay of Plenty Regional Council

The Bay of Plenty Regional Council (BoPRC) recently went through the process of changing its On-site Effluent Regional Plan. A key aim of the plan change was to bring consistency around the competence of practitioners (Long 2013), resulting in the requirement for "Suitably Qualified and Experienced Persons" (SQEP) to sign off many aspects of OSW design and installation.

The resulting plan change defines a "Suitably Qualified and Experienced Person" as *a person who is independent, applies good professional practice, is familiar with wastewater disposal and competent to make reports in accordance with the relevant New Zealand Standards and this regional plan. The person will have attended a training course approved by Bay of Plenty Regional Council and be accredited in site and soil assessment for on-site wastewater management system design. The person may be a member of a professional body* (BoPRC 2013).

To support this plan change, BoPRC require an "approved" training package. BoPRC's desire is for this training package to be to a national standard, and BoPRC had discussions with a number of potential training providers, including Opus. BoPRC decided to proceed with a training package based on existing unit standards, which were deemed to meet most, but not quite all, of BoPRC's requirements.

Proposed Training Package

The proposed training package is shown in Figure 1, based on the following six NZQA registered unit standards:

25124	Demonstrate knowledge of domestic wastewater treatment processes
25125	Describe domestic wastewater land application systems, and their selection, for site and soil characteristics
25126	Demonstrate knowledge of hydraulics and pump types and fittings for on-site domestic wastewater treatment systems
25127	Carry out a site and soil evaluation for an on-site domestic wastewater system
25128	Design an on-site domestic wastewater system, and describe regulatory requirements
25129	Describe package treatment, and wastewater land application systems

The unit standards have been packaged for delivery in a way that meets the stated requirements of the industry during consultation, while being cognisant of the commercial realities of delivering a training package. Individual modules have been limited to a maximum length of three days, and packaged into three separate modules:

Module One: Introduction to OSW

Module one is a three-day module applicable to all practitioners working in the OSW industry, providing an introduction to wastewater treatment processes and land application systems. This provides background knowledge of OSW systems, and is therefore best delivered in a classroom style. Assessment of knowledge-based unit standards is most efficiently done through traditional written tests. It is expected that experienced OSW practitioners would be able to demonstrate their understanding of this background knowledge through an RPL process. This RPL process is currently under development. On successful completion of module one, including the assessments, attendees will be awarded the NZWETA Certificate "Principles of On-site Wastewater".

Module Two: OSW Hydraulics

Module two is a one-day module applicable to practitioners who are either designing OSW systems or reviewing/approving designs. Prerequisite to attendance of module two are the NZWETA Certificate

"Principles of On-site Wastewater" or RPL. The hydraulics material is best delivered in classroom style, with assessment by written tests.

Module Three: OSW Site & Soil Investigation and Design

Module three is a three-day module applicable to practitioners who are either designing OSW systems or reviewing/approving designs. Prerequisites to attendance of module three is the NZWETA Certificate "Principles of On-Site Wastewater" or RPL and successful completion of module two, including the assessments. The delivery of module three will be partly classroom based, and partly delivered on-site. Written assessments will be completed post-course. On completion of module three, including the assessments, attendees will be awarded the NZWETA Certificate "On-site Wastewater System Designer".

One discipline that is not adequately covered by the unit standards is the installation of OSW systems. While many suppliers have a training and approval process in place for their own installers, the industry may decide that installer training to a national standard is required. In which case, it may be necessary to work with the Primary ITO to develop an additional unit standard.

Training delivery will commence in March 2014 in the Bay of Plenty region. Registrations for OSW training to this national standard, and applications for RPL, can be made through the NZWETA website www.nzweta.org.nz/nz-waste-and.html

National Uptake

Now a training package to a national standard is available the industry has the opportunity to adopt this package nationally. BoPRC has pioneered this by adopting the training to support its recent regional plan change. As other regional councils and territorial authorities follow suit this will increase the credibility of the training package as a truly national standard.

The OSW industry may wish to consider some form of national register of practitioners who have obtained the "Principles of On-site Wastewater" and "On-site Wastewater System Designer" certificates.

Conclusions

OSW training to a national standard is now available. Adoption of this training will provide authorities with the confidence that practitioners are competent to a known and repeatable standard.

Recommendations

It is recommended that regional councils and territorial authorities adopt this OSW training package as and when their plans are updated, or earlier if their plans allow. This will result in consistency nationwide with regard to OSW practitioners.

Acknowledgements

The authors acknowledge the BoPRC and Auckland Council for funding the development of the OSW training material, and to the working group of Opus, NZLTC (Sandy Ormiston, Ormiston & Associates), SWANS-SIG (Rob Potts, Lowe Environmental Impact), On-Site NewZ (Ian Gunn), BoPRC (Terry Long) and Auckland Councils (Judy-Ann Ansen).

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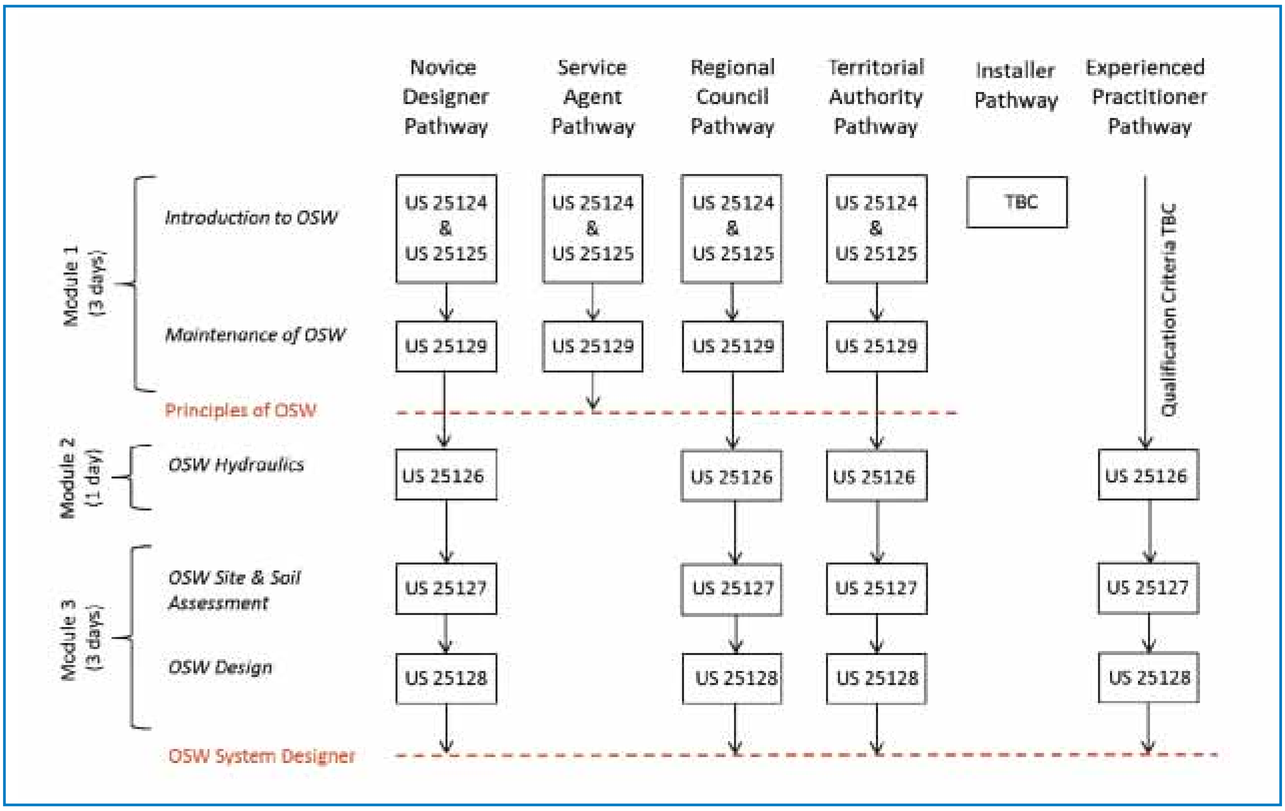
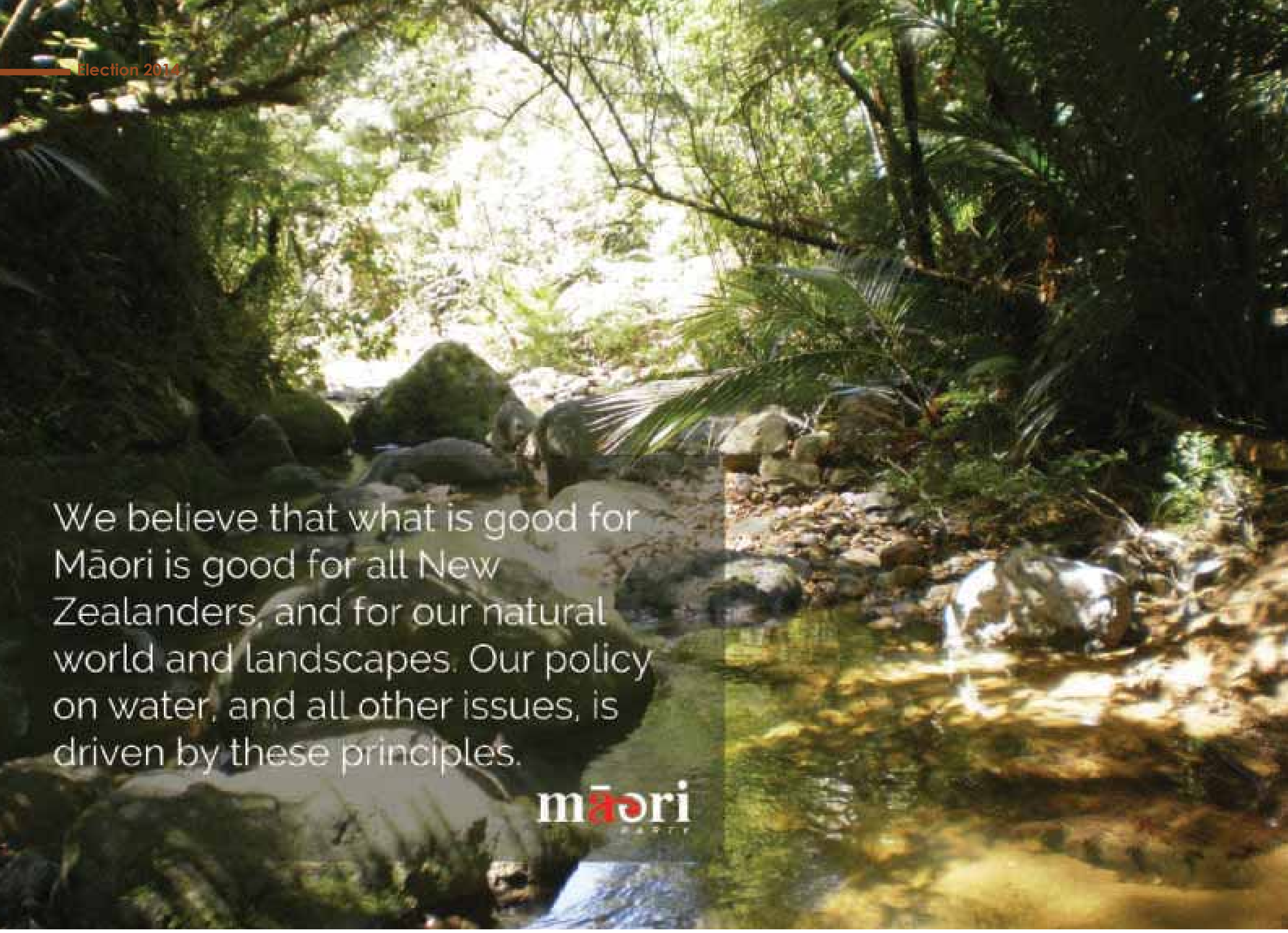


Figure 1 – Proposed OSW training package



To give the readers of WATER an insight into Party policies on water we are giving the Maori, Green, Labour and National Parties the opportunity to describe the issues they see as important leading up to the General Election. In this issue of WATER the Maori Party outlines its approach to water and its management.

Maori Party Water Policy: A Call for Full Co-operation by all Stakeholders and Citizens

Maori Party policy positions on issues related to water need to be considered in the wider context of kaupapa Maori – Maori philosophy, principles and custom, as they apply to current issues in water and waste management.

That is because the Maori Party sees itself as a voice to represent and advocate for tangata whenua in the Parliament and in Government. So what is important is not just the stance of the Maori Party on a particular issue, but how we enable the views of tangata whenua to be advanced and their customary interests to be protected.

Tangata whenua, the customary owners of a particular area, have wide-ranging and inalienable relationships with their natural environment and landscapes; relationships that go far beyond Western ideas of 'property rights' or 'ownership'.

In the cosmology of tangata whenua, the world is descended from Ranginui and Papatuanuku, and their children, the atua who govern all aspects of the natural environment. That includes people, who are descendants of Tane, along with the forest species, birds, and animals. So people are related to the natural world.

Over many generations the key features of their landscapes have also become integral to tribal traditions, history, culture and identity – as the scenes of battles, as sites of settlements, as sources of food, as burial places for ancestors. The collective identity of the tangata whenua group becomes inseparable from their mountains, their coasts, their rivers and lakes.

"I am the river, and the river is me" is an expression of this sense of tribal and personal identity with the natural environment. This sense of identity is what makes a tribal community 'tangata whenua' – people of the land.

If their iconic rivers or lakes are degraded, polluted, barren or toxic, and tangata whenua cannot talk with pride about the deeds of heroic ancestors, then current generations will feel the burden of their responsibility to look after the natural heritage handed down by their ancestors.

Western science recognises that if a river is polluted, the health of the people will be affected. At the individual level, toxic pollutants affect personal health. For tangata whenua, the survival of their traditional community is equally important. If ecosystems are harmed, food chains are broken and food sources disappear, the ability of the community to provide for themselves or to fulfill their cultural obligations to offer hospitality may be lost. And if traditional methods of hunting, fishing, gardening, and preparing food are abandoned because they are no longer worthwhile, then living links with ancestral life and customs are lost.

So tangata whenua are driven by their culture and heritage to maintain their responsibilities and rights to manage their environment in accordance with custom. No-one has a greater incentive to protect and sustain healthy environments for the benefit of all people and for future generations. If hapu and iwi cannot do that, their mana as tangata whenua is compromised.

Any time this happens is a clear breach of the *Treaty of Waitangi.* The Treaty rights that tangata whenua claim in relation to natural resources are not merely exclusive property rights, but the opportunity to fulfill their cultural responsibilities and duties in decision-making as Treaty partners of equal status to the Crown.

Because this relationship between tangata whenua and their natural environments is primarily cultural, and concerns the identity and mana of the community, the primary qualification is the ability to represent the community, rather than scientific and technical expertise. Therefore, while the Maori Party's policy on issues such as water and waste management reflect widely-held values among tangata whenua, our policy is not set out primarily as an election manifesto to appeal to voters.

Neither is the Maori Party a tangata whenua group, so our policy is, in a sense, irrelevant to our constituents. What matters is how effectively we can support tangata whenua to express and implement their policies and plans for water and waste management in their own tribal areas, in accordance with their own custom.

We see our role in Parliament as facilitating dialogue directly between tangata whenua groups all over the country, and Ministers and agents of the Crown, so tangata whenua can represent themselves and their (local) issues with their Treaty partner.

This approach is reflected in the Maori Party's submission in April last year on the Government's proposed freshwater reforms. As the covering letter from the Co-leaders states:

> "In our discussion of the proposed freshwater reforms, we take a step back to look at the wider framework within which those reforms would sit. Fundamentally, what we want to see is the principle of partnership, as laid down in *Te Tiriti o Waitangi*, reflected in arrangements relating to governance, management and decision-making on freshwater."
>
> "What this requires, at a pragmatic level, is namely 1) the development of robust and accountable work practices by local government when working with mana whenua; 2) the development of Maori-led environmental monitoring and evaluation of freshwater resources; and 3) the development of options for improving water quality."

The structure of the Maori Party's submission supports that overarching approach.

Section one, **'A Collaborative Planning Process'**, asks what incentives there are for councils to adopt a more collaborative process; whether a plan developed through effective collaboration should become binding on councils; the need for culture change in communication between councils and their communities; and the importance of collaboration in reviewing plans and implementing them.

Section two, **'Effective Provisions for Maori Involvement in Freshwater Planning'**, is in two parts. The first, covering involvement of relevant 'Maori', considers the special role and relationships of tangata whenua with their environment. It notes that many of the protective roles of kaitiaki fall to whanau or hapu within broader tribal areas; and that tangata whenua themselves must determine who are the appropriate representative bodies. The second section, *'Maori involvement may require capability development'*, refers

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to Land and Water Forum recommendations to build community expertise including in research, information management, economic analysis, training, capacity, technology transfer, and outreach services – especially for tangata whenua who are often voluntary.

While central Government may support councils to run robust planning processes, will councils likewise support tangata whenua? It also notes that collaboration and consultation in planning, and enhanced monitoring and reporting, are steps towards a Treaty partnership, not evidence that such a partnership exists.

Section three is headed **'Stronger Central Government Leadership'**. It says that, twenty years after enactment of the RMA, some councils' efforts to respond to resource management issues of importance to tangata whenua are still a 'work in progress', and argues that that is an indictment on central government's leadership. Central Government's role in disseminating 'best practice' across the water management regime must include guidance to councils on how to engage with tangata whenua. This could be done through relevant performance measures for councils, and Government intervention if that fails.

The design and review of such performance measures should involve tangata whenua, and central Government's performance should also be reviewed (by the Land and Water Forum). This section also questioned the Government's timeframes for freshwater reform, given the importance of tangata whenua status and rights in relation to natural resources, and the fact that the Waitangi Tribunal had not then reported on Maori claims to water.

Section four, **'Bottom Lines'**, supports the need for enforceable minimum standards, aimed at preventing water pollution and improving water quality, to counteract the cumulative effect of permits and consents granted under the RMA. In setting and monitoring bottom lines, again, a key consideration is that tangata whenua should be involved; and that, alongside enforcement, information and education can help to achieve the objectives sought by bottom lines.

In section five, **'Managing within Limits'**, options are traversed for punishing water pollution. The Maori Party argues for a restorative approach rather than purely punitive. Fines and imprisonment do not restore the environment to the way it was or address the offending attitudes; remediation is the goal, with education and management systems review to prevent recurrence. Councils' own roles must be audited, both for enforcement compliance with the law, and also their management of the resource. The aim is to seek 'win-win' solutions, identifying opportunities through active and dynamic water management, rather than simply trading off competing values.

Finally, section six, **'Managing Quality'**, suggests that statutory environmental service orders could require offenders to restore or enhance the environment; or permanent national (and possibly local) funds could be established to pay for environmental restoration where the offender was unable to pay or could not be found. Any fines for pollution offences could be paid into such a fund.

This submission fleshes out the principles of the Maori Party's current environment policy, which is under review prior to the coming election.

That policy states:

Environment

We believe in the efficient use of water, energy conservation and the need for sustainable environmental management. We are concerned about water management; restoration of water quality; and environmentally sustainable land use that does not degrade our water systems.

- *Develop iwi environmental monitoring and evaluation on the quality of water in our rivers, lakes, seas, and rural water supplies to homes and marae; and develop options for improving water quality as a result*
- *We will ensure that iwi, as Treaty partners, are involved in governance, management and decision-making on freshwater within their rohe*
- *Expand the mandate of the Environmental Protection Authority to include Crown minerals and freshwater*
- *Transfer the role of kaitiaki back from the Department of Conservation to mana whenua*
- *Retain and resource the Enviroschools/Kura Taiao*
- *We will subsidise organisations to undertake environmental impact assessments to support businesses to become more environmentally friendly*

The Maori Party believes that the kaupapa and tikanga tuku iho of tangata whenua, such as manaakitanga or hospitality and generosity, kotahitanga or unity of purpose, rangatiratanga or responsibility and integrity, are embracing and inclusive.

Treaty principles of mutual trust and co-operation and utmost good faith further clarify how we can work together, in this case, for the protection of water quality and enhancement of ecosystems to provide sustainably for current and future generations.

We believe that full co-operation by all stakeholders and citizens is the best way to address urgent and complex environmental problems. Claims by tangata whenua in relation to natural resources are driven, not by opposing interests, but by cultural responsibilities to uphold the mana of the ancestors who bequeathed our natural heritage to us, to hold in trust for our grandchildren and great-grandchildren.

We believe that what is good for Maori is good for all New Zealanders, and for our natural world and landscapes. Our policy on water, and all other issues, is driven by these principles.


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The Changing Tide: Law Reform in 2014

Helen Atkins – Partner; Vicki Morrison-Shaw – Senior Associate and Phoebe Mason – Law Clerk, Atkins Holm Majurey

Introduction

Right from the get go 2014 looks set to be a year of change, with law reform in several sectors affecting water. In this article we briefly review developments in local government law which are of general interest to readers – the Local Government Act 2002 Amendment Bill (No 3), and an update on the progress of the Auckland Unitary Plan. We then provide a brief discussion of the Building Amendment Act 2013 which affects dam owners, and the proposed amendments to the National Policy Statement for Freshwater 2011 which were released by the Government last year. We finish off with some recent cases of interest in respect to water.

Summary of the Local Government Act 2002 Amendment Bill (No.3)

On 4 November 2013 the Local Government Act 2002 Amendment Bill (No 3) ("the Bill") was introduced into Parliament. The Bill forms part of the second stage of the Government's 'Better Local Government' reform programme, the first stage of which culminated in the Local Government Act 2002 Amendment Act 2012.

Much of the Bill is based on reports by the Local Government Efficiency Taskforce and the Local Government Infrastructure Efficiency Expert Advisory Group. The Advisory Groups noted certain themes arising with striking regularity during their investigation – "simplification, integration, collaboration, transparency, innovation, process, and accountability."[1] The present reforms are designed to "encourage and enable local authorities to improve the efficiency and effectiveness of their operations and processes."[2]

The Bill's changes operate under six heads:

1. Development Contributions

The appropriateness of development contributions as a means of funding infrastructure has been reviewed, resulting in guiding principles, the narrowing of the range of projects which can be financed by development contributions, the encouragement of greater private provision of infrastructure through development agreements and collaborative joint service arrangements in the delivery of infrastructure services, and clarification of the processes involved in these arrangements.

2. Local Boards Outside Auckland

The Bill includes provisions to enable the use of the two-tier 'local boards' model outside of Auckland, to combine the benefits of large-scale institutions with the benefits of local community based governance.

3. Efficient Delivery and Governance of Local Authority Services

The Bill envisages the development of a performance framework for local government to ensure efficient delivery and governance of local authority services. The proposed provisions also encourage and facilitate collaboration between local authorities.

4. Consultation, Decision-making and Long Term/Annual Plans

The Bill provides for new policies on consultation and engagement in the development of plans, as well as a new "concise and focused consultation document" for plans. Such a document is intended to provide a plain language explanation of the matters which are important to local communities, and help to inform discussions on those matters.

5. Financial Reporting Amendments

The Bill makes amendments to financial reporting regulations, requiring the disclosure of standard balance sheet information on previously unavailable assets – water, wastewater, stormwater, flood protection and roading.

6. Infrastructure Delivery and Asset Management

Of particular interest to readers are the proposed improvements to infrastructure delivery and asset management. Provisions in the Bill "reinforce the importance of asset management planning as part of a council's prudent stewardship of resources; require councils to prepare an infrastructure strategy for at least a 30 year period and to incorporate this into their long term plans from 2015; and require councils to disclose risk management arrangements, such as insurance, for physical assets in their annual reports."[3] These reforms aim to address the long term life of assets like water pipes, and to encourage good management in order to provide communities with essential services.[4]

The Bill has been referred to the Local Government and Environment Committee for consideration and submissions on the Bill closed on 14 February 2014. The Committee's report on the Bill is due by 12 May 2014.

Unitary Plan Process: Hearings Panel and Deadlines

Environment Minister Amy Adams and Conservation Minister Nick Smith announced the composition of the proposed Unitary Plan Hearings panel in mid-December last year. The panel is to be chaired by David Kirkpatrick, a recently appointed Environment Court Judge who has extensive experience in consenting and planning appeals both as a barrister and as an independent hearings commissioner. Mr Kirkpatrick is joined by seven other panel members – Mr Des Morrison (former Auckland Councillor); Ms Janet Crawford (resource management consultant); Ms Paula Hunter (planning consultant); Mr John Kirikiri (tikanga Maori expert); Mr Stuart Shepherd (economics and business strategy advisor); Mr Greg Hill (resource management consultant); and Mr Peter Fuller (resource management barrister).

The deadline for submissions on the Unitary Plan is 28 February 2014. While previously there was some uncertainty around the closing date (due to the legislation indicating a closing date of 60 working days post notification i.e. 14 January 2014), Mr Kirkpatrick has confirmed that, if necessary, waivers will be granted for all submissions received after 14 January 2014 and up to and including 28 February 2014.

Summary of the Building Amendment Act 2013

Passed in November 2013, the Building Amendment Act comprises a set of changes to the existing dam safety scheme – a risk management regulatory regime for dams in New Zealand, prescribed by the Building Act 2004 and the Building (Dam Safety) Regulations 2008. The Amendment Act changes some of the definitions, which determine whether or not a dam is included in the scheme: the threshold for a 'large dam' has been increased from three or more metres in depth to four or more metres in depth; the 'height' of a dam has changed and the 'crest of a dam' has changed. These three provisions are already in force, but further changes will follow in a forthcoming amendment to the Regulations. All 'classifiable' dams will be required to undergo potential impact category assessment, with obligations flowing from the level of potential impact a dam

"These issues may result in decisions that provide insufficient protection for environmental or cultural values, or unnecessarily constrain economic growth and development."

failure could have on people, property and the environment. Guidance will be provided by the Ministry of Business, Innovation and Employment once the regulations have been passed.

Freshwater Reform Discussion Document Released November 2013

In November last year, Environment Minister Amy Adams and Minister for Primary Industries Nathan Guy, released Proposed Amendments to the National Policy Statement for Freshwater Management: A Discussion Document. The document follows on from the National Policy Statement for Freshwater Management 2011 ("NPSFM"), and Freshwater Reform 2013 and Beyond, the Government's freshwater vision statement released in March 2013.

The document aims to make the NPSFM more effective. While providing some of the guidance for councils implementing the NPSFM envisaged in 2011, the changes also address the following emerging issues:

- Freshwater management decisions being made with insufficient information
- Lack of clarity about how to manage water to protect community and Iwi values
- Costly and lengthy debates over science obstructing discussion of values
- A lack of national consistency in defining minimum acceptable states for water quality
- Tangata whenua values for fresh water not being clearly articulated
- A need to monitor progress towards achieving freshwater objectives

The discussion document asserts that:

> "These issues may result in decisions that provide insufficient protection for environmental or cultural values, or unnecessarily constrain economic growth and development. In addition, disagreements about decisions can impose additional costs and delays on the planning process, and contested decisions are often transferred to the Courts."[5]

The Ministries for the Environment and for Primary Industries assessed four options to address the identified options – the provision of guidance material; the creation of a new regulatory instrument; the development of a new National Environment Standard, and amendment of the existing NPSFM. Amending the NPSFM was seen as the most efficient and effective way of addressing all the identified issues.

In response to the identified emerging issues, the proposed amendments introduce five corresponding developments.

1. Accounting System

Firstly, the proposed amendments require councils to implement a more thorough accounting system of all water takes and discharges. The accounting will encompass the relevant authority's 'freshwater

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management unit', an area which could be a single catchment, multiple catchments, or part of a catchment. Information would be reviewed annually for water quantity and every five years for water quality.

2. National Objectives Framework

Secondly, a National Objectives Framework (NOF) will be introduced to support and guide the setting of freshwater objectives in regional plans. The NOF will provide a 'menu' of values and uses, which communities and tangata whenua can select to tailor objectives to the local water body. A set of attributes will attach to each value or use, with numerical values assisting in the management of the value or use – for example an "A state" for nitrate toxicity represents less than 1mg per litre, and no observed effect on the waterway, whereas a "D state" represents greater than 6.9mg per litre, significantly impacting the growth of some species. A collaborative process for setting the objectives from the selected values will also be set out.

3. Compulsory National Values

Thirdly, two compulsory national values are proposed – ecosystem health and human health for secondary contact. The proposed attributes for ecosystem health are: total nitrogen and total phosphorous for lakes; nitrate toxicity and ammonia toxicity for lakes and rivers; and dissolved oxygen (below point sources) and periphyton for rivers. The attributes proposed to safeguard human health are: E. coli, and planktonic cyanobaceria levels. National bottom lines will adhere to each of these compulsory national values, in order to provide protection to widely held values. Exceptions to these bottom lines are envisaged for waterways contaminated by natural processes, waterways subject to historic activity that has created lasting impacts on the water, or where the water is affected by significant existing infrastructure.

4. Tangata Whenua Values for Freshwater

Fourthly, the Document envisages clearer articulation of Te Mana o te Wai and tangata whenua values for fresh water.

5. Monitoring of Representative Sites

Fifthly, and finally, the document would require councils to monitor a range of representative sites in order to track progress towards, or achievement of, the freshwater objectives. It provides consistent measuring and monitoring techniques for this purpose.

Submissions on the discussion document closed on 4 February 2014.

Recent Water Cases of Interest

1. Definition of 'Watercourse' – Warburton v Porirua City Council[6]

Mr Warburton applied, unsuccessfully, to the Environment Court for declarations regarding the illegality of stormwater and drainage system work undertaken by Porirua City Council at Titahi Bay, a north-west facing beach in Porirua.

The relevant stormwater pipe discharged at Titahi Bay and produced a flow across the foreshore towards the Tasman Sea. The flow was guided by a watercourse approximately five metres wide and some tens of metres in length, constructed from 'rip-rap' (quarry rock and compacted gravels) mixed with compacted and contoured beach sand. Prior to the works there had been a discernable and discrete flow of water across the beach, although not as well constructed, and the flow path matched that of the Kapakanui Creek, first surveyed in 1873.

The issue for the court was the definition of the 'watercourse'. If the flow was the bed of a river, a resource consent would have been required, making the unconsented construction undertaken by the Council unlawful. If it was not the bed of a river but an artificial watercourse, then the Council's work was lawful. The Court held that as the water flowing through the open channel came directly from pipes, it was not fresh water (the definition in s2 RMA specifically excludes water in any pipe, tank or cistern) and thus could not form a river according to RMA definitions.

The case turned on the fact that the watercourse was defined in a holistic manner, as this was considered to be the appropriate approach. The open section of the watercourse, which flowed across the beach, could have been a river if considered discretely. However, the Court asked the question: "Was it the intention of the RMA that a short flow of water from an urban stormwater system ought to be regarded as a river for the purposes of the Act?"; and found that the answer was no, due to the inapplicability of the land control purposes set out in s30(1)(c) RMA – maintenance and enhancement of water quality; maintenance of water quantity; or maintenance and enhancement of ecosystems. Thus the waterway in question was an outlet of a piped stormwater system and not a river.

For completeness the Court explored the difference between artificial and modified watercourses. Although the Court found no judicial test distinguishing the two, it was held that overwhelmingly the watercourse in question would be artificial, as any natural pathway had been "piped beyond recognition." The Court held that the source of any water will be a major determinant in the definition of the waterway.

2. Milk Processing Plant Consents for Discharges and Land Use – Fonterra Co-Operative Group v Manawatu-Wanganui Regional Council[7]

This decision concerned an appeal against four resource consents awarded to Fonterra by the Manawatu-Wanganui Regional Council for discharges to water, land and air from a milk-processing factory, and a land use consent for a new structure. The plant converted whole milk into milk powder by removing the water. This process produces condensate, which was discharged into the Mangamutu Stream; wastewater which was discharged to land; and odour which was discharged to air. The land use consent envisaged a new structure permitting discharge into the Mangatainoka River, rather than the Mangamutu Stream, although consultation revealed land based discharge of the condensate to be the preferred option. The consents granted to Fonterra operated as a package of discharge alternatives.

The appellant, Mr Gillespie, alleged that the discharge into the Mangamutu Stream breached a prohibited activity rule of the Manawatu Catchment Water Quality Plan. The Court held that the rule was in fact void for uncertainty, but that the discharge would warrant exception in any case. The discharge permit was to be for a short fixed term of one year until discharge into the river was enabled, and would enable the continuing operation of the factory, which was of considerable importance to the community as an employer, and the dairy industry as a processor. Also, under the Proposed One Plan (POP) the activity was discretionary and not prohibited, and the POP was to become operative in the reasonably near future.

As an alternative Mr Gillespie proposed an entirely land-based system of disposal, or disposal by land-irrigation. The Court held that due to a shortage of land for such a process, a dual system of some land-based disposal and some discharge into water was appropriate. Although the Mangatainoka River was held to be an important natural resource, highly valued for its natural characteristics, its amenity value, and its value as a fishery, the Court was satisfied that consent conditions could balance the value of the river with the value of the discharge scheme and the factory itself. The appeals were dismissed and the consents affirmed, subject to conditions which would satisfy the requirements of s5(2)(a)-(c) RMA, and prevent any 'more than minor' adverse effects on the river environment or the land environment once the discharge was removed from the Mangamutu Stream. ■

Footnotes

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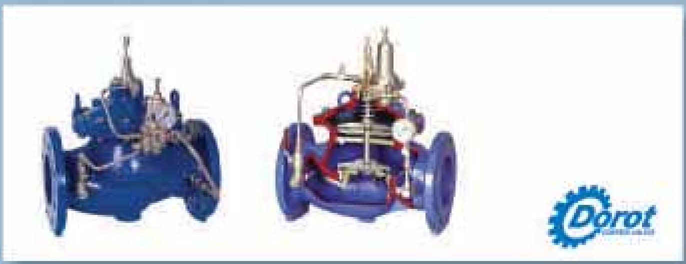

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How Too Many Cooks Can Create Solutions – SCIRT, Lessons Learnt

Chris Maguire – MWH NZ

Abstract

Throughout the near two year journey of the Stronger Christchurch Infrastructure Rebuild Team (SCIRT), there has been a determined push to drive innovation and to learn from the experience. However learning from our experiences takes time, energy and a willingness to accept that we can do things better.

We can learn from all aspects of the engineering design and delivery process, whether it be from mistakes, problems, innovation or success – but where do we start? How do we translate the lessons learnt to the rest of our individual organisations and the wider industry? What have we learnt from the process to-date and how do we continue to learn?

"We can learn from all aspects of the engineering design and delivery process, whether it be from mistakes, problems, innovation or success – but where do we start?"

This paper will give examples of how the learning process has been undertaken in SCIRT, of what has been learnt, and how we all can continue to share best practice to drive our industry forward.

Keywords

Christchurch, Lessons Learnt, Learning Process, Success, Innovation, Best Practice, Knowledge Sharing

1. Introduction

The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) was established in May 2011 with the purpose of rebuilding Christchurch's horizontal infrastructure following the September 2010 and February 2011 Canterbury earthquakes. SCIRT is an alliance organisation formed by a board of the three owner participants: Canterbury Earthquake Recovery Authority (CERA), Christchurch City Council (CCC) and New Zealand Transport Agency (NZTA), and five non-owner participants (City Care, Downer, Fletcher, Fulton Hogan, McConnell Dowell).

Figure 1 – SCIRT Structure

Within SCIRT, the Integrated Services Team (IST) undertakes asset investigations, programming, design and producing target out-turn costs. This team consists of engineers from the board and over 20 other design organisations. The IST provides designs and target out-turn costs to the Delivery Teams (contractors), who are the five non-owner participants for construction.

The IST contains four design teams, which each have set KPIs to deliver projects on-time and to budget for design services. Design teams are challenged to share knowledge and to ensure that all teams are working to the current standards.

Two years after the creation of SCIRT, there has been a dramatic change in the way that the organisation is sharing knowledge and developing industry best practice. This change towards knowledge sharing and innovation is not natural for most people, especially in an environment where they share an office with 20 other normally competing organisations. This is where the importance of establishing a framework for understanding and capturing innovations becomes essential.

2. The Value and Innovation Framework

As with the development of most progressive organisations, SCIRT acknowledged a need to develop a platform from which to capture lessons learnt. SCIRT developed this in the form of a value and innovation framework, which was tasked with developing a pathway to create innovation and to capture best practice.

From the outset, one of the key tasks of SCIRT was to up-skill the construction industry. Key Results Areas (KRAs) were established for the SCIRT programme of works, to benchmark performance. In the Value KRA, innovation has a 25% weighting, where 7 or more innovations captured a month is given an outstanding rating.

The value and innovation framework itself was not fully scoped at the conception of SCIRT and, true to its name, has adapted to different situations and changed to suit the organisation. The ability for the framework to be agile and adapt to changes has created further opportunities to improve how knowledge sharing is created. The SCIRT Innovations Framework was created to describe the existing process and to highlight where areas could improve (refer Appendix A).

Figure 2 highlights the areas where the innovation framework has been improved based on the SCIRT model and through which the framework has been implemented. The process starts with identifying and promoting the Values and Purpose of the organisation, setting up innovation spaces to allow innovation capture. Once the initial frame work is established, this allows the organisation to identify issues, develop solutions and share innovations.

Figure 2 – VIIDS, Creating Innovation Process

Implementing and managing lessons learnt and best practice takes time, effort and energy. SCIRT appointed an innovation co-ordinator who is tasked with developing the innovation process and collating, reporting and sharing all innovations captured within the organisation. Another important aspect of their role is to filter innovations from what is considered normal industry standard practice.

The following sections describe how innovation and knowledge capture has matured within SCIRT through a culmination of discussions with designers, managers and innovation co-ordinators within the organisation.

2.1 Values and Purpose

When SCIRT was formed, the Board and Management Team underwent a comprehensive process to outline what SCIRT's purpose was, what its values were and what were the key mindsets/ behaviours that attributed to those values. This is the same process as most modern organisations, however at SCIRT the purpose became a mantra for undertaking projects: creating resilient infrastructure that gives people security and confidence in the future of Christchurch.

This purpose was visible in every office, in the lunch room and in every meeting room. Very few organisations publicise their core purpose to this degree. The SCIRT mindsets and behaviours were also developed from the outset to encourage collaboration and innovation. The intent was to have an integrated and collaborative approach where the 'organisational hat' that the individual wears outside of SCIRT is left at the door. The mindsets and behaviours to be nurtured include; listening actively; having honest conversations; working together; having the courage to speak up; leading by example; striving for excellence and walking the talk.

The mindset poster was also visible everywhere in the organisation, although it wasn't only passive promotion. At every communications session the purpose and values were repeated to ensure that everyone understood their individual contribution to the purpose.

"When SCIRT was formed, the Board and Management Team underwent a comprehensive process to outline what SCIRT's purpose was, what its values were and what were the key mindsets/behaviours that attributed to those values."

Key Learning: the starting challenge for other organisations is to dig out their core values and promote them. This will get the team engaged in the work they are doing, by understanding the fundamental reason they are there.

2.2 Innovation Spaces

The design and layout of the SCIRT building develops informal connections between the team. This is achieved by having one common meeting space in the living room in the central hub of the building and eliminating distraction points such as water coolers or individual break out areas. Encouraging daily informal interaction creates 'spark' moments where members from the various teams will openly discuss their projects in the common meeting space and others will join in the conversation with their ideas.

Figure 3 – SCIRT Mindsets & Values

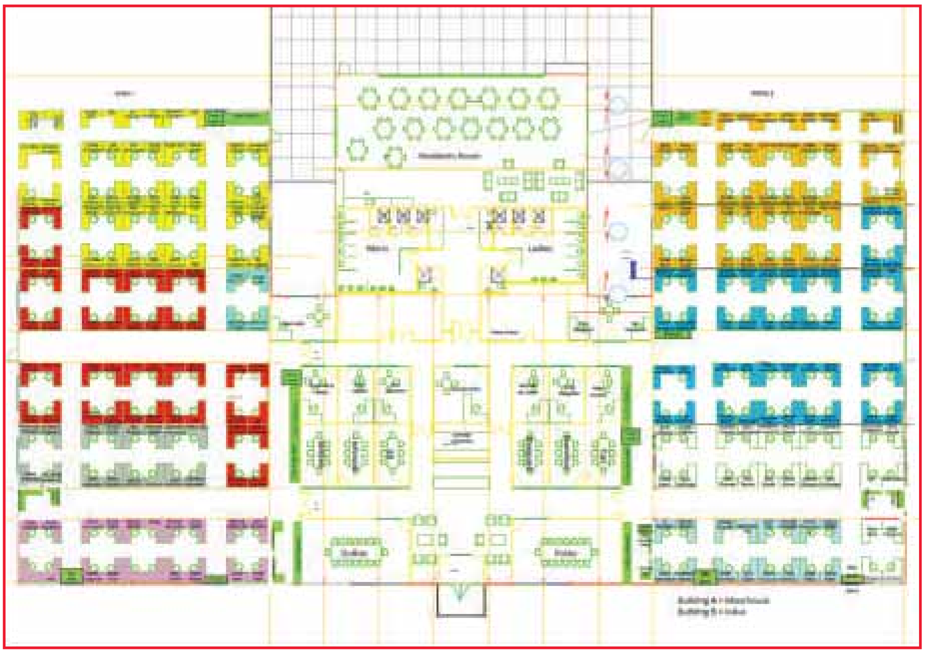

Figure 4 – SCIRT Building Layout

The meeting rooms are in the heart of the working area and are basic in form with plain walls and colours to ensure focus is on the task at hand. Each meeting room has the purpose and mindsets on the wall in a very visible place. Each room has the SCIRT meeting etiquette on display to ensure that each meeting has a purpose, is punctual and develops actions.

Alongside physical innovation spaces, sits the Innovation Register. The register is a virtual space in an online form that enables anyone in SCIRT to log innovations that they have seen or developed. These innovations are then tasked to a technical group who discuss the merits of the ideas and produce recommendations to develop further or to decline and record.

Key Learning: creating an atmosphere for innovation is not just about creating an understanding of the process, it is also about providing places for sharing ideas.

2.3 Identifying Issues

Technical groups were set up to provide guidance around aspects of design and process throughout SCIRT. There were initially six technical groups set up which covered water, stormwater, wastewater, pump stations, roading and geotechnical. These groups were made up of technical specialists and other engineers with a keen interest in developing best practice for resilient design.

Each technical group worked effectively in processing design innovations and changes, ensuring high quality outputs. However, given the nature of the groups, there was a tendency to focus on finite detail of designs and ideas within the meeting format.

This focus on detail could, in some cases, lead to bottle necks where decisions or outputs were delayed as specifics were debated. SCIRT placed a non-technical chair on each group in recognition of this. These non-technical chairs are managers from each of the design teams, with their main purpose to ensure decisions were made based on value and risk and recording the assumptions that the decisions were based on. Potential for bottle necks was minimised and the technical decision making process sped up by creating this decision enabling role in the technical groups.

There was also a need to assess the merit of each innovation when issues or opportunities transpired into an innovation. SCIRT developed an innovation assessment matrix covering aspects such as cost and time saving, safety, resilience, and usability. This has helped to separate good ideas from usable innovations.

Key Learning: through identifying and placing decision makers in our meetings, we can ensure that too many cooks can make decisions!

2.4 Developing Solutions

SCIRT has increased collaboration between design and delivery through the use of Early Contractor Involvement (ECI). ECI is essential for understanding risks and opportunities that arise from the designer/contractor interface. Both the contractor and designer need to follow the same values and mindsets in order to do this successfully. There needs to be open and honest communication and both sides need to break free from the 'Designers vs Contractors' mentality. Each party needed to realise the value that the other brings to the process of delivering a quality project.

At SCIRT there was a perception in early projects that the ECI process was not working as effectively as it could. This perception was in part due to inexperience in the style of ECI process proposed with both the engineers and delivery teams. It was also perceived that often senior engineers attended the ECI meetings without the site engineers who will be undertaking the construction. An ECI Co-ordinator provided overarching guidance to the teams and encouraged the 'guys on the ground' to attend in order to improve the situation. This has greatly improved how the ECI process has been perceived and has resulted in value management through contractor-led innovations.

Another key aspect in developing innovative solutions was encouraging designers to get out of the office. Only through understanding the impact of their designs on construction, especially on operational health and safety, could innovation be brought to the front. This also created an atmosphere of respect between the designer and contractor.

SCIRT also identified that there was a lack of ownership when an innovation had been developed. This meant an innovation was left on the shelf as a good idea and not fully researched or implemented. This was tackled by allocating 'caretakers' to each innovation that was approved by the technical groups and research time was given to develop the innovation.

Key Learning: getting designers out of the office and listening to the guys on the ground creates respect and understanding of construction issues.

2.5 Sharing Innovations

Without innovation sharing there is little ability to affect industry-wide change. Innovation sharing at SCIRT has been developed through traditional meeting formats and through technical innovation newsletters. Delivery teams and designers are invited to present Lunch and Learn sessions on their work and innovations. Design meetings are used to disseminate new design procedures and processes that often come from mature innovations.

Design challenges have been developed to test design thinking. This can often highlight where previous innovations or design practices can be applied or can be captured. The design challenge is undertaken by different teams ensuring that there is knowledge transfer between all members within SCIRT.

The innovation register is the central location for all recorded innovations and decisions. Innovations that are tested and adopted are then published into an innovations update document which is circulated to all the design and delivery teams. The technical groups not only develop and verify innovations, they also serve the purpose of disseminating information to the rest of the design teams through the design meetings. The TechTimes is an internal newsletter which highlights the key outputs from each of the technical groups.

Figure 5 – Innovation & Knowledge Sharing

SCIRT has also collaborated with the Institution of Professional Engineers New Zealand, Canterbury Branch, to deliver a Technical Talks Series. These talks were aimed at highlighting the SCIRT knowledge on the seismic design of horizontal infrastructure. This has allowed the Canterbury engineering industry to directly engage and share knowledge with the SCIRT engineers and also highlighted the opportunities of IPENZ to SCIRT engineers.

SCIRT is not the only major infrastructure organisation to identify the need to improve industry best practice. The London Olympic Delivery Authority (ODA), which developed the infrastructure for the London 2012 Olympic Games, set itself and the supply chain challenging targets above industry standards. The ODA also developed its own lessons learnt process to share knowledge and deliver a suite of documents called Learning Legacy, (refer to Figure 6). These documents highlighted where the ODA went above industry best practice to deliver long-term, sustainable outcomes. SCIRT is planning on developing similar lessons learnt documents, which will be publically available.

Key Learning: encouraging and Sharing innovation is the key to affecting industry wide change.

2.6 Example Site Innovations

Innovations not only occur within the four walls of the design centre, they also occur in the onsite delivery of the construction projects. The following examples are just two of the many site innovations, which have been shared around SCIRT. These innovations have led to increased productivity, quality and safety in the field. They have all originated from workers on site, who strive for innovation and can see better methods and techniques for construction.

Figure 6 – Example Learning Legacy Report

Project: Pipelaying, at depth, in adverse conditions

Issue: Trench shields are required to protect the workers from side collapse due to the sandy nature of soils in Christchurch and to enable accurate laying of pipes. However, it was found that the void left behind by the trench shields, weakened the compacted backfill and could cause slumping.

Innovations: Modified Trench Shields

Tru-line Civil developed a system that enabled the shield to sit above the trench and allow compaction against native ground, removing the shield voids. This also provided edge protection, removing the need for separate fencing.

Worthington also fabricated a bracket that allows their trench shield to be lifted off the bottom of the trench. In addition, wheels were added to the lifting bracket enabling movement of the shields without the use of a digger. This modification not only improved quality but also increased

Left – Tru-Line Civil Trench Shield; Middle – Worthingtons Trench Shield (photos courtesey of SCIRT, Tru-line Civil and Worthingtons); Right – McConnell Dowell Modified Dumper (photo courtesy of SCIRT and McConnell Dowell)

production by allowing for smoother operations and minimising vehicle movements within the worksite.

Project: Pipelaying, backfilling in confined urban space

Issue: Safety in construction associated with the backfilling of trenches in urban environments and with little viable working space.

Innovations: Modified dumper allows safer backfilling of excavations

McConnell Dowell modified a dumper to enable backfilling of excavations to be safer by leaving edge protection in place. The dumper has pivotal rotation providing more accurate placement of backfill. McConnell Dowell identified that this would eliminate the need for workers to shovel material into the excavation, minimise risks associated with manual handling and enable edge protect to remain in place.

3. Conclusions

In the two years since the establishment of SCIRT, there has been a step change in the way innovation and collaboration is both viewed and celebrated. SCIRT has been able to put measures in place that improve the performance of its design and delivery teams through understanding the innovation process and removing road blocks.

The improvements in technical design, safety, performance, and introducing new products to the New Zealand market has led to increased quality and has reduced the costs in construction. SCIRT has begun to lead the way for other major infrastructure projects in New Zealand by devoting time and resources to identifying innovations and best practice.

Over the next two years we will see a further step change in the way lessons learnt are recorded and shared by SCIRT, leading to further improvements in safety, quality and performance in the construction sector. ■

Acknowledgements

Annalise Johns, Innovations Coordinator, SCIRT; Rod Cameron, Value Manager, SCIRT; Worthingtons; Tru-line Civil; McConnell Dowell; Shane Bishop – Team Leader, MWH

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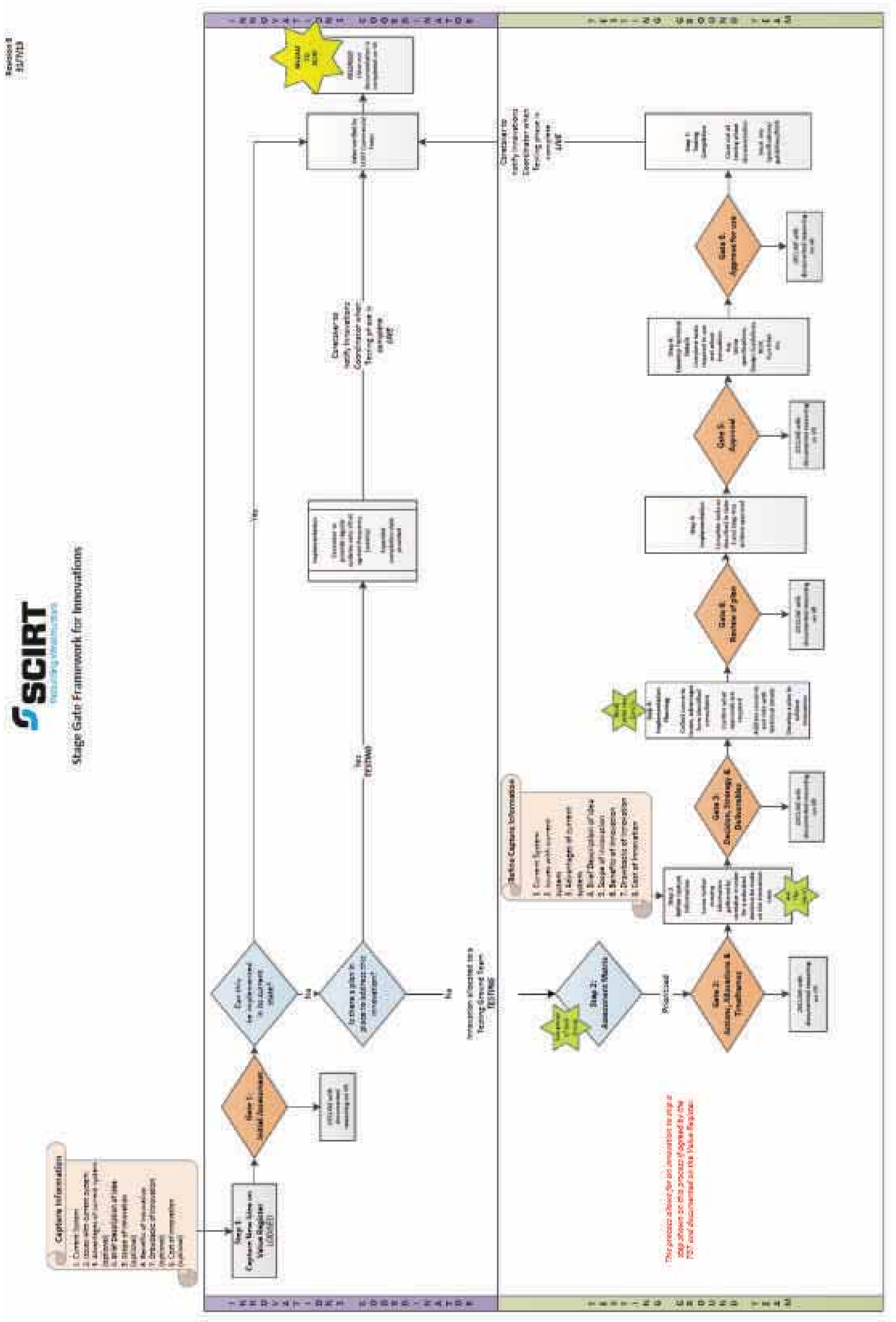
"The improvements in technical design, safety, performance and introducing new products to the New Zealand market has led to increased quality and has reduced the costs in construction."

Appendix A: SCIRT Framework for Innovation



Smart Planning for Growth – Meeting the Need for an Expanded Wastewater Treatment Plant without Huge Infrastructure Costs

Shane Bishop – Team Leader Water and Waste, MWH Global

The Eastern Selwyn District communities of Rolleston, Lincoln, and Prebbleton are facing unprecedented growth, particularly as Christchurch residents resettle after the earthquakes of the last three years. The Selwyn District Council (SDC) grappled with the planning issues of how to convey, treat and, dispose of wastewater in its eastern towns in the face of a growing population, while not burdening the district and its residents with huge infrastructure costs. Limitations within the installed wastewater treatment and disposal schemes for each town would mean that without an alternative solution, development would be curtailed.

The Eastern Selwyn Sewerage Scheme (ESSS) has been developed to meet the needs of these Christchurch communities by following a route of centralisation. It ensures a staged and managed approach to the development of wastewater conveyance and treatment and disposal infrastructure, while at the same time provides equality in the scheme costs for existing residents, new developments and meets the needs of future generations. The ESSS involves diversion of the discharges from Lincoln and Prebbleton away from the Christchurch city wastewater system, to an upgraded treatment and disposal facility on the outskirts of Rolleston, named the Pines Wastewater Treatment Plant (WWTP).

A balance was set between the need to accommodate immediate growth and the need to develop infrastructure to cater for future flows. Components of the scheme are designed to allow future upgrading without compromising on-going operations, and will be implemented in a modular fashion to minimise the impacts of future construction. The initial population equivalents within the area of the ESSS were approximately 18,000, with upgrades planned within the infrastructure to accommodate up to 60,000.

Critical to the success of the scheme is the ability to offset the capital expenditure by reusing existing assets. Over the past decades infrastructure has been installed to cater for the local communities, an investment that has an inherent value when considering potential development options. Therefore, steps were taken to consider how to integrate the current assets into the design of the new scheme. These include the existing Lincoln oxidation ponds and Sequencing Batch Reactors (SBRs).

The SBRs provide an ability to balance the incoming flows being pumped from Lincoln through to the WWTP. By pumping average flows, rather than peak flows, the size of the rising main and the capacity of the pumps are reduced. The oxidation pond will be used as an emergency storage basin in the event of damage to the ESSS such as a pipe burst. It adds an additional level of environmental protection to the scheme and will provide four days average dry weather flow storage which allows time for repairs to be completed.

"A balance was set between the need to accommodate immediate growth and the need to develop infrastructure to cater for future flows."

An interim measure has been employed using the pipeline originally installed to pump Lincoln wastewater flows to Christchurch. Instead, Prebbleton flows are now pumped back to Lincoln. Ultimately, a pipeline between Prebbleton and Rolleston, and then to the WWTP will be required. However, construction of this pipeline has been able to be delayed until the development in either Lincoln or Prebbleton is projected to exceed the installed capacity.

The recently commissioned Pines WWTP comprises of liquid and solid treatment stream processes capable of servicing a population equivalent of 30,000, and upgradeable to 60,000, with treated liquid effluent disposed of to land via centre pivot irrigators.

The original plant has been 'reborn' as a waste sludge gravity thickener and aerobic digester. Attached to this is a de-watering plant and solar drying halls. The drying halls, which include a robotic sludge management system, are a stepwise

Far left – Pines Wastewater Treatment Plant Expansion: March 2012, Above – Pines Wastewater Treatment Plant Expansion: May 2012, Above Right – Pines Wastewater Treatment Plant Expansion: August 2012, Right – Pines Wastewater Treatment Plant Expansion: November 2012, Bottom – Pines Wastewater Treatment Plant Expansion: officially opened August 2013

change to the management of sludge at the WWTP site. The sludge is stabilised and reduced in volume by thickening, de-watering and solar drying from one per cent, to more than 50 per cent dry solids. This provides significant savings in the handling and disposal costs for the waste sludge.

The footprint of the Pines WWTP site has been developed to allow for progressive construction of future stages of the WWTP without compromising the existing, on-going operations. Structures such as the inlet works and Ultra Violet (UV) treatment have channels constructed to allow additional mechanical plant to be installed to gradually increase treatment capacity to the ultimate design. The modular development of the site means that works can be brought forward or pushed out to meet the changes in population growth within the scheme.

By incorporating existing assets and developing the scheme on a modular basis, SDC have provided significant savings to both existing and future ratepayers. For the WWTP alone, capital savings in the order of $6million in net present value terms have been made by the staging of works at the site and incorporating the original plant within the design. The redeveloped and expanded Eastern Selwyn Sewerage Scheme, including Pines WWTP, was officially opened in August last year. ■

Membrane Bioreactor Technology Reaches Maturity in the New Zealand Market

Dr. Matt Savage Ph.D, MIChemE, CEng – Director, Apex Environmental

Introduction to Membrane Bioreactor Technology

Membrane Bioreactors are a technology that offer treatment of municipal and trade waste to a very high extent.

A membrane bioreactor (MBR) is a biological wastewater treatment system that incorporates a microfiltration membrane (typically a 0.1-micron low-pressure filter) on the discharge to remove virtually 100% of suspended solids, bacteria, and protozoa from wastewater. Due to the formation of a biofilm on the surface of the membrane, some types of MBR membrane (such as flat sheet membranes) have been tested to provide much finer filtration than 0.1 micron due to colloidal particles and viruses being adsorbed onto bacterial flocs and captured in the biofilm on the membranes.

For example, when MS-2 Colipharge (a 0.03micron virus) was spiked into an MBR with a 0.1micron nominal pore size the MBR system showed a total removal rate of 98% (Hirani 2010).

As well as directly cleaning up the wastewater discharge by filtering out these contaminants, the fact that this system retains 100% of the bacteria that are used for reducing the organic and nutrient loading of the wastewater, means that typically three times as much organic loading can also be removed in a given size aerobic wastewater treatment plant into which the membranes are incorporated.

This is due to the optimal Mixed Liquor Suspended Solids (MLSS) concentration in MBR systems being in the order of 10,000–15,000mg/L with concentrations as high as 25,000mg/L being achievable in some systems before throughput (filtration flux) significantly drops off.

Figure 1 – Raw and treated water from an Apex Environmental MBR

Compared to the 1,000–4,000mg/L MLSS encountered in aerobic ponds or traditional systems that rely on gravity separation of biomass such as activated sludge, or sequencing batch bioreactor plants, this means there are significantly more bacteria available within the bioreactor to process the incoming waste.

Figure 2 – Comparison of solids level in MBR tank and treated water

"Membrane Bioreactors are a technology that offer treatment of municipal and trade waste to a very high extent."

The main limitations on how high an MLSS level an MBR can be operated at are generally imposed by:

- High viscosity, low filterability mixed liquor, (at 25,000mg/L MLSS the reactor resembles a bubbling Rotorua mud pool), which significantly reduces the flow through the membrane.
- Reduced oxygen transfer in the aerobic tank also due to diffusion limitations in the high viscosity mixed liquor and the tendency of bubbles from fine bubble submerged aeration systems to coalesce into large bubbles with low surface area under high MLSS conditions.

Conversely, with many MBR systems, low MLSS concentrations can also negatively impact performance. This is due to the counterintuitive increase in membrane fouling that occurs under low MLSS conditions in the membrane tank.

"In New Zealand, the main area where MBR systems have proven to be an ideal treatment solution are where the receiving environment is particularly sensitive, or where a high level of treatment is required for beneficial reuse of the treated water."

In this case, when there are insufficient biological flocs present (e.g. < 5,000mg/L MLSS), free floating colloidal matter of similar size to the membrane pore size is able to be drawn directly into the membrane, rather than being adsorbed onto larger bacterial flocs or captured in the biofilm on the membrane. This process can easily reduce the throughput of a membrane system by over 50%, which highlights the importance of maintaining tight control of the MLSS concentration in the MBR system.

Another positive side effect of operating the MBR at such high MLSS concentrations is that this often results in a very low F/M (food to biomass) ratio in the reactor, which can significantly reduce the mass of waste sludge produced. The total volume of waste sludge produced by the system is further reduced by the high MLSS concentration – without any additional thickening the sludge is already at 1.5% total solids concentration when it is discharged directly from the treatment process.

In New Zealand, the main area where MBR systems have proven to be an ideal treatment solution are where the receiving environment is particularly sensitive, or where a high level of treatment is required for beneficial reuse of the treated water.

MBRs in New Zealand

The largest uptake of MBR systems in New Zealand has been focused in the central North Island where tight controls on nutrient discharges are required to prevent further eutrophication of inland lakes and catchments that are already very high in nitrogen and/or phosphorus due to other point discharges and non-point agricultural run-off. Some of the largest users of MBR technology are therefore the Rotorua and Taupo District Councils, South Waikato District Council and Matamata-Piarko District Council.

MBRs are particularly well suited to these applications due to their ability to handle widely variable incoming water quality whilst producing consistently high quality treated water. PVDF MBR membranes are also available that are compatible with aluminium-based coagulants and can therefore be used as part of a highly effective system for the precipitation and separation of phosphates from the wastewater stream.

"As MBR technology has matured, the increase in the number of companies manufacturing membranes and improvements in materials of construction have significantly reduced the capital cost of such projects."

For this same reason, other small-scale municipal, or domestic systems have been installed throughout New Zealand where discharge into sensitive receiving environments is required. A typical example of this is the system installed by the Department of Conservation at the Papatowai camping ground in the Catlins. This camping ground had previously been closed down due to overloading of the wastewater treatment plant and the unsuitability of the local soils for disposal of treated sewage.

As previously detailed in Water by Kroening (2012), the installation of a highly automated, remotely monitored MBR on the isolated camping ground site allowed the wastewater to be treated to a sufficiently high level to permit discharge to the estuary downstream of the Papatowai Scenic Reserve Wetland. The Otago Regional Council determined the MBR system discharging highly treated sewage to this area of outstanding natural beauty to have "less than minor" effect on surface water and air quality.

Other areas that have experienced a significant uptake of MBRs are mixed commercial/industrial sites where there is a need to treat industrial wastewater mixed with sewage produced by office blocks, or restaurants. A common example of this is wineries that produce both an industrial wastewater stream of typically 5,000–15,000mg/L BOD_5 from the winery as well as high strength sewage from an attached restaurant and/or offices. Generally, two separate wastewater treatment plants are required in these instances to prevent the industrial wastewater from being contaminated with pathogens from human sewage. Due to the extremely high level of pathogen removal achieved, MBRs however offer a practical option for treating these two streams combined to a level where the treated water can be discharged to surface water or reused for irrigation. Two such examples in New Zealand are Craggy Range's Giants winery restaurant in Hawke's Bay, and Mt Difficulty's winery restaurant in Central Otago. Although separation of these wastes is generally required, a number of synergies arise by being able to combine them in an MBR. Firstly the continuous production of sewage from the restaurant helps to keep the system running optimally outside of the highly seasonal wine making vintage, and secondly, whilst restaurant waste and sewage are high in nutrients that need to be removed, winery wastewater is notoriously nutrient deficient and therefore the biological processes in the treatment plant benefit significantly from the additional sewage nutrients.

The final area where MBRs are seeing a rapid rise in popularity is in large-scale industrial wastewater treatment where industries are seeing the need to either find better reuse options their treated wastewater, or open up alternative means of disposal. A current example of this is Redwood Cellars in Nelson who operate a large cider factory, and wished to achieve a very high level of treatment prior to discharging any waste to the environment.

Reducing Cost of MBR Technology

As MBR technology has matured, the increase in the number of companies manufacturing membranes and improvements in materials of construction have significantly reduced the capital cost of such projects.

Figure 3 – Taupo District Council Turangi MBR, which has recently been converted to SINAP membranes

For example, whilst all of the first generation of flat sheet MBRs in New Zealand were based on Chlorinated Polyethylene Kubota membranes with a nominal 0.4micron pore size, recent advances have seen more chemically resistant and easier to clean 0.1micron PVDF membranes, manufactured by SINAP enter the market. A significant number of existing MBRs in New Zealand already have, or are in the process of, removing their old membranes and replacing them with the new generation of SINAP membranes. Along with being manufactured from more inert materials, the significant reduction in cost of the newer membranes reduces both the capital cost of new plants and the on-going cost of replacement membranes in existing plants.

De-risking MBR Technology

Whilst MBRs provide a very high level of treatment, anyone considering installing an MBR system must be aware of the limitations and risks of this technology. The main risk is that of limited throughput through the system. Whilst this is less of an issue on systems treating municipal sewage due to the high body of experience that has been accumulated using MBRs in this application, issues such as sludge bulking, membrane fouling, nutrient imbalances, low ambient temperature and high wet weather flows can all cause capacity problems in these systems.

In industrial treatment systems however, specific wastewater components such as calcium, fats, oil and grease, or process additives such as bentonite can have a significant impact on the capacity of the installed system. For this reason pilot planting of industrial MBRs prior to proceeding with full scale design is strongly recommended, and in some industries essential.

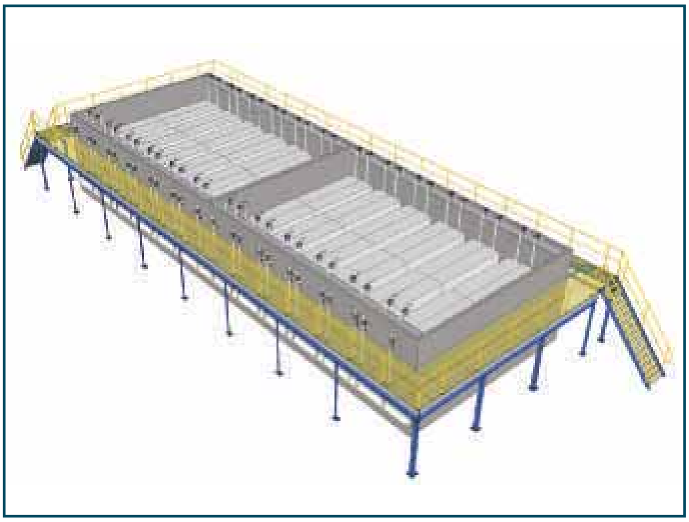


Figure 4 – 7,500m^3/day MBR system derated to 4,500m^3/day conservative capacity based on actual performance in an industrial application

About the Author

Dr. Matt Savage is a chartered chemical engineer with a Ph.D. in industrial wastewater treatment plant design and a decade's experience designing and installing a wide range of wastewater treatment plants around the world. He is a founder and director of Apex Environmental, which provides specialist design and build services to the New Zealand water sector.

The availability of a high quality, lower cost membrane has also gone a long way towards de-risking the installed capacity of these systems. Where there was previously a strong economic driver to install the minimum number of membranes possible due to their extremely high cost, system designers can now allow significant contingency in the installed capacity of the plant and still come in at a lower capital cost than previously. ■

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Te Kuiti Wastewater Treatment Plant Upgrade – Optimisation Through Remote Monitoring

Hugh Ratsey, Mark Curtis and John Crawford – Consultants, Opus International

Introduction

The Te Kuiti wastewater treatment plant (WWTP) services the township of Te Kuiti and receives domestic wastewater from a population of approximately 4,600 people. Two significant meat processing plants, Universal Beef Packers (UBP) and Te Kuiti Meats (TKM), also discharge to the WWTP.

The WWTP underwent a major upgrade in 2002 and 2003, with the conversion of a small part of the previous oxidation ponds to a new configuration including a modified activated sludge plant. While this upgrade significantly improved the quality of the treated effluent, it did not reliably meet all of the effluent quality standards specified in the resource consent (Opus 2010). As a result of this non-compliance, Waitomo District Council (WDC) committed to a further significant upgrade of the WWTP.

Opus was engaged by WDC to undertake preliminary investigations, detailed design, monitoring, supervision, quality assurance, commissioning and post-construction monitoring.

Resource Consent

The Te Kuiti WWTP is currently discharging treated effluent to the Mangaokewa Stream under continued use rights while the resource consent for discharge is being renewed. While the future consent conditions are yet to be finalised, near-final conditions are included in Table 1 for context.

Table 1 – Proposed Resource Consent Conditions (Opus, 2010)

Contaminant	Mean[1]	90%ile[2]	Maximum
Flow, m^3/d			7,000
cBOD5, g/m^3		20	
TSS, g/m^3		20	
Ammoniacal nitrogen, g/m^3		12	
E. coli, MPN/100ml		200	
Total nitrogen, kg/d	43 / 73		
Total phosphorous, g/m^3		12	

[1]43kg/d November – March, 73kg/d April – October
[2]shall not exceed in more than 10% of samples taken over any one year period

Treatment Challenges

Meat Processing Waste

The wastewater from meat processing plants provides significant challenges when discharged to municipal WWTPs, including:

- Seasonal and diurnal flow and load variations due to changing processing schedules
- Rapid flow and load variations
- High nitrogen (N) and phosphorous (P) concentrations and loads
- Colour, due to the presence of haemoglobin (Sutherland-Stacey et al, 2009) and other compounds

As a result of the discharges from the UBP and TKM meat processing plants, the peak population equivalent (p.e.) BOD load to be treated by the Te Kuiti WWTP is approximately 35,000, based on an industry standard per capita contribution of 80gBOD/h/d (Metcalf & Eddy, 2003).

> "The chemical dosing trials indicated that the UVT of the effluent could be significantly increased by dosing coagulant and polymer. This provided the confidence that UV disinfection could be installed as part of the upgrade and, if required, chemical dosing would effectively mitigate the adverse effects on the UV system caused by light absorbing chemicals in the wastewater."

The design flow and load for the Te Kuiti WWTP upgrade is shown in Table 2.

Table 2 – Design Wastewater Flow and Load (Opus, 2011)

Contaminant	30%ile	Average	95%ile
Flow, m^3/d	2,585	2,895	4,115
$cBOD_5$ load, kg/d	1,054	1,571	2,814
COD load, kg/d	2,882	3,589	5,482
TP load, kg/d	25	36	57
TKN load, kg/d	176	244	383

Hydraulic Limitations

The existing plant was furnished with a single 20 metre diameter pumped centre feed clarifier with a small diffusion well and no flocculation well. Under-floor pipe construction and clarifier sizing resulted in a maximum hydraulic capacity of 4,115m^3/day. Rather than building another clarifier (at >$1M), it was determined that inflows above 4,000m^3/d could be diverted to the old oxidation ponds for balancing, and gradually returned to the main treatment plant as capacity allowed.

Storm Flow Return

Using an old oxidation pond for raw sewage balancing adds the additional treatment complication that return flows are low in BOD but generally high in ammonia. While nitrification of this ammonia is relatively straightforward, there is a resulting carbon to nitrogen (C:N) inbalance when it comes to denitrification. This had to be accounted for in tuning the treatment process.

Chemical Dosing Investigations

Given the proposed resource consent condition of 200 MPN/100ml E. coli as a 90%ile, effluent disinfection prior to discharge was required as part of the upgrade. The preferred form of disinfection was ultra-violet (UV) disinfection, however monitoring in March 2011 confirmed that the treated effluent from the existing Te Kuiti WWTP had low UVT (@254nm), with UVT measured below 30% in both the clarified effluent and the oxidation pond effluent at that time. Typically UV systems for disinfection of secondary treated wastewater are designed for a minimum UVT of 45 or 50%. While it was expected that the upgrade to the biological treatment process would improve the UVT of the effluent to some extent, this was speculative and represented a high risk to the upgrade.

Bench trials were undertaken by Veolia Water and Orica in April 2011 to determine whether the UVT of effluent from the existing WWTP could be significantly increased by chemical dosing and, if so, by how much, and what the likely operating cost would be.

Chemical Dosing Results

These trials indicated that combinations of coagulant (aluminium sulphate (alum), polyaluminium chloride (PACl)) and cationic polymers could effectively bind a significant proportion of light absorbing material into flocs. If sufficient coagulant was dosed, the UVT of the clarified effluent could be increased from <30% to >50%UVT, providing the formed flocs could be removed prior to disinfection. Therefore, the effluent would be more conducive to disinfection by UV.

A typical set of results from the trials are shown as Figure 1, below.

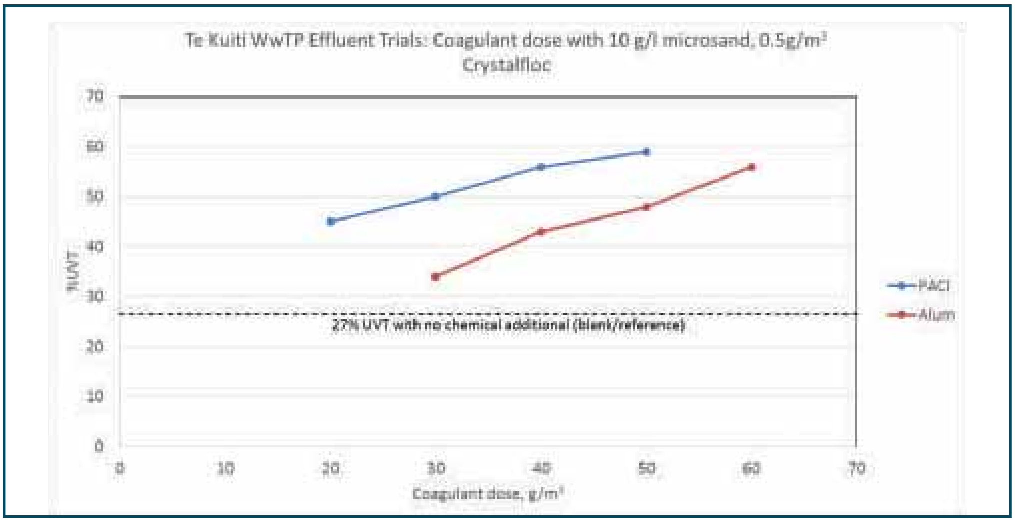

Figure 1 – Results of Chemical Dosing Trials

Implications of Chemical Dosing

The chemical dosing trials indicated that the UVT of the effluent could be significantly increased by dosing coagulant and polymer. This provided the confidence that UV disinfection could be installed as part of the upgrade and, if required, chemical dosing would effectively mitigate the adverse effects on the UV system caused by light absorbing chemicals in the wastewater.

However, based on the results of the bench trials, it was estimated that chemical dosing to increase UVT would cost between $50,000 and $225,000 per year, depending on the coagulant used and the desired effluent UVT. This would represent a significant ongoing cost.

Upgraded WWTP

Overview

BioWin modelling was undertaken to assist with the design of the main treatment plant upgrade. A modified Bardenpho biological nutrient removal (BNR) process was selected due to the necessity for phosphorous and nitrogen removal to achieve the proposed consent conditions.

A simplified schematic of the upgraded WWTP is shown in Figure 2.

Biological Nutrient Removal Configuration

While it would have been nice to be able to rebuild the treatment reactors from scratch in concrete, cost was a real factor and a key part of the design was to make use of as much of the existing infrastructure as possible. To this effect, the existing earthen aeration basin was used but extensively modified. An anaerobic zone was created in the centre of a donut configuration, with an extended aeration zone created around it to provide aerobic and anoxic zones. While a baffle curtain was employed to create a dedicated anaerobic zone, the boundaries between the aerobic and anoxic zones were designed with a moving interface depending on influent load and aerator configuration, rather than as immovable zones. The earthen aeration basin did not readily allow for the installation of diffused aeration. As a consequence, mechanical aerators were selected, with a combination of floating surface aerators and submerged aspirator-type aerators installed. This is shown in the plan of the BNR plant (Figure 3).

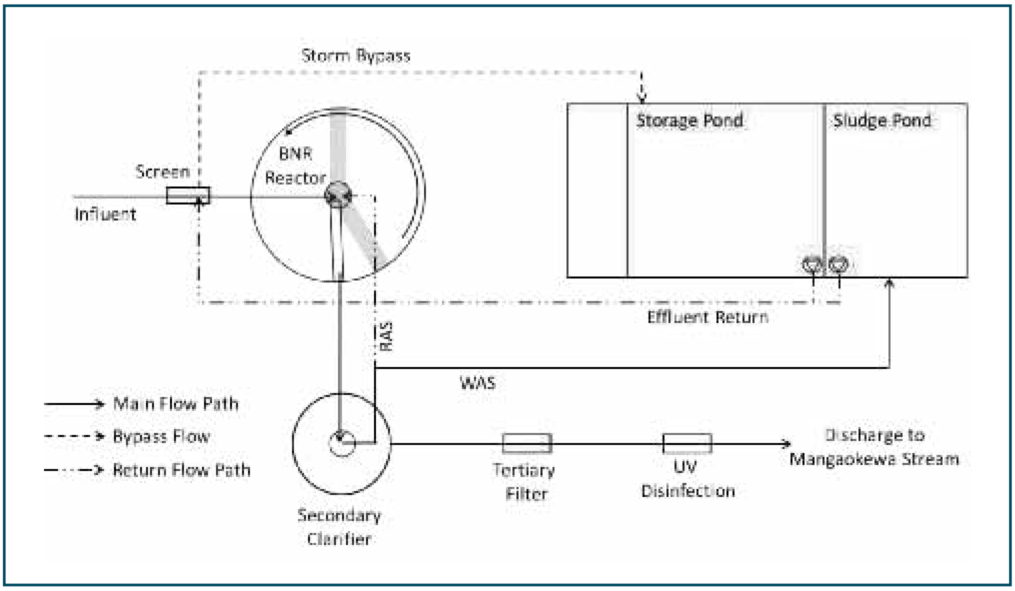

Figure 2 – Simplified Schematic of Te Kuiti WWTP

"While it would have been nice to be able to rebuild the treatment reactors from scratch in concrete, cost was a real factor and a key part of the design was to make use of as much of the existing infrastructure as possible."

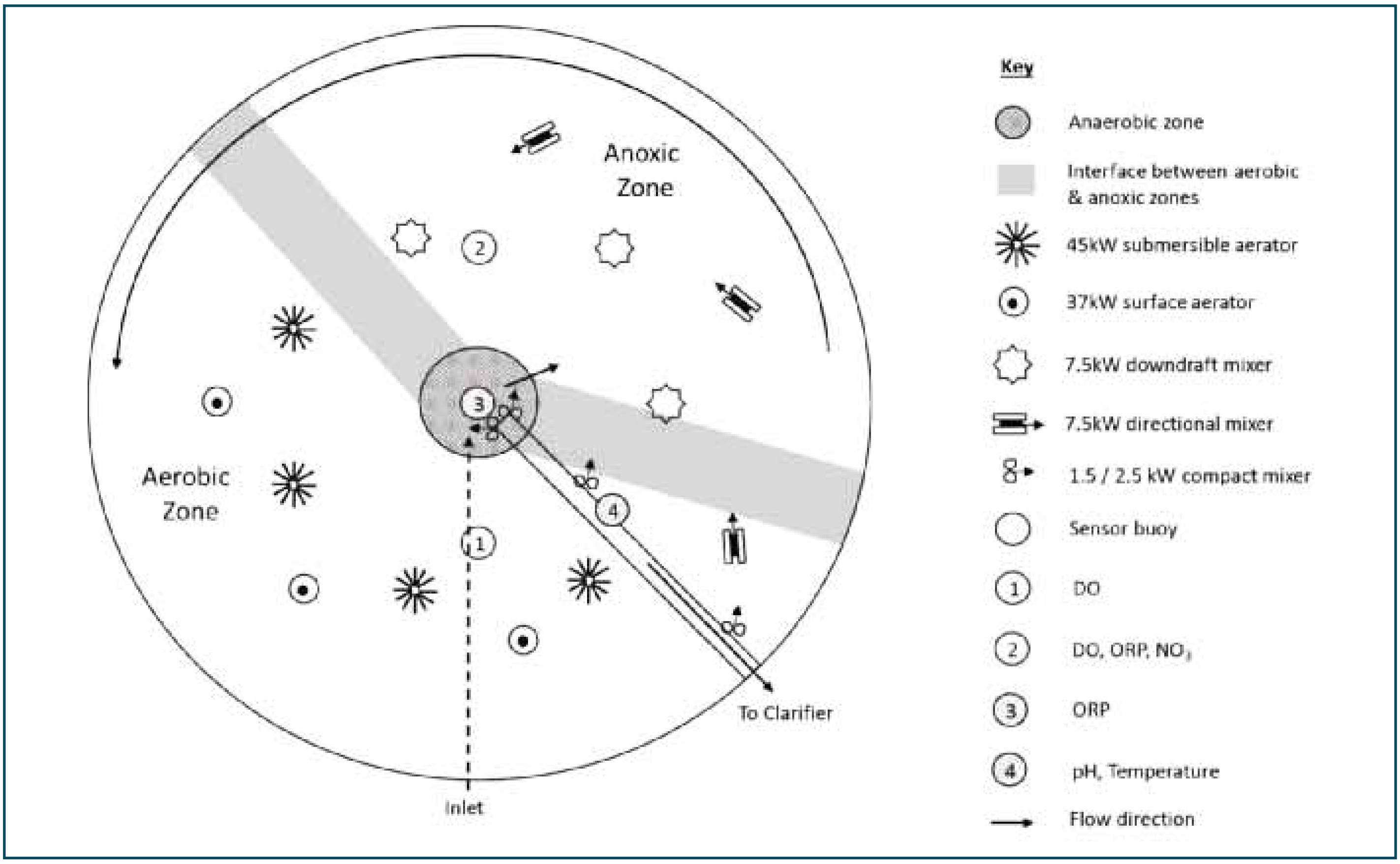

Figure 3 – Plan of Te Kuiti WWTP BNR

Due to the variations in wastewater flow and load resulting from the UBP and TKM processing plants, significant aeration turn-down and control was required. Aeration turn-down can be readily achieved with diffused aeration in combination with mechanical mixers, however can be more tricky when mechanical aerators are used, as dictated by the existing Te Kuiti infrastructure. A key challenge was to provide adequate mixing in the aerobic zone to keep the biomass in suspension during low loading periods. Rather than installing additional dedicated mixers in the aerobic zone, whole-zone mixing was achieved through sequencing of aerators.

Final Clarifier

The existing clarifier performance was improved by:

- Adding a flocculation well outside the diffuser, to aid in solids settlement
- Addition of a chemically dosed flocculator upstream of the clarifer to provide assistance during times of low ultra-violet transmissivity (UVT) and/or poor settling flocs
- Automation of the return activated sludge (RAS) weir so that the RAS flow can be controlled to a percentage of the reactor incoming flow

Tertiary Treatment

After clarification, effluent is filtered through Toveko continuous backwash sand filters, and disinfected by a Berson medium pressure UV system, designed for average and minimum UVT of 40 and 25% respectively. There is provision for chemical dosing to improve the effluent UVT prior to disinfection, if required.

Instrumentation for Control

Given the treatment challenges associated with treating meat processing wastewater combined with municipal wastewater, the Te Kuiti WWTP required a high degree of flexibility. To achieve this flexibility, instrumentation was a key component of the upgrade. As shown in Figure 3, on-line dissolved oxygen (DO), oxidation reduction potential (ORP) and nitrate (NO_3) probes were installed in various parts of the BNR basin, and UVT measurement was installed on the tertiary filtered effluent, prior to UV disinfection.

"Given the treatment challenges associated with treating meat processing wastewater combined with municipal wastewater, the Te Kuiti WWTP required a high degree of flexibility."

Dissolved Oxygen

DO monitoring is commonly used in activated sludge-based treatment plants for aeration control to achieve a set DO range in aerobic zones, with DO set-points in the range of 0.5 – 2g/m^3 being common but not exclusive, depending on the operational mode. While DO can be used to optimize aeration to achieve nitrification and to some extent denitrification, it is not a panacea.

Oxidation Reduction Potential

ORP measures electrical currents in millivolts (mV), and can be either positive or negative. Oxidizing agents such as oxygen result in an increase in ORP, while reducing substances such as BOD will lower ORP. Different wastewater treatment processes, such as nitrification and denitrification, occur within particular ORP ranges, as summarized in Table 3. Therefore, ORP can be used as a tool to control and optimise many wastewater treatment processes.

Table 3 – Biochemical Reactions and Corresponding ORP Values (YSI, 2008)

Biochemical Reaction	ORP, mV
Nitrification	+100 to +350
$cBOD_5$ degradation with free oxygen	+50 to +250
Biological phosphorous uptake	+25 to +250
Denitrification	+50 to -50
Sulphide (H2S) formation	-50 to -250
Biological phosphorous release	-100 to -250
Acid formation (fermentation)	-100 to -225
Methane production	-175 to -400

Ammonia and Nitrate

Providing environmental conditions in the aerobic zone of a BNR reactor are appropriate, nitrification will take place. These environmental conditions include adequate DO, sufficient sludge age, adequate alkalinity and the absence of inhibitory substances. Therefore, while ammonia probes would have been useful if they had also been installed at Te Kuiti, they were considered to be an unnecessary luxury. Instead, a nitrate probe was installed in the anoxic zone. This can be used, in combination with the DO and ORP probes, to confirm the extent of denitrification that is occurring, and thus allowing further optimising of the aeration.

Ultra-Violet Transmittance

Most, if not all, of the larger UV disinfection systems available within New Zealand have built-in intensity sensors to measure the intensity of light received after passing through the lamp, sleeve, and effluent. Along with retention time through the UV system, this intensity is used to calculate the UV dose received by the wastewater. Many systems can be set up to alarm if the received UV intensity or dose falls below pre-set levels. However, this could be considered to be reactive monitoring, and it does not differentiate between reduced intensity due to poor effluent UVT, and reductions due to other factors such as lamp ageing or sleeve fouling.

Monitoring the UVT of effluent can be a useful additional tool to help understand the quality of the effluent passing through to the UV system, and any UV system will be designed to achieve microbial deactivation based on a specific minimum effluent UVT. At Te Kuiti, because of the historical concerns regarding periodically low UVT, UVT measurement of pre-UV effluent was considered necessary.

Instrumentation Maintenance

It would be irresponsible to discuss the benefits of on-line instrumentation without also mentioning the required maintenance of such probes. When values are displayed through SCADA and shown on SCADA trends, assumptions can easily be made that the numbers are accurate. This can be a dangerous assumption to make. Regular cleaning, calibration and replacement of the probes is required, and the frequency of which, will be dependent not only on manufacturers recommendations, but also site-specific conditions. Some wastewaters will result in more rapid fouling of sensors, requiring more frequent cleaning and calibration. If critical instruments are not cleaned and calibrated appropriately, then inappropriate operational changes can easily be made based on erroneous results. Instrument maintenance must be a key consideration in the instrument selection and location as the maintenance and replacement of individual instruments can be costly.

Post-construction Monitoring

During commissioning of Te Kuiti WWTP, Opus was provided with remote access to the plant SCADA to view trends as well as review laboratory results. This allowed the process engineer to review real time data, identify any cause for concern, and immediately discuss them with WDC operators and engineers.

After successful commissioning, Opus has continued to provide this service to WDC. This remote access to SCADA has been invaluable for identifying potential treatment problems, optimising the BNR process, and ensuring compliance with the proposed resource consent conditions. An example of such optimisation follows.

Optimising Denitrification During Low Loading

Early in October 2013, the nitrate concentration in the BNR effluent was approaching 20g/m^3. At the design average flow of 2,895m^3/d, a nitrate concentration of 20g/m^3 would result in an exceedence of the summer mean total nitrogen load of 43kg/d in the proposed resource consent condition. In early October while the nitrate concentrations were close to 20g/m^3, the target DO concentration in the aeration zone was 1g/m^3, with actual concentrations ranging between 0.5 and 2g/m^3. These DO concentrations were adequate for nitrification to occur. However, the BOD load to the WWTP at this time was low, with both meat processing plants operating at limited production. The rate of oxygen uptake was consequentially low, resulting in DO carry-over into the anoxic zone. This was effectively identified by the ORP probe in the anoxic zone, which measured an ORP range of 50 to 125mV, above the range at which denitrification will occur (refer to Table 3). Figure 4 shows the DO concentration in the aerobic zone, along with ORP and nitrate measured in the anoxic zone, over a 15-hour period.

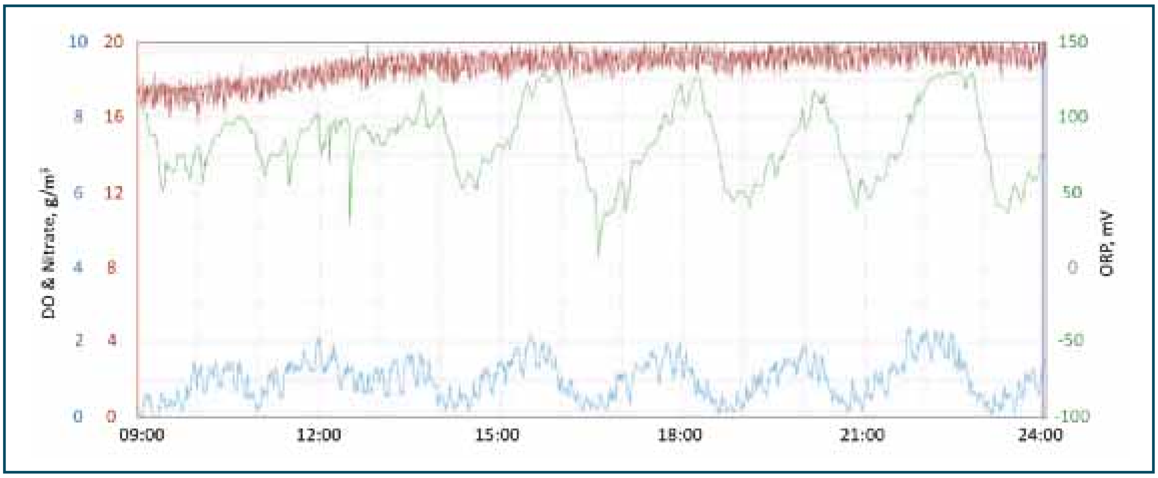

Figure 4 – SCADA trend; 2nd October 2013

The combined information of DO, ORP and nitrate was used to remotely optimise the control of the mechanical aerators in consultation with WDC operators, engineers and their PLC programmer. This was partially achieved by adjusting the target DO range in the aeration zone, with 0.6g/m^3 found to be optimal during periods of low loading, and partly through optimisation of the aerator control inputs such as delays between the aerator steps, introducing rolling averages for the input control and optimizing the setpoint deadband limits. While adjustments were being made to the aerator control and target DO set-points, measurement of the DO concentrations alone would not have provided the necessary control to correct the denitrification process due to DO carry-over into the anoxic zone. Being able to monitor ORP, thus confirming that conditions were optimal for denitrification, and the resulting nitrate concentrations was key. It would have been easy to reduce the DO concentrations to such an extent that adverse effects could occur, such as re-release of phosphorous or filamentous bulking. Co-monitoring of ORP and nitrate along with DO prevented this. The result of this optimisation is shown in Figure 5, with nitrate concentrations between 2 and 4g/m^3 achieved without any supplemental carbon dosing.

Optimising Nitrification During High Load

During November 2013, processing at the meat processing plants steadily increased, as it typically does through late spring and summer. The resulting wastewater load to the WWTP increased accordingly, resulting in very different optimal operating conditions being required. As was expected, it was quickly found that the target DO set-point of 0.6g/m^3, which was optimal through low loading periods was inadequate during high loading periods. The higher loads resulted in more rapid oxygen uptake through the aerobic zone and the front of the anoxic zone.

This caused the ORP in the anoxic zone to drop below the optimal range for denitrification, and ammonia breakthrough also started to occur from the aerobic zone. By increasing the target DO set-point in the aerobic zone from 0.6 to 0.9g/m^3, the BNR process was effectively optimized for high loading periods without any further changes to aerator sequencing required. The resulting SCADA trends under this high loading scenario are shown in Figure 6.

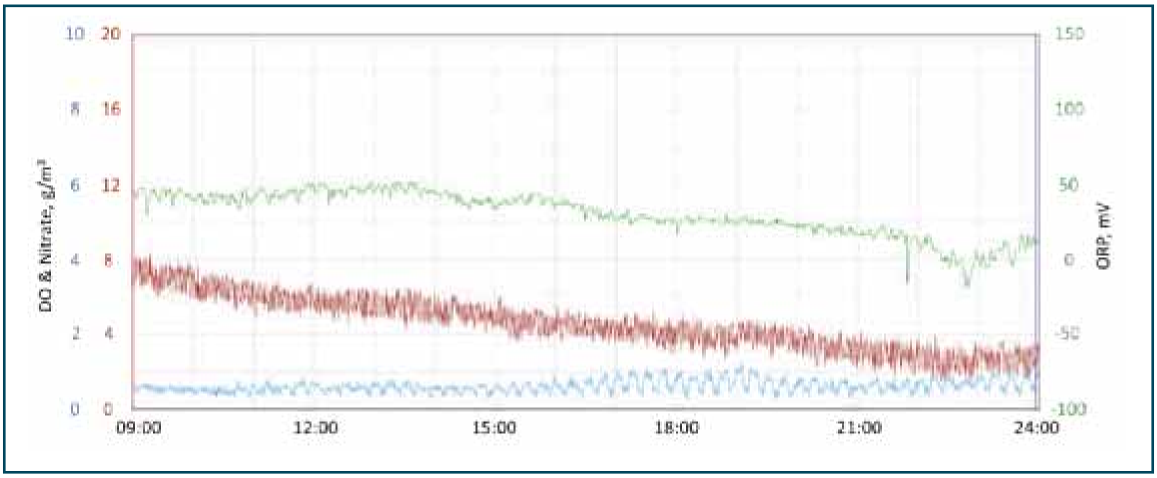

Figure 5 – SCADA trend; 12th November 2013

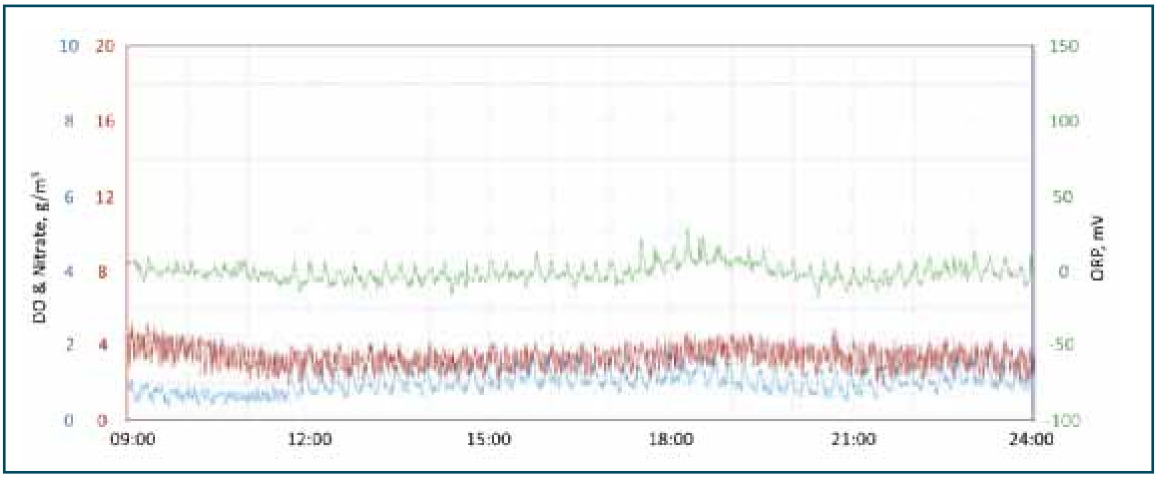

Figure 6 – SCADA trend; 22nd November 2013

UVT Monitoring

Through January 2014, the UVT of the tertiary treated effluent changed significantly, decreasing from 60% at the start of the month to 30% on January 21st, before increasing again through the remainder of the month. This trend is shown in Figure 7. The process engineer identified this trend through remote monitoring of the SCADA, and was able to raise potential concerns and implications with WDC operators and engineers. Consequentially, WDC has undertaken additional pre- and post-UV monitoring to determine the efficacy of the UV system under low-UVT conditions. At the time of writing these results have not been received from the laboratory. If results indicate compromised UV performance due to low UVT, chemical dosing can be brought on line to improve UVT and disinfection efficacy.

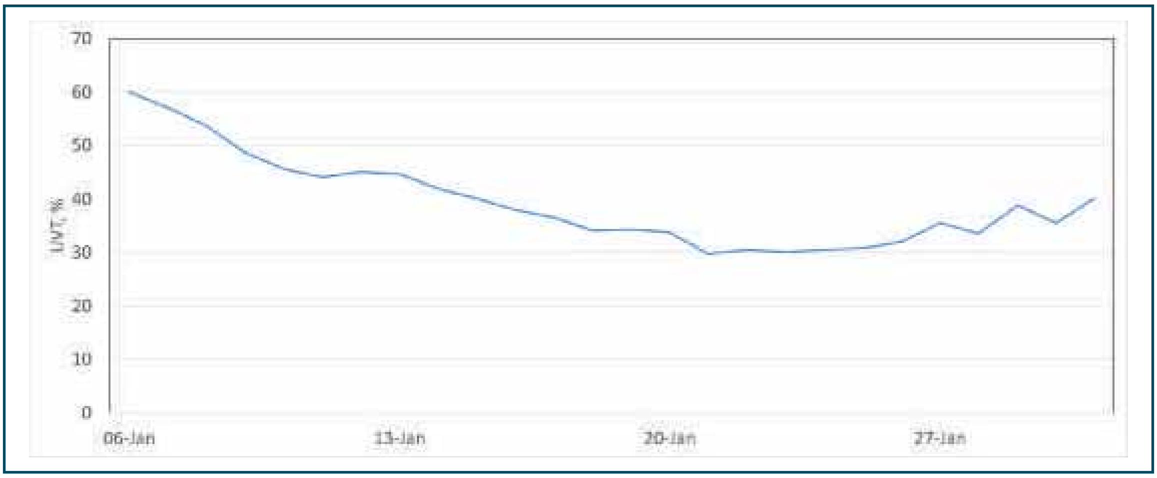

Figure 7 – SCADA trend; 1st – 31st January 2014

Conclusions

The Te Kuiti WWTP upgrade project shows the benefits of spending the time and money to fully understand the wastewater characteristics, flow and load to be treated, along with any diurnal and seasonal variations. Once the characteristics, flow and load are well understood, it is possible to optimise the design of the treatment processes to provide both the capacity and the operational flexibility to manage the expected flows and loads. This, in turn, allows a high degree of control over the use of consumables such as electricity and chemicals.

On-line instrumentation can allow improved understanding and control of treatment processes. Providing instruments are maintained as necessary to provide accurate results, process engineers can provide support to operators through remote monitoring of SCADA trends. This allows treatment plants to be effectively optimised after commissioning, ensures plants are operated as they were designed and allows for full transfer of knowledge from the designers to the owners and operators of the WWTP. ■

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Reliable gear & highly trained technicians

Microwave Measuring Technology for Sludge Treatment Optimisation

Applied Instruments

A lot of energy and chemicals are needed to optimise the drying of sludge originating from a wastewater treatment process. These costs can be minimised with the help of an advanced process control system.

The aim is to de-water sludge to a high solids content as cost-effectively as possible by:

1. Accurately optimising the dose rate of polymers to eliminate waste
2. Achieving high centrifuge efficiency by exact control of the solid matter loading through feedback to the sludge pumps

These two parameters will be controlled on the basis of solids content measurements. This means reliable and accurate measurements are required continuously, in line with the process. Previously, the short comings of in-line instrumentation meant laboratory testing was the only way to achieve accurate and reliable results. However laboratory testing methods mean the results are available too late to be used as a basis for continuous process optimisation.

In-line optical transmitters are sometimes used for measuring solids content. Based on the light scattering properties of the material, these transmitters require extensive maintenance and do not give results that are accurate enough.

Probe insertion-style ultrasonic sensors have been used with varying degrees of success. Although the measuring principle is robust, there can be problems due to fouling of the insertion probes.

> "Probe insertion-style ultrasonic sensors have been used with varying degrees of success."

A modern and well-proven solution for continuously measuring solids content is the advanced non-intrusive microwave technology, which provides the perfect solution to the sewage processing industry. Solids measurements are precise and reliable, without costly maintenance or downtime.

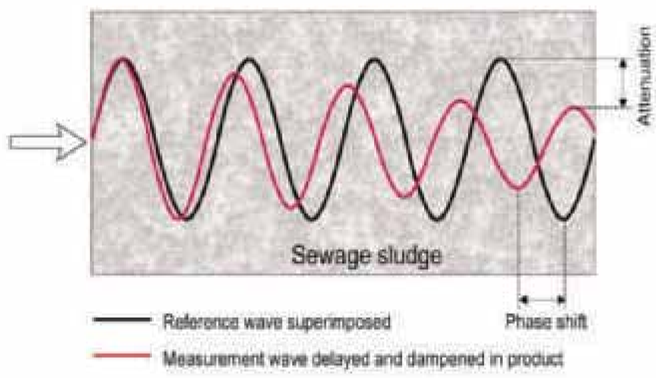
This is achieved because the sensor is effectively a short section of pipe about 200mm long (flanged measuring cell) with a completely smooth bore. Nothing at all protrudes into the sample stream. Microwaves pass from one side to the other. In brief, the measuring principle exploits the property of water that alters the height and frequency of the microwaves as they pass through. This phenomenon is very repeatable and directly proportional to the amount of water present.

The more detailed explanation is the system generates two identical microwave signals; a measurement signal and a reference signal. The measurement signal is transmitted to the measuring cell via a cable and, after the microwaves pass through the product, is returned to the system for processing via a return cable.

The reference signal is transmitted through a single cable, which has the same combined length as the two measurement cables. This arrangement perfectly compensates for changes in ambient temperature. As mentioned earlier, the molecular structure of water in the sewage sludge changes the speed of the microwaves (phase shift) and the height of the microwaves (attenuation).

The magnitude of the changes is perfectly repeatable and directly proportional to the moisture content of the sample stream. The phase shift and attenuation is determined by comparing the returned measurement signal with the returned reference signal. All other elements in the sewage sludge have practically no influence on the behavior of the microwaves.

The graph below shows the reference signal superimposed over the measurement signal as it passes through the sewage sludge, highlighting the phase shift and attenuation of the microwaves.



The dry solids content is determined from the moisture measurement by a simple calculation:

%dry solids = 100% – %water

The repeatability of the measurement is typically better than 0.2% dry solids.

The advantages of using a non-intrusive microwave measurement system are:

- Low operational costs, minimal maintenance requirements and infrequent calibration intervals
- The selective measuring principle provides high reliability of the measurement
- The reference system provides drift-free measurements, repeatability better than 0.2%DS
- Low capital cost, economically priced, minimal operator training required
- Reliable and repeatable measurement requiring only one calibration factor, even for different digested sludges ■

Case Study – Germany

Sewage Plant Putshagen, Gütersloh

The sewage treatment plant in Gütersloh processes both household and industrial wastewaters from an area comprising of approximately 195,000 inhabitants. The measuring task is to determine the solid content so that the flocculent agent can be controlled and the filling of the centrifuge can be constant.

The digested sludge has a total solids content of between 2–5% and they achieved results with an accuracy of 0.25 weigh-% TS.

By using the non–intrusive microwave measurement, the flocculating agent consumption could be reduced by 16%. According to the operator, this meant that the microwave measuring system was paying for itself after just one year.

Oil-in-Water Fluorescence Sensor in Wastewater and Other Industrial Applications

Dr. Vadim Malkov – Hach Company, Loveland, Colorado and Dr. Dietmar Sievert – Hach-Lange, Dusseldorf, Germany

Keywords

Oil-in-Water (OIW), UV fluorescence, PAH, wastewater, refinery, heat exchanger, cooling tower, cooling water

Abstract

In order to simplify and accelerate the analyses of oil and grease in industrial wastewaters, particularly discharged from various parts of the oil-refining process, a UV-fluorescent sensor sensitive to polycyclic aromatic hydrocarbons (PAH) was tested. The correlation between total oil-in-water concentration and concentration of the model PAH compound was found to be achievable in samples containing stable content of oils.

Introduction

The analysis of oil and grease in industrial process waters and wastewater in general, and in the oil refining industry in particular, presents a real challenge due to variability in the analytes and the matrix. This variability depends largely on the applications where the water is used and the challenge arises most sharply in the areas where on-line analysis is implemented.

The major task in applying methods other than direct oil-in-water (OIW) laboratory analysis is to prove correlation between the oil concentration and the instrument readings. General description of existing methods for measuring OIW along with their respective advantages and drawbacks is presented in Table 1.

Table 1 – Comparison of different methods for OIW measurements

Method	Advantages	Disadvantages
Lab analysis of a grab sample	Ultimate method for direct determination of oil and grease in water	Long and complex analysis, special equipment required, representative sample required
Nephelometry (light surface scattering)	Cost effective on-line instrumentation	Difficult to distinguish between turbidity caused by oil and other particulate matter
UV absorbance	Robust well known technology	Interference from other than oil compounds, biological matter, and suspended solids
VIS fluorescence	LPP on-line analyzers and submersible probes	Low sensitivity to PAH, interference from natural organic matter
UV fluorescence	High sensitivity and selectivity toward PAH, wide range of measurements, online analyzers and submersible probes available	Relatively high price, necessary to calibrate per matrix/application

The challenge of establishing the correct correlation becomes particularly important when a method is based on response of a specific model compound found in the oils and not in the water matrix. Ideally, this model compound should be present in all kinds of oil to provide no limitation by type of product to be analyzed. It should generate a strong enough and free of interference signal to be detected and correctly interpreted by the instrumentation.

Several compounds regularly found in crude oil and refined oil products that can serve as a model for optical methods are aromatic hydrocarbons represented by two major groups of substances – monocyclic aromatic hydrocarbons (Benzene, Toluene, Ethylbenzene, Xylenes – BTEX), and Polycyclic Aromatic Hydrocarbons (PAH).

Polycyclic aromatic compounds present in oils are mostly derivatives of naphthalene, anthracene, and phenanthrene and their common structural feature is a system of conjugate bonds (Fig. 1) allowing for fluorescent properties of these substances.

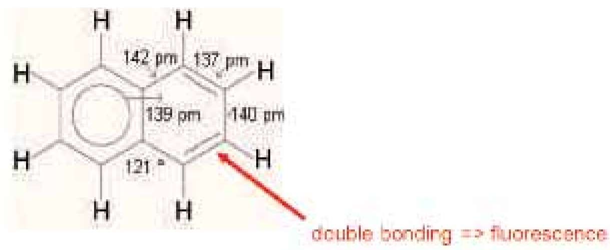


Figure 1 – Structural formula of naphthalene as an example of PAH

The subject of this testing – a UV fluorescence probe was chosen based on the potential applicability to all refined and crude oils due to the fact that the method is sensitive and quite specific to PAH, which are considered to be constituents of all such products.

Since the BTEX and PAH are both detectable also with spectrophotometry, it was interesting to compare this method with fluorometry.

Experimental Part

Instrumentation for testing was chosen based on the comparison of the methods (Table 1), being a medium priced compact size sensor able to provide reagentless measurements specific to oil content. Physical dimensions of the sensors varied based on what light source was implemented, resulting also in different ranges of light spectrum analysed by the probe. Our main interest was placed on a UV fluorescence probe (pictured in Figure 2, left), where the light source was a standard Xenon flash lamp with interference filter producing light at 254nm (excitation) and collecting feedback at 360nm (emission).

An alternative to the UV fluorescence sensor was a visible light based fluorescence probe (VIS-fluorescence), where the light source was an LED, which normally has major characteristics within: excitation = 370–460nm / emission = 520–715nm, depending on the intended analyte. Such sensors are less expensive and have a smaller physical size, therefore a VIS-fluorescence probe intended for detection of crude oil was also tried in this study.

The testing conducted for the VIS-fluorescence sensor was minimal and the main focus was on the UV-probe, therefore most of the information found below is related to the latter instrument.

General schematic for both UV- and VIS-probes is presented in Figure 2, right.

Both types of sensors can be purchased in either stainless steel or titanium body, and they produce an analog signal that can be registered by a standard controller. The UV-probe generated a 4-20mA signal that was processed by sc1000 controller used in this study. The readings were displayed in either raw format (mA) or in relative (% of scale) or absolute concentration of oil in water based on calibrations.

Figure 2 – UV-fluorescence OIW sensor and principle of its operation

The main technical specifications for the tested UV fluorescence sensor are presented in Table 2. The measurement range limits are set at the factory and the calibration standards are also available for both low and high range sensors (Table 2).

Table 2 – UV-fluorescence sensor technical specifications

Parameter	Specification
Detection Parameter (PAH)	Phenanthrene (model compound)
Measuring Principle	UV-fluorescence (Excitation 254nm / Emission 360nm)
Measuring Range	Related to Phenanthrene
Low range probe	0–50ppb & 0–500ppb, corresponding to 0–1.5ppm and 0–15 ppm oil calibration standards
High range probe	0–500 ppb & 0–5000 ppb, corresponding to 0–15ppm and 0–150ppm oil calibration standards
Limit of detection	1ppb (Phenanthrene)
Probe housing material	Stainless steel, Titanium
Mounting options	– chain (submersible) – in-line (in-pipe mounting hardware) – bypass (flow cell)

Currently, there is also some optional equipment such as an automated cleaning system available, which would also be very helpful during this study.

"Laboratory performance evaluation was conducted prior to moving onto the field testing. The main goal of the laboratory testing was to establish correlations between concentration of the model compound (Phenanthrene) and total oil concentration to confirm the probe's suitability for determination of such oils in water. Thus, the calibration coefficients and measurement ranges were derived for readily available oil products. The matrix effect analysis was also conducted for some representative oils."

Results and Discussion

Laboratory Testing

Laboratory performance evaluation was conducted prior to moving onto the field testing. The main goal of the laboratory testing was to establish correlations between concentration of the model compound (Phenanthrene) and total oil concentration to confirm the probe's suitability for determination of such oils in water. Thus, the calibration coefficients and measurement ranges were derived for readily available oil products. The matrix effect analysis was also conducted for some representative oils.

The results of the laboratory calibrations are presented in Figures 3 and 4 below.

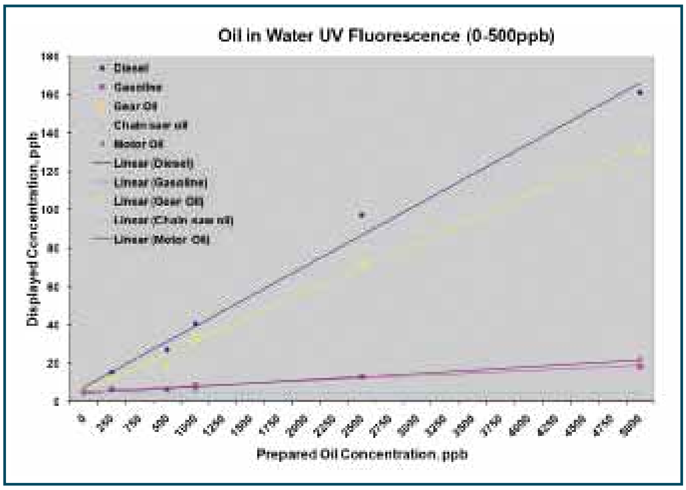


Figure 3 – Calibration curves for series of available oil products in water

Figure 3 shows linear response of the sensor calibrated to Phenanthrene concentration (Y-axis, Fig. 3) to the prepared oil concentration in DI water (X-axis, Fig. 3). The calibration coefficients (slope and offset) can be easily established based on the linear regression for several oil products such as diesel fuel, gasoline, gear oil and motor oil (Fig. 3). In the same time, the chain saw oil being a natural product (derived from a biological raw material) did not show presence of the model compound (Fig. 3).

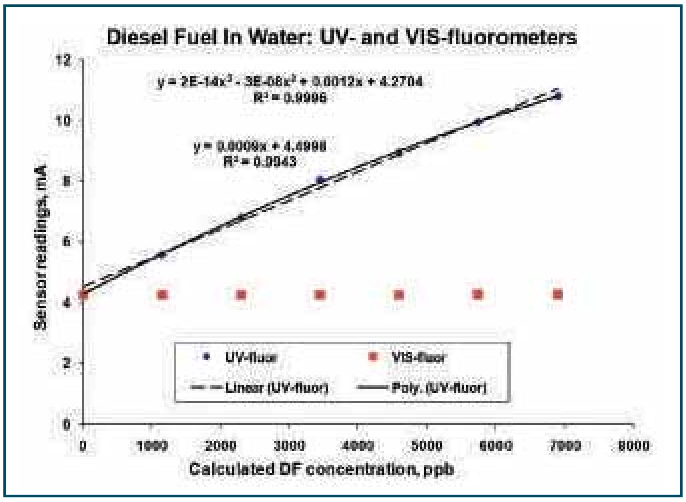


Figure 4 – UV-fluorescence: Diesel fuel calibration test results

In Figure 4, the results for simultaneous testing of both UV and VIS fluorescence sensors are shown. As seen from the charts, the VIS-sensor did not show any response to diesel fuel, which was found to be a most indicative oil for the UV-based probe.

The readings from both sensors were registered in raw mA format and scaled to the same 4-20mA range. As also follows from the experiment, the linearity of response of the UV-based probe does not change much for the wide range of the analyte concentration (Fig. 4). Based on the correlation coefficients (R2, Fig. 4), the relationship may be considered linear throughout the entire range of tested diesel fuel concentrations.

The UV sensor comes with daylight automatic compensation, therefore it was not necessary to take any precautions to avoid ambient light.

A set of experiments was conducted to define the matrix effect on the measurement of OIW concentration with UV-based sensor (Fig. 5, Y-axis = ppb).

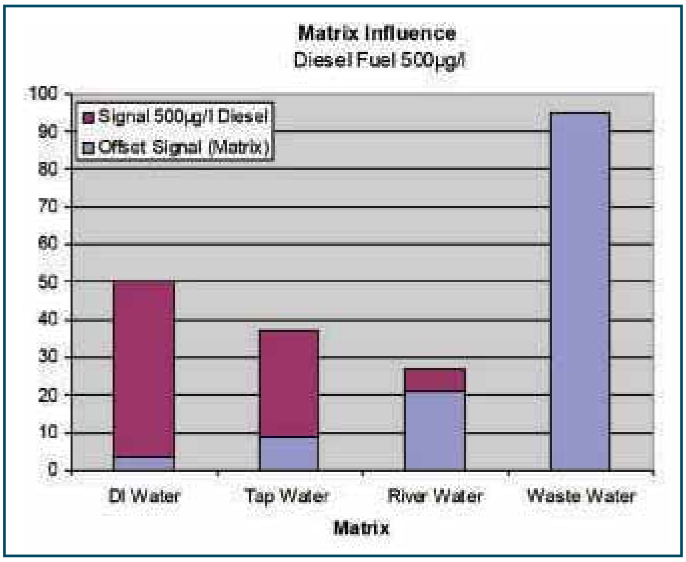


Figure 5 – Water matrix influence at 500ppb of diesel fuel concentration

The test results presented in Figure 5 were performed in DI water, tap water, river water and wastewater. A significant influence of the water matrix suggests calibration of the sensor in process (grab sample analysis) or in the process sample (standard additions method) as preferred calibration procedures.

As seen from Figure 5, the signal of 500ppb of diesel fuel in wastewater was very small due to the matrix effect. However, raising the analyte concentration 10 times provided a clear response even in this type of matrix (Fig. 6, Y-axis = ppb).

Therefore, the UV fluorescence probe may be considered suitable for wastewater applications, because the limit of detection for diesel fuel was found to be significantly lower than 1ppm, which is considered low enough.

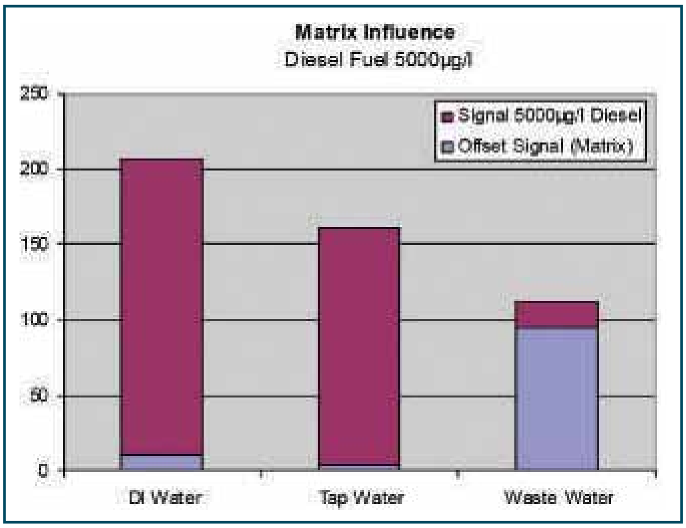


Figure 6 – Water matrix influence at 5000ppb of diesel fuel concentration

The comparison of performance of the UV fluorescence and UV spectrophotometric (Hach UVAS instrument, 254nm) sensors was conducted to identify key differences between these technologies. A test for sensitivity to pure phenanthrene in water revealed that the probe based on UV absorbance was approximately 10 times less sensitive to this model compound than the UV fluorescence sensor. Also the slope of linear correlation was approximately 100 times lower for the spectrophotometric method versus fluorescence (0.0443 vs. 3.945).

A test for sensitivity to the same set of oils (Fig. 4) showed expected lower sensitivity of light absorbance to all oils but the chainsaw oil, which was a natural product that did not contain PAH. This observation confirmed that UV absorbance is not specific to the presence of PAH and therefore will suffer from interferences.

After finishing the series of laboratory tests discussed above, several field test opportunities were identified and some of them have been conducted. Our main focus was on testing the sensor in municipal WW applications and also at different applications involving industrial process water. Major interest laid in refinery applications as the most challenging due to the environment and demand.

From analysis of the literature and through extensive personal experience, we identified a list of potential applications for the OIW sensors in municipal waters (drinking water and wastewater) as well as numerous opportunities in industrial waters (Table 3).

Table 3 – Potential Applications for OIW Sensor

Industry	Application
Drinking water	• Environmental – early detection in natural sources • Detection of oil in artificial reservoirs, as well as in raw water (WTP inlet) • Desalination plants water intake monitoring
Wastewater	• WWTP inlet • Monitoring direct and indirect discharge • Stormwater runoff • Membrane plants (water reuse) • Ground water reclamation sites
Industrial water	• Fuel storage tank area drainage systems • Cooling water • Condensate return • Leaks from heat exchangers • Turbine oil in power plants' process water • Effluent monitoring after an oil-water separators (refineries) • Aircraft and truck wash-down facilities • Petrochemical: detection of oil in water separated from the crude oil • Maritime applications (holding tanks wash down: <15ppm OIW discharge limit)

Field testing

Municipal WWTP Testing

A UV fluorescence high range sensor (0–5000ppb) was installed at the inlet of a municipal WWTP in Germany. Possible sources of oil contaminations were some small manufacturing plants together with a small town and several villages in the surrounding area, thus representing the typical structure of a mid size municipal WWTP.

The probe was installed in the tail water at the bottom of a weir, located between screen and sand trap and allowing strong mixing of the sample and a more or less even distribution of the oil contamination. To test the performance of the probe a mixture of 2L of Diesel fuel in 20L water was spilled into the waste water several meters upstream of the weir. An immediate response could be observed as shown in Figure 7.

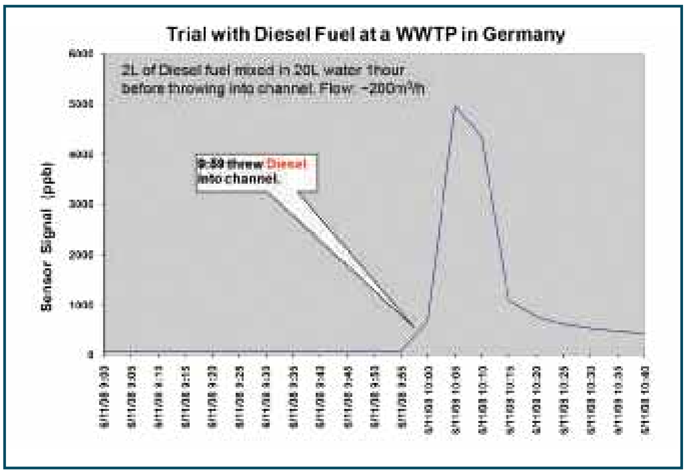


Figure 7 – Experiment at a WWTP, HR sensor

After several days of normal operation with readings close to zero an oil spillage accident led to a severe contamination of the first stage of the plant (Figure 8). The contamination was described by the plant operator as a fuel oil based emulsion.

"After finishing the series of laboratory tests discussed above, several field test opportunities were identified and some of them have been conducted."

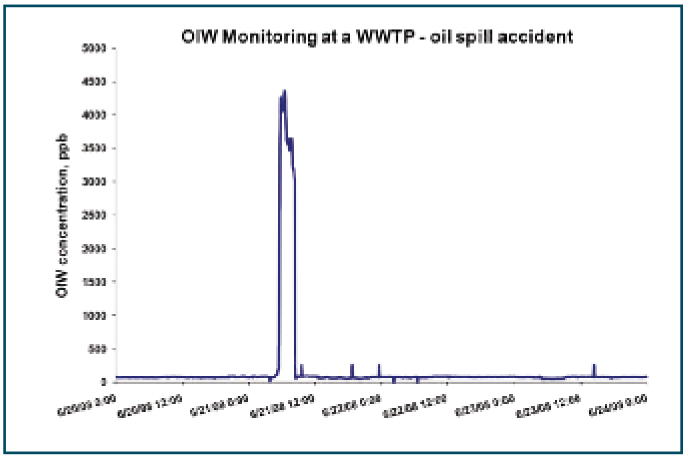


Figure 8 – Real-life oil accident at a WWTP, HR sensor

Another example of data collected at a municipal waste water treatment plant (WWTP) is presented in Figures 9 and 10. The instrument (UV fluorescence LR sensor, 0–500ppb) was installed at the inlet collector before the central aeration station of a large water reclamation facility in Sankt-Petersburg, Russia. The water was coming from a commercial marine port area and the customer was legitimately concerned with possible excessive discharge of oil products from the ships and other port infrastructure. The installation was performed in the open well (chain mounted sensor) and the test lasted for several months.

A grab sample analysis was conducted in laboratory at the beginning of the test to establish a base-line for normal OIW background (pink dot on chart, Fig. 9) and shortly after this, an event was registered by the instrument (Fig. 9).

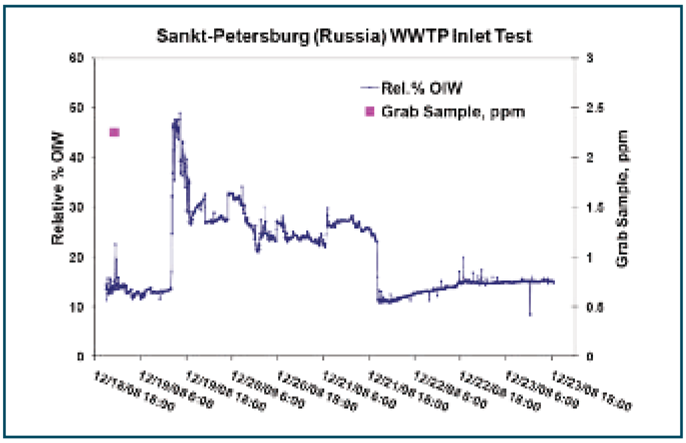


Figure 9 – WWTP test in Russia – first results

Because the event happened right before the weekend, the violation could have gone unnoticed; however, the OIW monitor registered it. Therefore, based on this finding a decision was made to equip the monitoring point with an autosampler connected to the same controller and driven by the OIW monitor.

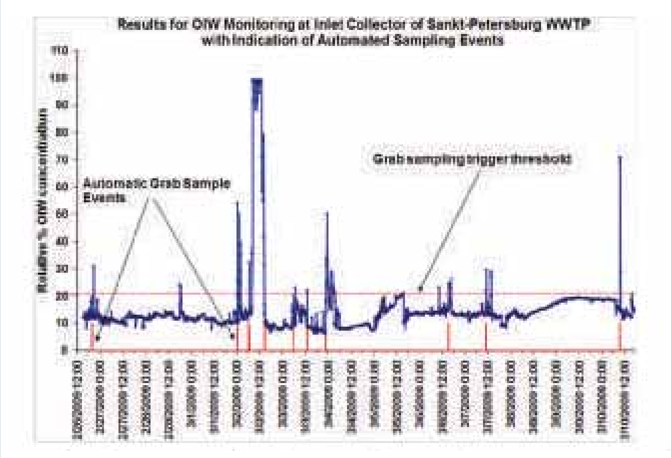


Figure 10 – Russian WWTP – long-term trial with autosampler

Thus, in further testing the automatic grab sampling routine was triggered when the OIW concentration exceeded the pre-programmed threshold, which was set at the level of 3.5ppm OIW that corresponded to ~25% of the scale (Figure 10).

The auto-sampler provided the customer with an opportunity to analyse the stored water samples later in a laboratory (within 4 hours from the sampling) to determine absolute concentration of oil products at the time of event, which would help to pinpoint the source of contamination. Unfortunately, the customer considered the laboratory analysis too expensive and did not use the opportunity; however, combining the auto-sampler with the OIW monitor can definitely open some new horizons.

Refinery Testing (WW)

In conversations with petrochemical customers, three potential applications were identified as most valuable for refineries: wastewater (WW) after API separators (prior to bioreactor), desalters, and cokers. The desalter and coker applications normally involve high sample temperatures and high concentrations of chloride (desalter), therefore required special body materials (titanium), at a minimum.

The WW application does not require special precautions such as titanium body material or intrinsically safe electronics, therefore, it was chosen as the most appropriate for field testing at a refinery.

The installation was conducted at a refinery in Wyoming where customers have tried several approaches to monitor the OIW concentration in WW discharge into bio-treatment, because excess of oil can wear out the bacteria, which is costly to replace.

The customer implemented an induced air flotation (IAF) procedure right after the API separator to reduce the amount of oil in wastewater coming to the bioreactor. This refinery tried a full-scale on-line OIW analyser based on chemical method several years ago, however abandoned the instrument due to its high maintenance requirements and the unreliable results it provided. The refinery currently conducts several different lab analyses of the sample along with on-line turbidity monitoring (surface scattering) in order to evaluate the OIW content and keep it under control.

The two sensors: UV (LR, 0–500ppb) and VIS fluorescence (crude oil) were installed on the same sample line with the surface scatterer after the IAF device and the data were collected with the single multiparameter controller (Hach sc1000) – Figure 11, left. The sensors and controller were mounted on a panel along with a flow chamber made out of available materials.

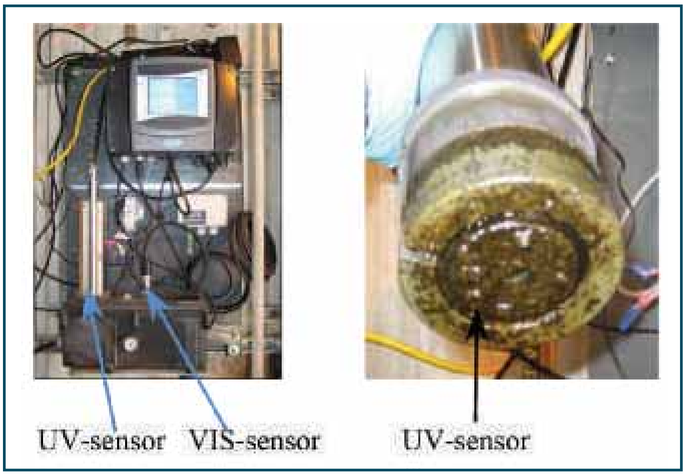


Figure 11 – Refinery installation – wastewater stream after IAF, before the bioreactor

There were several challenges met in this application, first – fast sensor window fouling (Fig. 11, right) due to slow sample flow through the chamber. Unfortunately, the flow could not be increased without interfering with the surface scatterer, and hence the results provided by that instrument. Also, the automated air blast cleaning system was not available at the time of testing.

Another challenge was with the nature of the oils in the sample – according to the customer, there was never only a single type of crude oil being treated at the refinery at a time. Therefore, the sample content was never consistent in terms of the oil kind and consequently the PAH content in the sample. This resulted in inconsistency of the readings received from both sensors with the grab sample analyses (Figure 12). All attempts to calibrate the sensors using the grab sample data failed due to the abovementioned limitations.

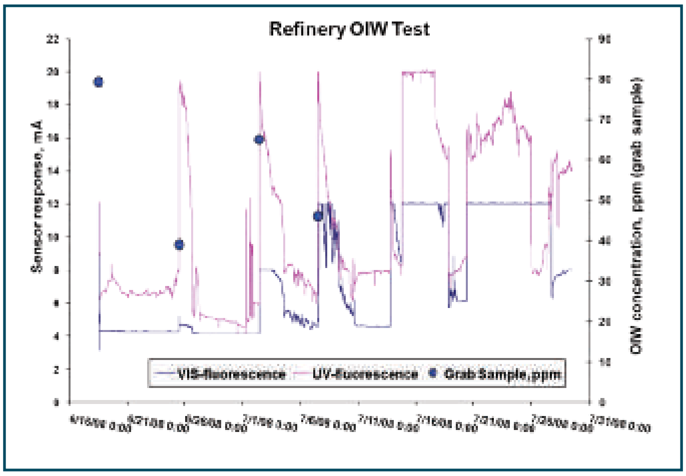


Figure 12 – Refinery WW application test results

On a positive side it should be noted that there was a similar trend found between the results collected from both sensors, however, the VIS fluorescence provided a significantly narrower range and therefore was excluded for the further experiments (Fig. 12).

Given the discovered limitations, the next test was conducted in an industrial application with lower to no variation in oil types found in the wastewater discharge.

Auto Parts Plant (Industrial WW)

This time, the test involved only the same UV fluorescence probe (LR, 0–500ppb) that demonstrated a wider range of response to the OIW concentrations in previous trials. The sensor was installed in an

> "Another challenge was with the nature of the oils in the sample – according to the customer, there was never only a single type of crude oil being treated at the refinery at a time."

open channel (well, chain mounted) at the inlet to the wastewater treatment facility of a Chrysler auto parts plant in Michigan (Figure 13).

Figure 13 – Installation

In this process, the wastewater is collected from all plant operations in a tank and then undergoes chemical treatment prior to discharging to the municipal collector. The major constituent of the analyzed sample in terms of oils was identified to be various lubricants from the metal works.

The entire test continued for approximately two months and the data was logged by the controller, which also allowed for remote wireless access to all data and the controller's functions. The process of calibration was performed in the middle of the test using the process sample technique presented in Figures 14 and 15 and described below.

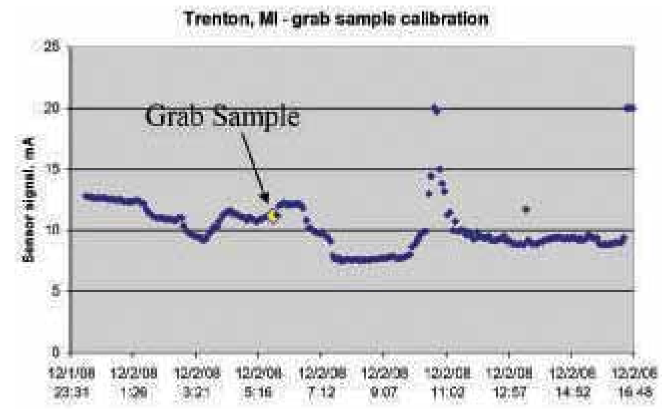


Figure 14 – Process calibration procedure

The grab sample was taken at a stamped time (Figure 14) and after laboratory analysis; the obtained OIW concentration was entered in a simple linear relationship, which yielded the calibration equation (Figure 15).

"According to the customer, without such early notification, the leak would have been discovered only after the shutdown of the compressor on low oil level."

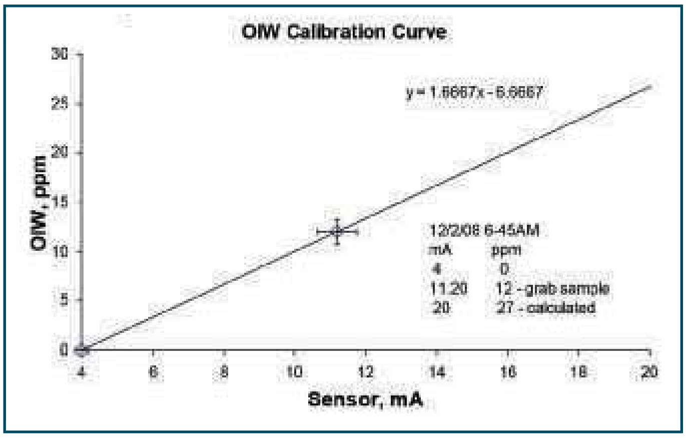


Figure 15 – Industrial WW test – calibration

The calibration coefficients (slope and offset, Fig. 15) generated by the equation were used to calculate the concentration range in units of OIW, and then the probe was calibrated to display the concentration. After the calibration, the customer was able to make adjustments to their process to optimise the chemical treatment (Figure 16). In communication with the customer, the nature of the positive spikes was discussed and there was always an explanation providing legitimacy of the probe's response.

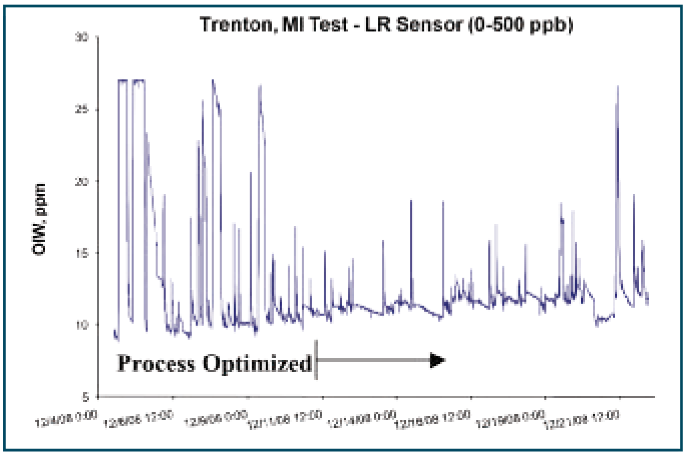


Figure 16 – Auto parts plant in Michigan (industrial WW) – test results

As seen from Figure 16 and according to the customer, the process optimisation resulted in smoother wastewater treatment operation.

Cooling Water (Heat Exchanger)

A UV fluorescence high range sensor (0–5000ppb, Titanium) was installed at a cooling tower of the gas production facility in Southwestern Colorado. The customer's major concern was the repeated oil leaks from the heat exchanger serving the compressors to produce liquid carbon dioxide. The system was installed in a shed, harboring the chemical feed system for corrosion control near the cooling tower and the sample feed was provided with the flow cell as shown in Figure 17.

Figure 17 – Cooling Tower Installation

After several days of normal operation with readings close to zero, an oil leak from the heat exchanger was detected (Figure 8). The contamination cost the customer more than $1,000 in the oil loss. Besides the direct loss of oil, the company had to complete a series of procedures to clean up the cooling water, which involved the use of a biocide, oil absorbing mats, higher chlorine injection, draining of the entire cooling tower water, re-establishing chlorine and polymer levels in the cooling water. All these actions required approximately eight hours of work time and an additional $1,000 in materials.

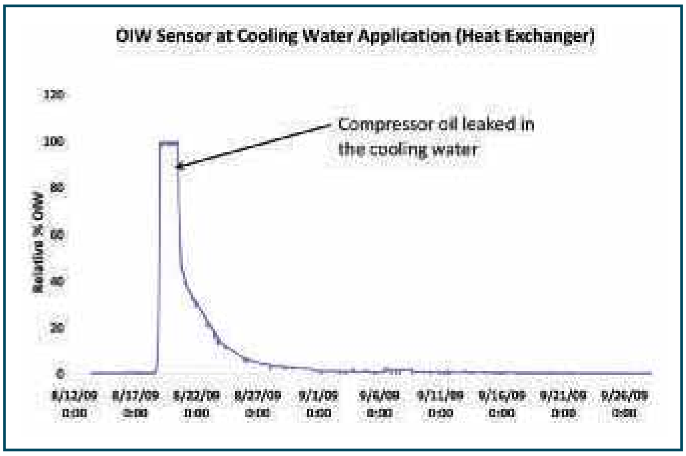


Figure 18 – Real-life oil leak from heat exchanger

Thus, the accident cost was high enough; however, it could have been more costly if there were no sensor installed at the time.

"This could lead to possible plant shutdown, or damage to the compressor and extensive cleanup of the cooling tower, which could end up in many thousands of dollars of losses for the company."

Figure 19 – After-test inspection of the flow cell and sensor window

According to the customer, without such early notification, the leak would have been discovered only after the shutdown of the compressor on low oil level. This could lead to possible plant shutdown, or damage to the compressor and extensive cleanup of the cooling tower, which could end up in many thousands of dollars of losses for the company.

"After several days of normal operation with readings close to zero, an oil leak from the heat exchanger was detected (Figure 8). The contamination cost the customer more than $1,000 in the oil loss. Besides the direct loss of oil, the company had to complete a series of procedures to clean up the cooling water, which involved the use of a biocide, oil absorbing mats, higher chlorine injection, draining of the entire cooling tower water, re-establishing chlorine and polymer levels in the cooling water. All these actions required approximately eight hours of work time and an additional $1,000 in materials."

As seen from Figure 18, the accident apparently went unnoticed for about two days, because the communication between the controller and the plant's monitoring system was not established, while the controller allows for such communication. The controller was equipped with a relay card allowing to send an analog signal to either the central monitoring post or to display an alarm locally in the case of exceeding the prescribed oil in water level. The other opportunity for remote access and control was the wireless communication option enabled through Global Packet Radio Service (GPRS) provided by most cell phone companies. Unfortunately, due to the extremely remote location of the test site, no such service was provided by major US wireless carriers in the area.

Nevertheless, the sensor proved itself very useful by saving the customer a significant amount of money at nominal cost not exacerbated by the maintenance requirements. Regular maintenance of the system involves cleaning of the sensor window and its frequency depends on the application. For example, when the sensor is submersed in a slow moving dirty sample, the cleaning may occur daily depending on the sample conditions and its origin (application). The cleaning frequency can be significantly minimized by using either an air blast auto cleaning system (for submersible installations), manageable from the same controller or the flow-through cell. In the latter case the maintenance can be nothing other than occasional cleaning of the strainer installed in the sample line feeding of the flow cell.

As a matter of fact, in the presented case study, there was no maintenance conducted on the sensor during more than 45 days of testing. There was some expected fouling found in the flow cell and on the sensor window during the post-test inspection (Figure 19); however, it obviously did not prevent the probe from producing correct readings. As seen from Figure 18, the sensor was operating well during the entire test.

Conclusions

The main conclusions can be expressed in following statements:

A signal produced by the UV-fluorescence sensor was found to be proportional to the oil-in-water concentration.

The tested UV-fluorescence sensor adequately and specifically responds to oil products containing PAH including crude oil.

The UV-fluorescence provides better sensitivity and selectivity in OIW analysis than UV-absorbance.

The sensor performance can be improved by implementing specially designed flow cell providing faster flow and/or automated cleaning system for open-channel mounting.

The sensor response can be calibrated by using either purchased standards or based on the grab sample analysis, however, inconsistent oil content may prohibit quantification of the results.

Acknowledgement

The authors would like to express deep gratitude to Chris Fair (Hach), Sabine Warnemuende (Hach-Lange), Pat Michels (Hach), as well as Chad Hurst and Jerrod Hughes (Linde, Inc.) for their help in conducting field installations and laboratory experiments. ■

Tauranga and Mount Maunganui Sewerage – Twins Joined at the Hip

John Fitzmaurice FIPENZ – Life Member WEF, Life Member NZWWA

Tauranga the Borough

In 1913 a report by the Borough Engineer HW Climey described a scheme for the reticulated sanitary drainage of the residential and commercial area of the borough. It provided for a large septic tank in the Strand with discharge to Tauranga Harbour. The scheme covered the area from Brown Street to Second Avenue. Outside this area, soakholes continued to provide satisfactory drainage into the pumice and sandy subsoil.

Tauranga – Mt Maunganui area from 7000m altitude (Photo: Air Logistics (NZ) Ltd)

Tauranga the City

The population increased over time, and in 1963 Tauranga was declared a city, with a population in excess of 20,000. Seepage of effluent soakage became noticeable around the foreshore, prompting the city to commission consulting engineers Worley Downey Muir & Associates to undertake design of extensions to the reticulation and a treatment system.

Stage one of the Chapel Street Treatment Plant, built on reclamation adjacent to Chapel Street at the harbour edge, was commissioned in 1969 under City Engineer, Hugh Binney. The plant provided primary and secondary treatment using the conventional activated sludge method. It had a treatment capacity of 5900m3/d to serve a population equivalent of 20,000 persons. Discharge was through a 1100m outfall to the Otumoetai Channel in the harbour. It discharged continuously at a depth of 8 metres.

Stage Two Development

In 1978 the plant was enlarged. This stage two development provided treatment of sewage for an equivalent population of 48,000. As part of the stage two extensions a second primary sedimentation tank, equal in size to the original tank, was built. The secondary treatment unit was modified from direct feed activated sludge to a step feed "contact stabilisation" method.

Two final effluent clarifiers were added. A second anaerobic, heated sludge digester was built. The administration building was extended to house a new system of blowers for the activated sludge plant and a larger diesel standby generator was provided for emergency power supply. Pumps were also installed to increase the capacity for pumping raw sewage, to remove the sludge from the primary and secondary sedimentation tanks and to increase the flow rate of treated effluent through the outfall.

Stage two also included the provision of centrifuges for de-watering the sludge.

By 1985 the city was fully reticulated and in 1987 a third primary sedimentation tank was added to the plant.

Borough of Mount Maunganui

Under the initiative of Mayor AR Harris, the Borough Council in 1969 commissioned consulting Civil and Sanitary Engineers Steven & Fitzmaurice to undertake initial investigations for a sewerage scheme for the borough. Like Tauranga, the area had relied on borehole soakage for individual septic tank effluent disposal with two soakholes per property, one duty one standby with a changeover system with a plug in the pipe going to the standby soak.

Indeed, if anything, the sandy isthmus provided better soakage than the city area. However, intensified residential development and the increasing popularity of 'The Mount' for seasonal holiday makers was in danger of impairing public health and blighting the renowned reputation of the Oceanside Beach for both swimming and shellfish gathering, leading to the Department of Health requisitioning the implementation of a reticulated sewerage system for the borough.

The investigations considered a number of treatment and disposal methods including oxidation ponds or a treatment plant, both with a harbour or ocean discharge; partial treatment with an ocean discharge; or treatment in the city plant. Water classification standards as prescribed by the Waters Pollution Regulations precluded discharge to the southern upper reaches of the harbour as well as costs made combined treatment in the city plant unattractive.

Oceanographic studies of dye and float tests undertaken in 1971 by the consultants showed that an outfall preceded by preliminary treatment (comminution, fat and grease removal), or primary treatment, (removal of settleable solids, grease and oil), and discharging 1800m offshore would be only marginally compliant with foreshore water quality requirements that had, by then, been upgraded by regulation to shellfish standards; but that an outfall discharging oxidation pond effluent at a distance of 900m offshore, would readily meet the receiving water standards prescribed.

The borough in 1972, now under the gavel of Mayor RA (Bob) Owens, resolved to construct the recommended reticulation and disposal scheme and set about seeking the necessary statutory approvals including loan approval, subsidy and water discharge right. In order to construct the oxidation ponds in Rangataua Bay in the upper reaches of Tauranga Harbour, the borough promoted a local parliamentary Bill for reclamation of part of the bay, and in 1975 the Mount Maunganui Borough Reclamation and Empowering Act was passed. With all statutory approvals in place, the scheme proceeded and the works were commissioned in 1979.

The long-serving Town Clerk, Bruce Cunningham, adroitly steered all the administrative issues into place.

Again, it can be noted that, as with Hamilton, a ten year gestation period was needed to get this initial scheme in place.

There were some glitches along the way. The consultants' recommendations regarding the scheme were challenged by the Borough Engineer at the time. Without any dialogue with the consultants, he proposed to his Council a Passveer Ditch type plant sited much nearer the borough development. The consultants

"Difficulties were experienced with both the outfall pipe across the isthmus to the ocean foreshore and with the outfall itself."

condemned this on both type of treatment and location. Council was persuaded to adhere to the consultants' recommended scheme; however, it was an unfortunate and unseemly incident.

At the request of Council, local surveyors, Shrimpton & Lipinski (still existing in the form S & L Consultants) were engaged by Steven and Fitzmaurice to do all the levelling and survey work for the extensive sewer reticulation. This provided local input and valuable on-site liaison with owners of affected properties. Indeed, sharing routine engineering of this type or architectural services with local consultants was the normal practice of this specialist consultant for major sewerage schemes as, in most instances, each scheme represented the biggest financial outlay the local community would experience in that time, if not indeed for all time, and Councils generally were keen to have maximum local involvement.

The contract for construction of the oxidation pond and outfall sewer, including the ocean outfall, was awarded to Vadnjal & Mellsop Holdings Ltd. Andre Vadnjal and Ian Mellsop applied their considerable energy to the work, initially utilising a suction dredge within a containment embankment in an attempt to form the oxidation pond in the tidal area of the bay. However this was frustratingly slow for the impatient Andre and to expedite progress he breached the embankment, de-watering the work area and was able to use motorised scraper earthmoving equipment to lower the sandy harbour bottom to the required level.

Difficulties were experienced with both the outfall pipe across the isthmus to the ocean foreshore and with the outfall itself.

Pressure testing of the landward section of pipe revealed leaks. The contractor called in Bruce Henderson FIPENZ, a well known local consulting engineer, to argue that the leakage was within contract tolerances. Bruce took a relatively impartial view, and little persuasion was required to have the contractor repair the pipes.

The ocean outfall section was a different story. The 950m of post-tensioned concrete pipeline was assembled in trench on shore, mounted on lightweight packing house rollers, such as are used in the local horticultural industry, preparatory to an ocean pull launch into the sea. A winch mounted on the foreshore dune with the cable around pulleys on an offshore 'deadman' anchor beyond the planned position of the outfall diffuser was to pull the outfall out to sea.

However, sand which had accumulated around the bogie wheels during the lengthy time taken to assemble the pipeline greatly increased friction and imposed delay while additional pulling power was applied. The launch had to be stopped with the pipeline only partially launched, and high seas over the following few days then damaged the pipeline. Additionally, the pipe string had to be dragged over a foreshore dune creating curvature stress. As the launch pull proceeded, the pipe weight sequentially collapsed rollers, creating considerably more drag friction and cracking each glued pipe joint in turn.

The pipeline then encountered an offshore sand dune, half burying the pipeline and added more resistance to the launch. A large bulldozer was then deployed behind the inland end of the pipe to provide additional pushing force, and a Harbour Board tug was used to assist the offshore pull. The upshot of these difficulties was that the outfall section failed pressure leakage tests when tested once in place and buried beneath the sea bed. Diffuser ports, sealed to provide buoyancy during launch, were kept sealed while a solution was sought.

Line of landward effluent pipeline and marine outfall – Tauranga City photo

The solution was in fact a solution. Frank Lowe, a chemist in the consultant's laboratory, and a well known figure in the water industry, formulated a solution of two calcium salts, which when separately pumped into the line and held in the outfall pipeline under pressure, chemically mixed and seeped into any hairline cracks. Over a period of time, the leaks were sealed with calcite deposits, such as those formed in limestone caves. It did take many months to achieve an acceptable hydraulic test but the result proved to be a most cost-effective solution.

Much of the marine work, especially the burial of the outfall, was undertaken by Kelly Tarlton, the renowned marine "adventurer". Some years later, Kelly and Ian Mellsop developed the Underwater World aquarium in the disused sewage holding tanks in Tamaki Drive, Auckland.

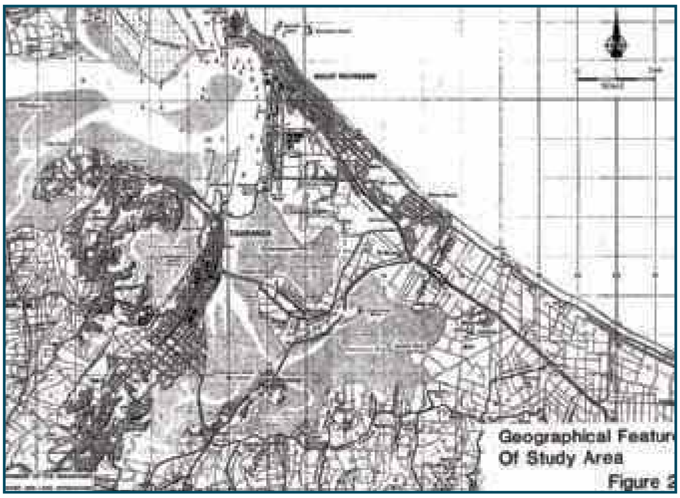
What might be termed an amusing incident occurred before the launch of the outfall. While the pipeline was still assembled onshore Graeme Leggat FIPENZ , the partner in the consultant's firm supervising the outfall construction, decided to do an internal inspection of the glued joints.

All stood around while Graeme, armed with torch and walkie-talkie and lying face up on a makeshift trolley, propelled himself by his feet, backwards through this 600mm diameter 950 metre long pipeline, sealed at the far end with the nosecone. Markers at metre intervals on a trailing cable attached to the trolley showed progress through the pipe. Once the inspection was satisfactorily completed, and at the dead end of the pipe, a momentary delay in movement of the trolley evinced the query, "Are you there?"; a further momentary delay raising the pitch of the enquiry, followed by, "Get me out!" These things should be left to junior engineers!

A junior engineer very much involved in all aspect of the Mt Maunganui sewerage scheme was Gordon Henderson MNZIES who designed the preliminary sewerage reticulation and the set-out and supervision of the original oxidation pond and the second pond with its associated wetlands, added in 1983.

This second 12ha pond increased the pond area to a total of 18ha, providing a capacity for the permanent 50,000 equivalent population and 20,000 summer visitors.

In 1988, in response to complaints from local Maori, Council investigated possible leakage from the ponds and contamination of titiko (amphibola crenata), which were gathered for food from the area. The results indicated very low leakage of approximately 20ml (one tablespoon) per second at five sites around the ponds. As titiko do not obtain their food from water, they do not concentrate wastewater bacteria unless gross pollution occurs, and the investigation concluded that it was unlikely that the leakage directly affected the quality of titiko or other edible shellfish.



Geographical features of Tauranga Mt Maunganui area – Crown copyright acknowledged

Joining the Twins

Local government reorganisation in 1989 saw Tauranga City and Mt Maunganui Borough combine to become Tauranga District Council.

In 1990, under the chairmanship of Mayor Keith (Nobby) Clark, the district engaged Beca Steven, a division of Beca Carter Hollings & Ferner created by the merger with Steven & Fitzmaurice, to undertake a study and review of wastewater planning for the combined area. The review recommended continued use of the district's treatment plants at Tauranga and Mt Maunganui and recommended cessation of effluent discharge to Tauranga Harbour.

The review recommended that the capacity of the Chapel St plant in Tauranga be capped and that the majority of the population growth in the District be served by expansion of the Mt Maunganui plant at Te Maunga.

A survey of the coastal receiving waters was undertaken as part of this review. The survey was a major multi-disciplinary exercise involving dye and float analysis, aerial photography and laboratory analysis. Dr Michael Larcombe of Bioresearches Ltd, DSIR for current meter deployment and analysis and Frank Sleath of Tauranga District Council staff piloted the aircraft for aerial photography. Wally Potts, Chapel Street Treatment Plant superintendent even did the shellfish diving.

Computerised analysis of effluent field dispersion was carried out by Dr Andrew ("Sandy") Elliot (son of renowned diabetes researcher, Prof. Bob Elliot) of the consultant's staff. The survey confirmed the suitability of a combined discharge of Tauranga and Mt Maunganui effluent streams through the existing Mt Maunganui outfall.

These studies involved considerable public and council consultation, and were facilitated in no small measure by the council engineering staff, particularly the director of technical services, Bruno Petrenas MIPENZ and wastewater services engineer Kel Carryer FIPENZ assisted by Murray Read.

As part of this general strategy change, Beca Steven was commissioned to report, in 1992, on process modifications desirable for the Chapel Street Plant. Changes included the introduction of fine screens and an improved grit removal facility, together with a biofilter for removal of odours, a flow balancing tank with intermediate pumping between the primary sedimentation tanks and the activated sludge plant, and dissolved air flotation to allow waste activated sludge to be separately thickened.

Ultra-violet disinfection units were added after the secondary clarifiers. The consultants persuaded Council to make a feature of these by housing the UV channels in a stand-alone building where the array of UV lamps and the blue coloured light which emanated from them could be readily viewed by visitors to the plant. This has proved to be of both general and educational interest.

Ultra-violet disinfection units – Tauranga City photo

A pipeline was constructed to take the effluent to new wetlands at Te Maunga. The lightweight fibreglass pipe was threaded through the concrete box girder sub-structure of the Tauranga Harbour Bridge.

"In 1990, under the chairmanship of Mayor Keith (Nobby) Clark, the district engaged Beca Steven, a division of Beca Carter Hollings & Ferner created by the merger with Steven & Fitzmaurice, to undertake a study and review of wastewater planning for the combined area. The review recommended continued use of the district's treatment plants at Tauranga and Mt Maunganui and recommended cessation of effluent discharge to Tauranga Harbour."

En-route to Te Maunga, disinfected final effluent was to be taken from this pipeline and used on parks and golf courses in the area. For this purpose a major tapping (150mm or 200mm) was made at the Omanu Golf Club course with a pipe laid across the railway line to Maunganui Road. It was laid along Maunganui Road to allow field irrigation at Links Avenue Reserve, Mount Intermediate, and Mount College.

It was only ever used by the golf course for a couple of years. Now it sits idle – its demise caused by the combination of an ongoing adequate supply of golf course borewater and the negative public perception of contact with treated sewage effluent.

Tauranga to Mt Maunganui pipeline route – ex Beca Steven report

On completion of the connecting sewer between Tauranga and Mt Maunganui, the original harbour discharge was eliminated. Also, as part of this general upgrade, new wetlands were constructed at Te Maunga. Ultimately the effluent is pumped, together with the Mt Maunganui flows, into the Pacific Ocean via the 950 metre outfall off Omanu Beach.

2001 aerial photo of Te Maunga showing original Mt Maunganui Borough oxidation ponds (constructed in 1970s) and wetlands built in the 1990s – Tauranga City photo

The cost of the works described was approximately $19M.

When the writer re-visited the treatment plant at Te Maunga in May 2001, he found a neatly laid out activated sludge plant with aeration tanks and circular clarifier.

"When the writer re-visited the treatment plant at Te Maunga in May 2001, he found a neatly laid out activated sludge plant with aeration tanks and circular clarifier."

Since then, both the Chapel Street and Te Maunga plants have been upgraded year-by-year in an ongoing programme to provide additional capacity to match the needs of the ever growing population of Tauranga.

Recent improvements in efficiency of the treatment systems are referenced below.

The combined sewerage scheme for Tauranga and Mt Maunganui serves a current census population of 111,000.

Acknowledgements

The author acknowledges the helpful comments of many of those involved in the works described, particularly staff of Tauranga City Council, and expresses thanks for the use of photographs supplied.

About the Author

John Fitzmaurice is a Consulting Engineer in Environmental Engineering. Over the past 40 years he played a major role in the design of many of the main sewerage schemes in New Zealand. John has been a Deputy Commissioner of the Environment Court of New Zealand and is currently a member of the Audit Group for Project Manukau. He was personally involved in much of the work described in this article. ■

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Prevention or Cure – Designing Sewers to Achieve Low I/I

Steve Carne, Graeme Salmon and Christian Gamst – GHD Limited

> "Analysis of a significant number of projects has shown there is now a robust knowledge base to make far more reliable and informed predictive estimates of I/I reduction levels that will be achieved from varying levels of system rehabilitation."

Inflow and Infiltration in Sewers

Inflow and infiltration (I/I) is the unauthorised ingress of rainfall runoff and groundwater into a separate wastewater collection system.

As shown in Figure 1, I/I comes in two forms – rainfall dependent inflow and infiltration (RDII) and ground water infiltration (GWI).

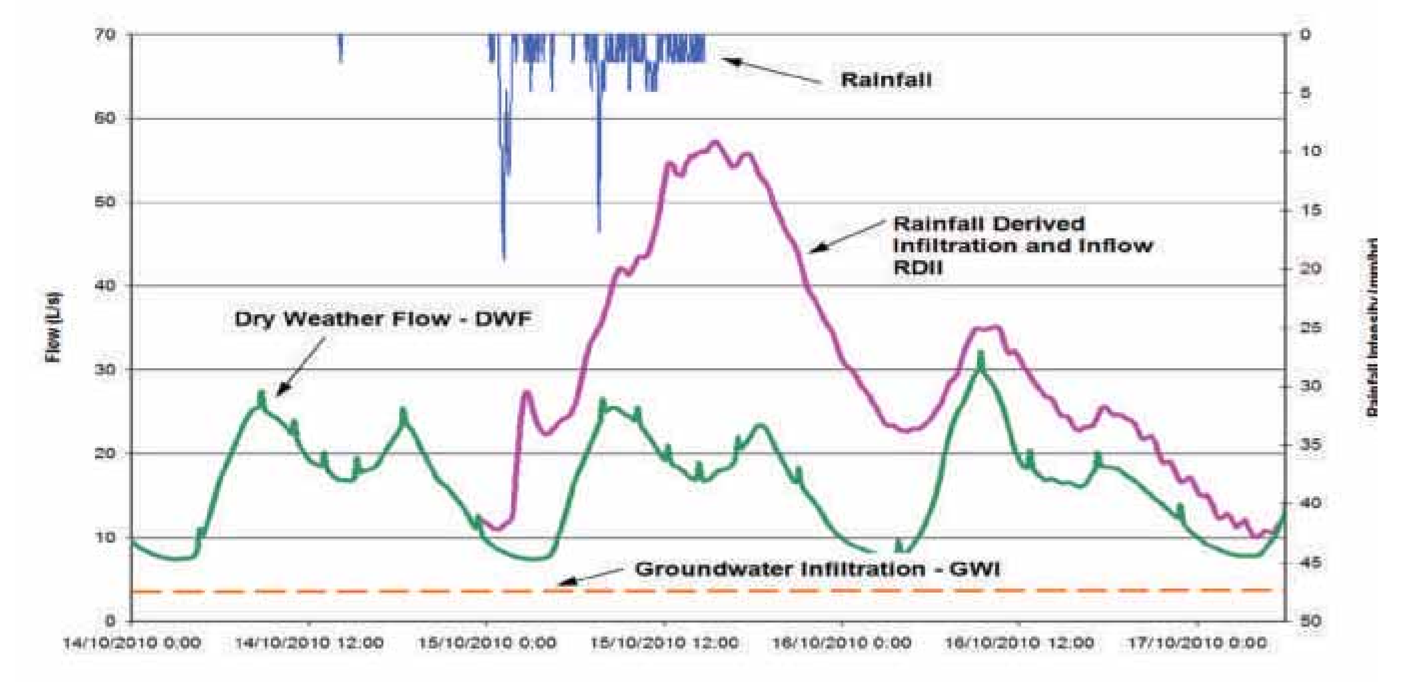

Figure 1 – Sample I/I Flow Components (WSAA Wastewater System Inflow/Infiltration Management Good Practice Guideline Document)

Rainfall dependent inflow and infiltration is due to runoff during and after a rainfall event entering the system through illegally or erroneously connected impermeable areas and through defects such as cracks in both sewers and in house laterals. Groundwater infiltration is generally considered constant but can change seasonally in response to water table movement or tidal changes in coastal areas.

I/I can cause stress on the sewerage system in a number of ways that can result in problems such as:

- Overflows during rainfall events when the capacity of the collection system is exceeded
- Adverse effects on treatment plant processes and exceeding discharge consents

Cure – Developments in I/I Reduction Technologies

For more than 20 years, I/I reduction programmes through system rehabilitation works have been a part of wastewater planners' and managers' toolbox for reducing wastewater overflows. Until recently though, implementation of the technology has been plagued by uncertainties in outcomes from investments in rehabilitation programmes.

In response to the evolving market need of its member organisations, The Water Services Association of Australia (WSAA), engaged GHD (in association with local consulting partner Urban Water Solutions (UWS)) to develop a Good Practice Guideline Document on I/I Management. Carried out in two stages of work, the project outputs define both theory and practice of good I/I management.

Analysis of a significant number of projects has shown there is now a robust knowledge base to make far more reliable and informed predictive estimates of I/I reduction levels that will be achieved from varying levels of system rehabilitation. The work gives wastewater planners and managers a far more robust basis to undertake I/I reduction programmes through system rehabilitation with the expectation of certain outcomes for a given financial investment. This is considered to be a significant global advancement in the planning of wastewater system improvement and management programmes.

The work defined a number of parameters in establishing best practice:

- Establishment of a common understanding of current I/I performance and management processes across the participating WSAA member organisations.
- Benchmarking of practices between those used in Australia, New Zealand, the USA and other jurisdictions.
- Definition and adoption of a consistent set of I/I key performance indicators and provision of a set of standardised calculation routines for these.

- Threshold values for these parameters, below which it is not considered cost effective to undertake system rehabilitation to achieve I/I reduction. Other overflow mitigation techniques based around enhanced conveyance or detention storage are considered more suitable in such cases.
- Definition of a five-step process, which if followed rigorously, will most likely result in reduction outcomes consistent with the most successful programmes completed in these jurisdictions.
- Information on processes associated with saline groundwater or seawater infiltration reduction.
- That approximately half the removable I/I getting into a system comes through the private laterals – and that not addressing private lateral I/I will severely limit I/I reduction outcomes.
- Guidance on how to reduce I/I from private laterals, including the vexatious issue of who pays.
- Guidelines on likely I/I reduction levels that can be achieved when various levels of rehabilitation are undertaken. These guidelines are based on the results of analysed projects across New Zealand, Australia and the United States. The guidelines suggest that up to 85% of I/I is removable when the entire system is rehabilitated up to the gully trap at the house, but only 50% is removable if only the public system is rehabilitated.
- An overview of appropriate I/I source detection and system rehabilitation techniques currently available in the market and guidelines on unit cost estimating rates for these.
- An overview of new technologies and specifications now available in Australia for the design and construction of new gravity wastewater collection systems that are aimed to prevent I/I occurring in the future over the life of the asset.

Prevention – Designing New Low I/I Sewers

Extending on the discussion of this last chapter of the WSAA Guideline Document for designing gravity sewers for low I/I, advances in modern sewer technologies, replacement of networks with new wastewater systems can effectively exclude or significantly reduce I/I.

Advances in standards, systems, and technologies have seen alternative wastewater collection system technologies advance significantly in reliability, acceptance and reductions in cost (both capital and operational and maintenance).

"Building on an established track record overseas, pressure sewer systems are now being installed or being considered in many locations across New Zealand."

Modern Gravity Sewer

Modern gravity sewers are an evolution of standards and specifications, which emphasises the use of modern materials (such as PVC or PE). Alternate low infiltration specifications have been developed such as Low Infiltration and Leak Tight (used by Sydney Water) and NuSewer (used by Queensland Urban Utilities) systems with the specific aims to:

- To provide a sealed system capable of avoiding root intrusion and stormwater infiltration
- To eliminate or minimise the need for personnel entry into confined space maintenance holes

For all technologies, utilising modern pipe materials and methodologies for construction, operation and maintenance in the design of a sewer system, we are able to reduce the opportunities for stormwater/groundwater to enter the pipe network. Plastic pipes (PE/PVC) allow fully sealed connections and are flexible to resist cracking.

Modern maintenance techniques have eliminated much of the need for concrete manholes, limiting the requirement for confined space entries. Fewer manholes are required, and those that are can be installed in low I/I materials such as small diameter maintenance shafts. Eliminating concrete manholes, provides benefits of reduced capital cost, future maintenance requirements, and increased public safety with no manhole lids to be displaced.

The Low Infiltration and Leak Tight Sewer Specifications published by Sydney Water, recommend designing systems using hydraulic modelling assuming totals of two per cent and one per cent rainfall total ingress respectively. This is significantly less than normally accepted empirical design formulas which recommend peak wet weather flows be based on 5 times average dry weather flow.

Sydney Water are currently assessing the I/I performance of installed Leak Tight and Low I/I specified systems. Results are encouraging and are validating the specification of low I/I design parameters.

Pressure Sewer

Building on an established track record overseas, pressure sewer systems are now being installed or being considered in many locations across New Zealand. In addition to its attributes of being well-suited to areas of high water table, flat or low lying ground or steep and rocky ground, pressure sewer is also inherently effective at the exclusion of I/I. Significant experience and capability is now available in the New Zealand water industry for the investigation, design, construction and delivery of pressure sewer projects. Having solid knowledge of the level of 'on property I/I' that can be expected when servicing existing residential catchments, is key when pressure sewer systems are retrofitted to existing towns or villages.

> "Vacuum systems are now also being installed in some locations in New Zealand."

In the design of Low Pressure systems, it is common practice for wet weather peaking factors to be minimal in the design of greenfields systems. Peaking factors of 1.2 on normal dry weather flows are usually applied for retrofitted systems to conservatively cater for possible I/I sources, upstream of the gully traps. This is also significantly less than normally accepted empirical design formulas.

Work carried out by South East Water in Melbourne indicates that low pressure sewer systems installed there over 10 years ago are displaying very low I/I characteristics that have been consistent over their period of operation.

Vacuum Sewer

Vacuum systems are now also being installed in some locations in New Zealand. The Kawakawa Bay scheme in Auckland is one such scheme. Vacuum systems offer the assets owner a number of advantages. In particular, the ability to place assets in the public road reserve and not on private property, and orders of scale, with a single vacuum pump station being able to serve larger numbers of properties, within the constraints of a vacuum system i.e. topography and maximum lift.

In the design of Vacuum Systems, wet weather peaking factors of 1.2 of normal dry weather flows have been allowed for. This is also significantly less than normally accepted empirical design formulas for gravity sewers.

Conclusions

The cost of wastewater I/I to the environment, to public health and to the operation of networks is significant.

With the recent rapid developments in I/I reduction technologies, either in a corrective or 'cure' sense through the implementation of measures contained in the WSAA Guideline document for existing systems or in a preventive sense, or through the design of low I/I sewers using either modern gravity, low pressure or vacuum systems for new sewers wastewater systems, asset owners and managers now have a wider range of means to far better manage I/I. ■

Environment Commissioner Criticises Government's Proposals to Protect Water Quality

In February, Environment Commissioner Dr Jan Wright released a statement saying current proposals for freshwater management are not adequate for protecting water quality to even current levels in New Zealand.

Dr Wright's statement accompanied her submission on the Government's proposed National Objectives Framework (NOF) and amendments to the National Policy Statement (NPS) for Freshwater Management (2011).

Without changes, Dr Wright said that there is little in the NOF that would prevent the 2020 scenario in her recent report becoming reality.

"The big challenge is the nitrate runoff from the large scale conversion of land to dairy farming," Dr Wright said.

"Leaving this pressure unaddressed will result in a worsening of water quality in the short to medium term and make the job of improving it much harder and more expensive in the long term. The NPS should require regional councils to adopt interim measures to deal with this pressure."

"My submission is far from radical."

"Virtually everything I am recommending is consistent with the reports from the Land and Water Forum."

"The intent of the NPS is to maintain or improve the quality of freshwater. But, as proposed, any level of water quality is acceptable provided it is above the national bottom line. This could create pressure on councils to unwind some of the hard-won gains and community agreements that have been made over recent years to improve water quality."

"Leaving this pressure unaddressed will result in a worsening of water quality in the short to medium term and make the job of improving it much harder and more expensive in the long term. The NPS should require regional councils to adopt interim measures to deal with this pressure."

"Many New Zealanders are working hard to protect our rivers and lakes. We need a policy framework that clearly supports and encourages these efforts," said Dr Wright.

Dr Wright's submission is available at the All Publications, Submissions and Advice section at pce.govt.nz

Are Rising Nitrate Levels in Rural Groundwater a Public Health Concern?

Dr Jim Cooke – Director/Water Quality Specialist, Streamlined Environmental Ltd

Around 40 years ago as a new science graduate, I can remember reading papers citing the dangers of high nitrate concentrations in drinking water to young infants. I was impressed by the name (methaemoglobinaemia) of the condition that those unfortunate infants would be afflicted with, should they consume drinking water containing more than 50mg/L nitrate (11.3mg/L nitrate-N) – the World health Organisation (WHO) Guideline Value (GV) at the time.

Four decades on, what's changed? Nothing apparently, except that scientists continue to cite rising nitrate levels in groundwater as a health concern in the introduction to their papers, warnings continue to be issued about the dire consequences to our nation's future generations, and the WHO GV for safe nitrate levels in drinking water is still 50mg/L.

A recent opinion piece in the Christchurch *Press* by the Medical Officer of Health, described rising nitrate levels in groundwaters as a "ticking time bomb" that could lead to infant deaths if not more strictly controlled. This led me to think about the evidence that might support this statement. As a water quality scientist I'm acutely aware of the data demonstrating increasing trends in nitrate concentrations in groundwater[1,2], but I've not been aware of any reports of health effects on infants.

This struck me as interesting. If nitrate concentrations in groundwater are rising around the country, with at least some supplies over the WHO GV, one might expect at least a few cases reported. My initial investigations with the Ministry of Health provided at least some of answers. Methaemoglobinaemia is not a notifiable condition so it is possible some cases seen only by a GP are not referred. However statistics are kept on cases involving hospitalisation. Between 2000 and 2011 there were 22 cases of methaemoglobinaemia causing hospitalisation[3]. However, only two of these cases were infants (under one year old). There was no record as to whether drinking water was the cause of the infant hospitalisations.

Similarly there do not appear to be cases of infant methaemoglobinaemia reported in New Zealand Medical literature, though there are cases reported of methaemoglobinaemia in adults due to ingestion of nitrite from preserved meats[4]. It also features in New Zealand veterinary[5] and food science[6] literature for the same reason, i.e. excessive nitrite ingestion.

This leads to an important point. Nitrate, per se, does not cause methaemoglobinaemia – it does not have the ability to transform haemoglobin into methaemoglobin, a dysfunctional form of haemoglobin incapable of transporting oxygen. Nitrite, on the other hand can, and the reaction can be rapid, leading to severe oxygen depletion in tissues.

Nitrate must therefore be reduced to nitrite before methaemoglobinaemia can occur. Oxidation of haemoglobin to methaemoglobin occurs continuously in red blood cells, however powerful cellular processes involving the enzyme methaemoglobin-reductase converts the methaemoglobin back to haemoglobin[7], thereby ensuring that cells and tissues are provided with oxygen. Infants are more susceptible to methaemoglobinaemia because methaemoglobin-reductase levels are much lower than in adults and only attain adult levels at about six months.

The lack of evidence on significant incidences of infant methaemoglobinaemia in New Zealand led me to review current international literature to see what the situation was in other countries. Had advances in science led to improved understanding on its causes? Were the health effects of high nitrate (>WHO GV) concentrations in drinking water generally better understood?

There is, I found, a robust discussion in the literature on this topic arising from observations that, despite 2%–3% of the population drinking water with nitrate concentrations > WHO guideline in the US and the EU, the incidence of infant methaemoglobinaemia is extremely rare. This led researchers to examine the research that led to the original WHO guideline value. The first link between nitrate and the occurrence of methaemoglobinaemia was made by Comly[8], who described recurring episodes of cyanosis (blue discolouration of the skin due to lack of oxygen – hence the common name of blue baby syndrome) in two infants following ingestion of well water containing large amounts of nitrates.

"A recent opinion piece in the Christchurch *Press* by the Medical Officer of Health, described rising nitrate levels in groundwaters as a "ticking time bomb" that could lead to infant deaths if not more strictly controlled. This led me to think about the evidence that might support this statement. As a water quality scientist I'm acutely aware of the data demonstrating increasing trends in nitrate concentrations in groundwater[1,2], but I've not been aware of any reports of health effects on infants."

A large number of similar papers followed, culminating in a review by Walton[9] on behalf of the American Public Health Association, in which he reported on > 270 cases of infant methaemoglobinaemia in the United States. Walton noted that no cases were observed when drinking-water concentrations were < 10mg/L NO_3–N. To cut a long story short, this analysis became the basis for the WHO GV. As noted by Fewtrell[10], while both Comly and Walton commented on factors other than nitrate that may affect the development of infant methaemoglobinaemia, over time a simple role for nitrate became accepted.

A father and son team[7] from the University Hospital of Caen carried out a comprehensive review on the role of nitrate in the human body and, in particular the role of exogenous sources (food and water) versus endogenous (produced in the body) sources of nitrate and nitrite.

They also reviewed the original research carried out by Comly and others in the 1940s and 1950s and noted that the occurrence of infant methaemoglobinaemia also coincided with unsanitary conditions. For example, Comly[8] noted that the drinking water causing the condition "came from very undesirable wells. In many cases the wells were old, dug rather than drilled, had inadequate casings or none at all, and were poorly covered, so that surface water, animal excreta and other objectionable material could enter freely. In every one of the instances in which cyanosis developed in infants the wells were situated near barnyards and pit privies."

The L'hirondel's[7] showed that bacterial mediation was the likely cause of infant methaemoglobinaemia by demonstrating that bacterial conversion of nitrate to nitrite in carrot soup (used for treatment of diarrhoea and high in nitrate) caused cyanosis in infants when it had been left at room temperature for prolonged periods, but when freshly prepared, it caused no problems. From their extensive review of nitrate in human metabolism (beyond the scope of this article)[7] they concluded that conversion of nitrate (from drinking water) to nitrite in the gastrointestinal tract of infants was not plausible.

They suggested that any nitrite-induced methaemoglobinaemia arose from bacterial contamination of the drinking water and conversion to nitrite before being ingested. However, Avery[11] noted that methaemoglobinaemia can be a complication of diarrhoea in young infants due excessive endogenous formation of nitric oxide (NO) as a result of the condition. Avery proposed that many previous cases attributed to high nitrates in waters may have been due to the enteritis that the infants suffered from.

The two alternate and inter-related hypotheses (nitrate conversion to nitrite in polluted waters before ingestion, and endogenous production of nitric oxide as a by-product of diarrhoea caused by infection of which one cause could be consumption of polluted food or water) seems plausible. It would explain why cases of infant methaemoglobinaemia almost completely disappeared from the US and EU after the 1960s even though wells high in nitrate are still in use[11],whilst it is far more prevalent in Eastern Europe, India, and developing countries[12–15].

The hypothesis that bacterial contamination rather than nitrate is responsible is now widely accepted, even amongst researchers who are against raising the WHO GV because of other health-related issues (see below). For example, van Grinsven et al[16] commented, "There is consensus that the role of nitrate exposure in causing methaemoglobinaemia is minor and not a sound justification for the present nitrate standard for drinking water of 50mg/L."

Links with Cancers

Van Grinsven researches possible links between high nitrate in drinking water and various cancers. Much of the research in this field has been on gastric cancer. The hypothesis behind Van Grinsven's work and others researching the same field[17,18] is that N-nitroso compounds will be formed following ingestion of high nitrate waters (and certain foods). There is a likely strong carcinogenic effect of N-nitroso compounds (NOC) in humans based on animal evidence of carcinogenicity.

The metabolism and biochemistry surrounding nitrate in the human body, and particularly the possible relationship with various cancers, are complex and beyond the scope of this article (and the competence of this reviewer!). However, important issues identified and debated by proponents and opponents of the theory include:

i) The predominant source of nitrate (a large majority of an individuals' nitrate intake is from vegetables rather than water)
ii) The short half-life of nitrate in the human body
iii) The identification of N-nitroso compounds associated with cancer (some are harmless)

These issues and others are canvassed by van Grinsven et al[19], who naturally adopt the precautionary principle and argue that the WHO GV for drinking water should not be relaxed until sufficiently robust epidemiological studies have taken place, with controls for dietary intake of vegetable and other cofactors. Counter arguments have also been put forward[20].

> "The WHO Drinking Water Guidelines are, as they suggest, guidelines for the whole world. Thus even though infant methaemoglobinaemia due to drinking water has virtually disappeared from developed countries, it is still an issue in developing countries. Until the issue of whether infant methaemoglobinaemia is caused by microbial pollution in association with, or independently of, high nitrate water, it would be irresponsible of WHO to completely relax the nitrate GV."

Whilst this author is not qualified to comment on the medical merit of van Grinsven et al's[19] argument, with respect to the WHO GV their argument does appear to be circular. On the one hand they state there is no basis for the GV for infant methaemoglobinaemia (supposedly based on a dose-response relationship), but on the other hand they want to retain that same drinking water GV to safeguard against cancer risks for which there is no proven relationship.

However in the latest edition of the WHO Drinking Water Guidelines[21], Chapter 12 draws a conclusion on this subject stating, "A significant number of epidemiological studies have been carried out on the association of nitrate intake with primarily gastric cancers. Although the epidemiological data are considered to be inadequate to allow definitive conclusions to be drawn regarding all cancers, there is no convincing evidence of a causal association with any cancer site. The weight of evidence indicates that there is unlikely to be a causal association between gastric cancer and nitrate in drinking-water."

The WHO21 draws similar conclusions with respect to other reported links between nitrate in drinking water and other conditions, including congenital malfunctions, thyroid conditions and Type I diabetes, i.e. the weight of evidence is that there is no causal link.

Where to with the WHO Guideline Value? – Links with NZ Drinking Water MAV

Despite the general agreement amongst researchers that nitrate in drinking water, per se, has only a minor role in causing infant methaemoglobinaemia, the latest edition of the WHO Drinking Water Guidelines[21] retains the 50mg/L nitrate (11.3mg/L NO_3-N) GV. However, they do recognise the research reviewed above stating, "..and that if water is microbiologically safe it can be used for bottle-fed infants if the concentration is between 50 and 100mg/l (but not above 100mg/L)," (equivalent to 22.6 mg/L nitrate-N). Thus the WHO has effectively doubled the nitrate GV provided the water is microbiologically safe. This was also the case in the 2007 guidelines.

The WHO Drinking Water Guidelines are, as they suggest, guidelines for the whole world. Thus even though infant methaemoglobinaemia due to drinking water has virtually disappeared from developed countries, it is still an issue in developing countries. Until the issue of whether infant methaemoglobinaemia is caused by microbial pollution in association with, or independently of, high nitrate water, it would be irresponsible of WHO to completely relax the nitrate GV. However it is up to each individual jurisdiction to interpret the guidelines in terms of conditions in their own countries. For third world countries, supporting high populations in situations where hygienic drinking water is a luxury, it is entirely appropriate that the WHO Guidelines for nitrate are interpreted as a standard (even if rarely achievable).

However, in first-world countries such as New Zealand it is less clear cut as the source of nitrate is often spatially and temporally removed from drinking water intakes. In addition, municipal supplies are regulated to be free of microbial contamination, so only private bores are potentially at risk.

Our drinking water guidelines[22] adopt the WHO nitrate GV as the maximum acceptable value (MAV). However it is important to note that whereas most chemical MAVs reflect consumption of water with that maximum concentration for a life-time (70 years), the MAV for nitrate is only short-term (designed to protect bottle-fed infants). In other words, except for this vulnerable subgroup, there is no MAV at all. However, because of the difficulties of being 100% confident that infants will have access to an alternative supply, water suppliers (and MoH) accept that the short-term MAV is, in reality, still a long-term MAV.

Conclusions and Policy Implications

While there is still no consensus in the literature as to whether nitrate drinking water standards (or MAVs) that rely on the WHO GV could be relaxed, there does seem to be general agreement that infant methaemoglobinaemia (the raison d'être for the WHO GV) is not caused by nitrate alone. The evidence for its association with microbial pollution and/or some other gastrointestinal disorder causing diarrhoea is strong. While there are reports of increasing trends of nitrate levels in New Zealand groundwater, there is no evidence of increasing trends in microbial contamination. This may be because there is insufficient data to establish a trend, but it does appear that the incidence of microbial pollution in groundwater wells is low. For example, the latest report on nitrate concentrations in Canterbury groundwater[1] showed that 7% of wells sampled (305) had nitrate concentrations greater than the WHO GV, with about 60% in total having nitrate concentrations greater than 'background'.

In contrast, only 10% of wells had *E. coli* (faecal indicator bacteria) even detected (detection limit 1 *E. coli*/100mL), although the percentage detected was higher in shallow wells (18% in wells <20m deep). *E. coli* were detected in only one well > 50m deep. There did not appear to be any correlation (from visual comparison of graphs) between wells with nitrate concentrations > WHO GV and *E. coli* detects. Thus, in this example, the risk of infants developing methaemoglobinaemia from drinking water would appear to be low; although higher in wells <20m depth.

In contrast, the risk of contracting some other disease from microbial pollution generally appears much higher. For example, a quantitative risk assessment of contracting a campylobacter infection from shallow wells in an area of the Waikakahi catchment (Canterbury) under border-strip irrigation[23], estimated that the probability of infection on any given day was 0.50% to 0.76%, giving an estimated probability of infection during the irrigation season of 60% to 75%.

There may be some merit in attempting a similar quantitative risk assessment for infant methaemoglobinaemia, the results of which could feed into an analysis of policy alternatives (similar to a Section 32 analysis under RMA).

From my review of contemporary international literature I conclude that the health risks of drinking water high in nitrate are often overstated. In my view the issue of elevated nitrate concentrations in groundwater are more related to the ecological effects in surface waters upon recharge.

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Pressure Sewers Rebuilding Christchurch

Ecoflow

Pressure sewer systems have long been used around the world for their ability to cost-effectively service many types of ground conditions including hilly, rocky, flat, unstable and wet ground. The rebuild of the Christchurch wastewater infrastructure following the earthquakes has been perfectly suited to leverage the benefits of pressure systems for an expedient and cost-effective solution.

Since 2007, over 7,000 Environment One (E/One) Extreme grinder pumps, supplied in New Zealand by Ecoflow Ltd, have been installed in 15 council networks. The largest concentration of units can be found in the Bay of Plenty and Auckland Regions. The systems have been introduced as a means to reticulate existing development that previously relied on failing on-site treatment systems or in new development areas where traditional deep gravity systems were cost prohibitive. Pressure systems are also often used in place of gravity systems due to the sealed nature of the systems, which practically eliminates infiltration and subsequent loading on downstream infrastructure.

After the September 2010 earthquake, Christchurch City Council (CCC) identified the pressure sewer system as an effective method of providing temporary wastewater service to areas damaged by liquefaction and lateral spreading. After the February 2011 earthquake, it was clear that in some areas, pressure sewer systems would be ideal as a resilient permanent solution.

Pressure systems use specially designed pumps at each property or connection. The pumps feature a macerating unit that reduces any solids into slurry. The pumps are then able to transport the wastewater slurry through a small diameter polyethylene pipe

"The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) is designing, managing and delivering the infrastructure rebuild. E/One pressure sewers were identified as a key technology to provide cost-effective, permanent wastewater service to a number of catchments with significant damage to the gravity network or significant risk of damage from future seismic events."

Left – Installation of tank in progress, Below left – Final inspection of E/One system

to an existing gravity system or wastewater treatment plant. The E/One grinder pump is capable of generating 56m of head allowing it to pump several kilometres or up and over hills. Reticulation pipe sizes range from DN 40 to DN 225 depending on the number of pumps connected and the distances required.

The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) is designing, managing and delivering the infrastructure rebuild. E/One pressure sewers were identified as a key technology to provide cost-effective, permanent wastewater service to a number of catchments with significant damage to the gravity network or significant risk of damage from future seismic events.

The resilience of a pressure sewer system is most apparent in the high strength, flexible reticulation network. Similar in construction to a water main, the network follows the ground movement without breaking, collapsing or separating. All transport of the wastewater is done under pressure so there is no grade requirement for the reticulation and no risk of ground movements affecting the performance as compared to a gravity or vacuum collection system. Additionally, since the network is buried shallow (between 1–1.5m deep), the system is easy to repair if necessary and additional connections can be made with minimum cost and time.

To-date there are over 900 commissioned pressure sewer units within the rebuild of Christchurch and several thousand units are due to be installed by 2016. In addition to the rebuild, CCC is using pressure sewers in septic tank replacement programmes at Charteris Bay and Wainui in Banks Peninsula.

Pressure sewers can also be found in new residential and commercial development projects in the Christchurch and Waimakariri districts to sewer difficult ground conditions and accelerate the pace of construction. Economical systems range from single units to thousands in a single catchment.

The simple nature of pressure sewer systems makes the ongoing operation and maintenance easily manageable. Since the equipment is specifically designed for the application, it is incredibly reliable and does not require any preventative maintenance. In the event of a pump issue or homeowner misuse, most problems can be quickly resolved with onsite troubleshooting, and replacing the pump takes no longer than 20 minutes. Due to the 24 hour storage capacity in the pump chamber, emergency response is not required. The straightforward nature of the technology is paramount and operators have no trouble understanding how the system works. There are no complicated control systems or single critical assets to maintain.

Pressure sewers are far from being a new technology and have an excellent track record in New Zealand. The E/One product is utilised in 38 countries with over 500,000 units in operation and continues to lead the market that it invented 45 years ago. The resilience, ease of construction, operation, and maintenance make pressure sewer systems an excellent fit for Christchurch today and into the future.

Crushed Glass Sand – Making an Eco-friendly Wastewater Treatment System Even Greener

The eco-friendly wastewater treatment system – Advanced Enviro-Septic® (AES) – just became even greener following the announcement that recycled glass crushed within specifications can be used as the 'system sand' surrounding the AES pipes.

Dick Lamb, of Environment Technology, the sole distributors of AES in New Zealand said, "This is great news for the environmental impact of the AES system and also means drain-layers and installers have another option when looking for a suitable aggregate."

AES is new to New Zealand and purifies wastewater using a natural bacterial process within specially designed, aerated pipes installed in a sand bed, treating effluent to advanced secondary quality before passively dispersing it into the soil.

The AES on-site treatment system has several environmental advantages. It produces very high quality effluent, 10 times better than that required by the NZ Standards. This minimises the risk of groundwater contamination. The treatment process requires no external energy input, there are no complicated controllers, pumps, compressors to fail, no alarms going off and no regular servicing required. AES system components are made with significant quantities of recycled plastic. This gives it one of the lowest carbon footprints in the wastewater treatment industry. And for an environment with peace of mind no home owner interaction or intervention is required

Across the ditch the Australian distributors are jealous said Mr Lamb.

Randall Crisp of Chankar Environmental, the AES distributors in Australia, said, "We would love to be able to use crushed glass if it was available as sand at around 70 dollars per cubic metre is prohibitively expensive due to the Environmental Protection Agency shutting down many sand pits."

"The AES system is considerably more cost-effective to purchase and maintain than current conventional electro mechanical systems," said Mr Lamb.

"The lightweight Advanced Enviro-Septic® components are very easy to handle and transport, requiring only a locally-supplied standard septic tank and sand or recycled crushed glass materials. The durable components last indefinitely and come with a 20 year guarantee against manufacturing defects."

AES system pipes are flexible to allow adaption to any site shape – straight or curved, and can incorporate multi-level configurations. The wastewater treatment system performs with high capacity in areas of limited space and facilitates quick start-up after periods of non-use. AES pipes provide a large surface area for aerobic bacterial activity within the pipes, which allows for protection of the outer pipe layers and receiving surfaces so they remain permeable.

An average three bedroom household produces around 1,000 litres of wastewater per day. AES systems are easily adapted to small or larger wastewater flows and have been used in designs from 400 litres per day and, to date, up to 198,000 litres per day in a municipal application in Blodgett Landing, Newbury, New Hampshire, US.

The existing sand filtration beds were upgraded to AES beds in 2011. In August 2013 when the plant was required to renew its discharge consent license, the required testing interval was increased as the testing regime for the previous two years had produced consistent and high quality results.

There are in excess of 150,000 installations in the US State of New Hampshire, 95% of on-site treatment systems are AES systems and 25% of all houses in New Hampshire use AES.

The first AES systems have been installed in the Tasman district and interest has been received nationwide from councils and homeowners alike, said Mr Lamb.

"In order to help new designers and installers familiarise themselves with the basic procedures, an AES certification course has been developed," said Mr Lamb.

"Drain-layers will need to complete this course if they wish to install Advanced Enviro-Septic® systems and Designers are encouraged to use the course to familiarise themselves with the relatively simple design parameters."

"Drain-layers and Plumbers earn Continuing Professional Development Points for their satisfactory completion," said Mr Lamb.

Anyone interested is invited to view the training video and complete the questions. Further information is available at environmenttechnology.co.nz/aes-certification-process

AES is adaptable to virtually any residential or commercial application and can be retro-fitted to existing septic tanks as an upgrade or if the existing disposal field has failed. ■

Top left – The first installation in Golden Bay, middle – An example of crushed glass, top right – Demonstrating the lightweight nature and flexibility of the AES pipes, below – Dick Lamb and Hazel Pearson, Directors of Environment Technology

Left – Technical Innovation of the Year Award, Blue Plains Tunnel, Washington D.C., U.S.A; right – Environmental Initiative, National Grid, London

International Accolades for CH2M HILL

CH2M HILL began 2014 on a high note after receiving three awards at the prestigious NCE International Tunnelling and Underground Space Association awards in London in December, in recognition of the company's project successes and its contribution to tunnelling design internationally.

The NCE International Tunnelling Awards event, organised by New Civil Engineer, Ground Engineering and the International Tunnelling & Underground Space Association (ITA-AITES), celebrates the most innovative and successful projects, companies and individuals from across the global tunnelling industry.

With Tunnels and Earth Engineering practice centres of excellence across the United Kingdom, the United States, Canada, Australia, China, Argentina and the United Arab Emirates, CH2M HILL was named Global Tunnelling Design Firm of the Year at the event.

The firm's work was also recognised in the Technical Innovation category for The District of Columbia Water and Sewer Authority's Blue Plains Tunnel project. CH2M HILL is the lead designer for this design-build project, working for the Traylor, Skanska, Jay Dee Joint Venture.

> "The firm's work was also recognised in the Technical Innovation category for The District of Columbia Water and Sewer Authority's Blue Plains Tunnel project."

The project includes a 7,300m long, 7m internal diameter combined sewer overflow (CSO) tunnel constructed in soft ground under and adjacent to the Potomac and Anacostia Rivers.

The work involves the construction of five shafts up to 40m in diameter and 60m deep. For this project, the judges recognised the world-class size and depth, exacting vertical tolerances (0.12% or 1m/800m) and efficient radial and circumferential base slab reinforcement.

The National Grid Cable Tunnels project, for which CH2M HILL has been involved as the lead designer, was also honoured, taking out the Environmental Initiative of the Year award.

This project involves over 30kms of 3m and 4m diameter tunnels connecting 14 shafts ranging from 6m to 15m in diameter at sites across the whole of London to ensure power to the city for the future.

The project has included environmental initiatives across various disciplines, such as waste minimisation through tunnel design optimisation, a choice of less environmentally disruptive materials and incorporation of green roofs. While these measures will collectively improve resource utilisation, the carbon calculator developed by CH2M Hill played a critical part in providing evidence to the client to consider alternate methods for tunnel ventilation, with the potential to make significant carbon savings from future operations.

Key to communicating all this good work in a cohesive and convincing fashion was the project's Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL) application (jointly with National Grid and Costain), which recently received an "excellent" rating at the end of the Interim Verification Stage (awaiting ratification).

Martin Knights, CH2M HILL's global leader of tunnelling and earth engineering said the awards were a testament to the company's 500-member practice.

"It is an honour to see our industry peers recognise the firm's expertise in concept design and planning solutions, detailed tunnel and underground space design, and overall project implementation oversight," Mr Knights said. ■

Water New Zealand Conferences & Events

Water New Zealand Stormwater Conference 2014

14 – 16 May 2014
Rydges Latimer Square, Christchurch, New Zealand
For more information visit www.waternz.org.nz or contact Amy Aldrich at amy.aldrich@waternz.org.nz

Water New Zealand Annual Conference & Expo 2014 – *Implementing Reform*

17 – 19 September 2014
Claudelands Events Centre, Hamilton, New Zealand
For more information visit www.waternz.org.nz or contact Hannah Smith at hannah.smith@waternz.org.nz

Trade and Industrial Waste Forum

9 – 11April 2014
Hamilton, New Zealand
For more information visit http://confer.co.nz/tiwf2014/

Other Conferences

Australian Water Association Conference – *Ozwater 2014*

29 April – 1 May 2014
Brisbane, Australia
For more information visit www.awa.asn.au

IBAK Sets Up Shop in Sydney

German company IBAK Robotics recently announced changes in its Australasian market, as it established an Australian company and office an in Sydney.

IBAK Australia Pty Ltd Managing Director Dr Werner Hunger said, "In the future we will be represented directly with our own sales and service department. We are very confident that we can offer a high quality facility where IBAK equipment can be serviced. IBAK is proud to be present on the other side of the globe with our own company."

> "Mr Hunger said IBAK has very high service standards, which the company intends to transfer to its new team in Australia."

Mr Hunger said IBAK has very high service standards, which the company intends to transfer to its new team in Australia. One of the company's experienced technicians, Dirk Dannehl, will be the main contact for all service related topics in Australia and New Zealand.

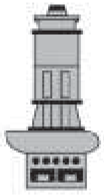
IBAK sales will now be managed by General Manager Sales, Darren Michalski, who has great knowledge and understanding of the IBAK product range.

Mr Hunger said IBAK decided to establish the Australian branch to best meet customers' needs. In cities throughout Australia and New Zealand, IBAK will continue to work with established service partners.

IBAK thanked its former distributor Austeck for its contribution and wished them success in future endeavours.

Further details, including the address of the new facility in Silverwater, Sydney will be announced as soon as the fit-out is completed. ■

For further information please contact – sales: Darren Michalski – dm@ibakaus.com.au, ph: +61 280 016 632, or service: Dirk Dannehl – d.dannehl@ibak.de, or organisational questions: Janina Galinski – jg.galinski@ibak.de



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