water

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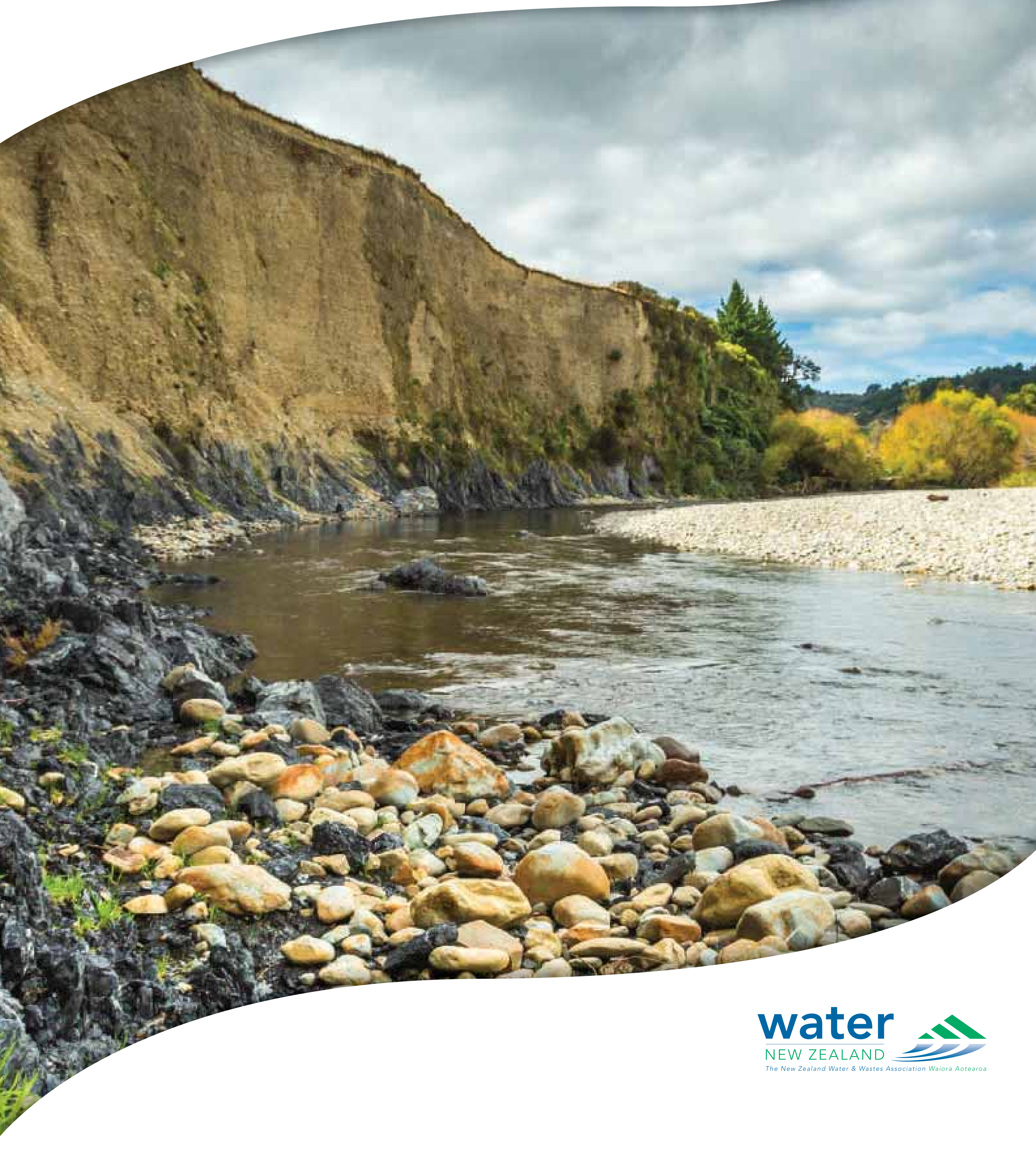
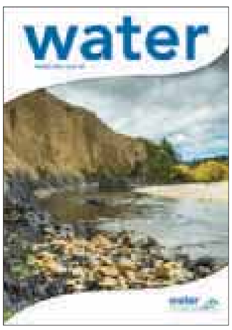


water
NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa

WATER

Water New Zealand News

Features and Articles



Cover photo: Earth's Vein by Martin Warenczuk
Martin's work can be viewed and purchased from www.beautifullandscapes.co.nz

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The official journal of *Water New Zealand* – New Zealand's only water environment periodical. Established in 1958, *Water New Zealand* is a non-profit organisation.

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The next issue of *WATER* will be published in May 2015.

Brent Manning

Law Reform: The Case for Change

It seems everyone has an opinion on the Ruataniwha Dam and recent decision of a High Court appeal post a Board of Inquiry decision in mid-2014 on the Dam.

While holidaying in Napier and Hastings over Christmas, I saw a carrier firm's truck labelled with the slogan "Don't Damn Our Dam" (presumably in support of the Dam construction) while I also had conversations with some local business owners who were against the Dam and all it entails.

A recent article by economist Peter Fraser damned the project economics, yet at our own Water Conference last year I saw a convincing presentation from Andrew Newman on the merits of the project.

Irrespective of your views on either the decision or the social good or environmental risks posed by the project, it is clear that we are reaching a nexus in New Zealand where the economic and engineering good of water infrastructure projects is pitted against social and environmental pressures. Sure we can design and build a dam to store 104 million cubic metres of run off river water, and to use that water to irrigate up to 58,000 hectares of drought prone country, however the real questions lie in how we see our country progressing into the future. Currently in the absence of a national debate on our aspirations for "New Zealand Inc", decisions on our future are being made in the expensive litigation and appeal processes under the auspices of the Resource Management Act (RMA).

On the one hand, there is widespread understanding that one of the keys to a more prosperous economy is in greater and more efficient use of our currently under-utilised natural and national resource, in the form of water. On the other hand, concern exists around environmental degradation and what damage may be done to our future environment. A key to unlocking our water potential in the future will be on compromise; that is, accepting some gains in one area, while possibly shouldering greater risk in others. I'm not sure our current legal framework is ideally set-up for these debates.

The RMA, legislated July 1991, has as its core purpose the principle of sustainable management for "natural and physical resources" which, when related to the natural environment, has a 'feel-good' factor about it which earned it the backing of environmental groups and the general populace. However, more than 23 years on, how have we fared?

There has been little new national environmental policy and few national environmental standards introduced in that time. The 2014 amendment to the National Policy Statement for Freshwater Management (NPS-FM) is a good move, however the dearth of local discussion on the impacts of the National Objectives Framework is deafening. Maybe it's early days but despite there being articles on this very topic in other sector magazines, it seems that national media and the general populace haven't really picked it up yet.

I don't think the RMA and its governing principles are wrong; it is largely the manner in which it is being enacted through district, regional and unitary plan rules and the resource consent decision-making process which is broken. It can be cumbersome and costly for the small private business or house owner who wants to make an alteration to their building, subdivide their property or start up a small business from home, only to find they have to engage a raft of technical experts to carry out, for example, a cultural impact assessment, produce an acoustic or traffic impacts report, or redesign the building to meet certain council planning restrictions. Many might consider this unnecessary expense for less than minor environmental gains or impacts – a cynic might say it goes more to protection of property values. So how does this all relate to water? Well it doesn't and that's my point.

For a large scale proposal with far reaching and long term changes to the natural environment, it is entirely appropriate that a deliberate and considered process be undertaken, involving technical expert evidence and the opportunity for public and sector group input, all heard by an appropriately qualified judiciary. The RMA and its recent reforms allow for these processes to occur, albeit in a streamlined manner and with the involvement of a national body (the Environmental Protection Authority or EPA) for the monitoring of effects and implementations, national policy statements, and water conservation orders.

> "Maybe it's time for local body planning and building related controls and decision making processes to be separated from large scale environmental applications."

Maybe it's time for local body planning and building related controls and decision-making processes to be separated from large scale environmental applications. Alternatively, the implementation of more central and national guidance in the form of NPS and NES may create more consistency of outcomes for the water sector. Is there a need (and appetite) for a separate Water Act?

Your Board intends to discuss and debate these matters this year, with the intent of seeking member feedback and raising the issues with the Minister for Environment as he considers Stage 3 of the RMA reforms.

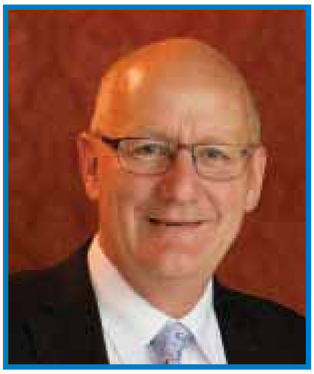
I welcome our new CEO, John Pfahlert, who replaced Murray Gibb from December – see John's first introductory column opposite. Feel free to send any feedback on this column or the journal content to John (ceo@waternz.org.nz). ■

Brent Manning,
President, Water New Zealand

New Members

Water New Zealand welcomes the following new members:

LILIAN SHEMAN
SALLY WYATT
KELLY KIM
GLYN WARREN
CRAIG HEMMINGS
TRACY FREEMAN
EVAN PETERS
HEATHER UWINS-ENGLAND
JAIN ROBINSON
SIMON CHAPMAN
NICK THOMAS
NIGEL PAULL
WILLIAM BONA
TIM JOYCE
DAVID JENNINGS
TOM NORMAN
JOANNA SAYWELL



John Pfahlert

Introductions – John Pfahlert, CEO Water New Zealand

Rather than attempt to write on a technical or policy issue related to water two months into the job, I thought I'd tell you something of my background and interests.

I was born and educated in Hokitika, so have some familiarity with living in a small town and the issues that are front and centre of people's minds in rural New Zealand. I recall being sufficiently interested in local government that when I graduated from Canterbury University in 1984 with my geography Masters and returned to work in Hokitika, I stood for the Westland District Council – unsuccessfully I might add!

I worked for two years with the Forest Service in Hokitika over the period when the Labour Government was dis-establishing the agency and eventually found myself working for the Department of Conservation in Wellington, responsible for managing mining and prospecting activities on land administered by the Department. This was an interesting time in Wellington, with plenty of changes in the way Crown agencies were administered.

After five years I joined the Minerals Industry Association, an organisation with which I'd had plenty of interaction in the DOC role. This was the start of a long period working for trade associations, of which *Water New Zealand* is the most recent. There were plenty of challenges in mining in the early 1990s, with the Resource Management Act having just been passed and local communities flexing their muscle with the new consultation procedures established by the RMA.

In 1996 I joined the Fishing Industry Association and Seafood Industry Council. They were going through a rather fractious period, with most of the time spent discussing how the industry should be represented, and by whom. The one thing that period did leave me with was a good appreciation of the sustainable management of New Zealand Fisheries. However, the sector is still bedevilled by criticism of the fisheries bycatch issue and their interactions with recreational and customary fishers, as well as conservationists.

In 1999 I moved to join the Contractors Federation, and spent about seven years working for them and the Building Industry Federation. These were challenging times for the construction industry with the leaky building crisis giving rise to wide ranging changes in builder licensing to remove the cowboys from the industry. I chaired the NZ Construction Industry Council for about six years during this period, a pan industry body that worked hard to develop a collegial approach to reform within the sector.

> "Being new to the sector I'm keen to hear from people with a view about how *Water New Zealand* can better represent your interests."

In 2006 I joined the Petroleum Exploration and Production Association and worked for them for the next six years. Oddly enough the challenges in this role had little to do with New Zealand. The BP oil spill in the Gulf of Mexico, the sinking of the Rena off the coast of Tauranga and the development of shale gas fracking technology in the USA dominated the work environment during the period I was there.

Oil and gas development in New Zealand had flown under the radar prior to this, but these three events brought to focus in New Zealand the potential for an oil spill off our coastline. I mischievously called for a ban on coastal shipping after the sinking of the Rena – it was clearly a dangerous activity!

I also have a range of interests outside work. My wife Liz and I are keen cyclists and rode 4000km together from Paris to Istanbul in 2008. We have also travelled extensively in southern Africa and Patagonia, as well as Europe and China. In 2013 I rode my bicycle with ten others across Canada, starting in Vancouver and finishing at St Johns in New Foundland. This 7500km journey took three months and averaged about 130km a day.

I also build and fly remote control model planes and model boats. I'm also keen on classical music and opera.

Having been in the job for eight weeks at the time of writing this article, I've spent the time getting out and meeting people in the industry around Wellington. I've also started a series of regional visits. I'm excited by the challenges ahead and plan to get about New Zealand in the coming year to meet with as many industry participants as I can, particularly those of you working in local government. Being new to the sector, I'm keen to hear from people with a view about how *Water New Zealand* can better represent your interests. Our success depends on providing value to members in the services we offer. ■

John Pfahlert
Chief Executive, Water New Zealand

Welcome to the first issue of *WATER* for 2015

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 and
- Technical topics/paper (up to 3-4000 words)

The next issue of *WATER* will be published in May, the themes are Stormwater; Water Sensitive Design; Climate Change; and Flood Management.

If you wish to contribute please contact the editor, Robert Brewer, at editor@avenues.co.nz

For all advertising contact Noeline Strange on Ph: +64 9 528 8009; M: 027 207 6511 E: n.strange@xtra.co.nz

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

To view the themes for 2015 visit www.waternz.org.nz and use the drop down links PUBLICATION/*Water New Zealand* Journal.

Water New Zealand's Annual Conference & Expo 2015

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 friends and colleagues, discuss the latest developments, 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 look forward to seeing you in Hamilton. Mark the following dates in your diary.

Key Dates:

Wednesday 25 March	Call for Abstracts CLOSE
Wednesday 10 June	Registration OPENS
Friday 24 July	Earlybird Registration CLOSES
Tuesday 28 July	Poster Summaries CLOSE

Conference Theme

Optimising Our Water Value is the theme of this year's Conference. While areas of this country periodically experience drought conditions, including this summer, we are, as a nation, endowed with an abundant supply of fresh water. The problem is too many of us take it for granted, too many of us think it is 'free' to all, and too many of us have no understanding of the costs of delivering a safe and secure supply. Our water's value is not all about money – it is an essential element of our health, well-being and economic future. The Conference will explore smart ways of allowing us all to better understand that value proposition.

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 exhibition sites at this event are extremely popular.

To view further information and to book a site visit www.waternz.org.nz and follow links to conference pages.

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 25 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 25 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.

If you have any queries regarding the conference please contact Hannah Smith, Water New Zealand on +64 4 495 0897 or email Hannah at hannah.smith@waternz.org.nz

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REGISTRATION IS NOW OPEN!

TO REGISTER VISIT:
www.stormwaterconference.org.nz

Register by 25 March to receive discounted Earlybird Registration rates.

Water New Zealand's
Asia Pacific Stormwater Conference

STORMWATER

20 – 22 MAY 2015, AUCKLAND

Liveable Cities, Liveable Communities

The 2015 Asia Pacific Stormwater Conference is to be held at the Pullman Hotel, Auckland.

The Conference theme is ***Liveable Cities, Liveable Communities*** and is on Wednesday 20 – Friday 22 May with optional site visits on the afternoon of Friday 22 May. Site visits offered include a Central Auckland Walking Tour, a Water Sensitive Urban Design Southern Site Visit, and an Auckland Motorway Stormwater Site Visit.

The Welcome Function sponsored by Harker Underground Construction Ltd is on the Wednesday night and the Conference Dinner is on the Thursday night.

The Conference Committee has put together a programme of keynote speakers and technical papers which should appeal to anyone interested in stormwater.

The preliminary programme and further information on the social functions and site visits can be viewed on the Conference site www.stormwaterconference.org.nz

Keynote Speakers

Dean Kimpton

Dean Kimpton is Chief Operating Officer for Auckland Council, Australasia's largest local authority, with over $40 billion of assets and a current annual capital and renewals spend of nearly $2 billion. Dean has a breadth of experience at the senior executive and governance levels, delivery of major infrastructure projects in New Zealand and overseas, and is knowledgeable in the regulatory and infrastructure business of council and its customers and suppliers.

Lykke Leonardsen

Lykke Leonardsen is the head of the Copenhagen Climate Unit in the Technical and Environmental Administration. Originally trained as an archaeologist and a master in Public Policy, Lykke has worked for the city of Copenhagen since 1997 working in several fields of urban development giving her a wide experience in social, physical and environmental issues that are all part of the development of the city. She has been working on the adaptation plan for Copenhagen since the very beginning and during that time the work has developed from the very early ideas on how climate change might affect the city up until now where they're implementing a city wide plan.

Hon Dr Nick Smith

Hon Dr Nick Smith was born and educated in North Canterbury. He completed an Honours (First Class) degree in civil engineering and a PhD in landslides at the University of Canterbury. Nick became a district councillor while studying and has held many offices prior to being selected as the National candidate for Tasman in 1989.

Nick has held 12 Ministerial portfolios, from Conservation, Building and Construction, Housing, Education, Immigration, Corrections, Social Welfare, Treaty Negotiations, Environment, ACC, Climate Change and Local Government.

National achievements in which Nick has played a significant role include the creation of the Kahurangi and Rakiura National Parks, 17 marine reserves, the introduction of the Emissions Trading Scheme to reduce greenhouse gas emissions, the establishment of the Energy Efficiency and Conservation Authority, and the Environment Protection Authority.

Dr Jan Wright

Dr Jan Wright was sworn in as Parliamentary Commissioner for the Environment for a five-year term in 2007 and reappointed for a second term in early 2012.

Jan has a multidisciplinary background with a Physics degree from Canterbury, a Masters degree in Energy and Resources from Berkeley in California, and a PhD in Public Policy from Harvard.

Jan's recent work has focused on the impact of climate change on New Zealand (focusing on sea level rise), onshore oil and gas, the relationship between land use and nutrient pollutants, and the management of conservation land. Current investigations include further work on climate change and sea level rise, as well as marine conservation, focusing on marine protected areas such as reserves. She is also preparing a commentary on air quality following the recent release of the domain report produced by the Government Statistician and Secretary for the Environment.

Sponsorship and Trade Exhibition Opportunities

The Stormwater Conference is a prime opportunity to promote your organisation through sponsorship and trade exhibition.

If your company is interested in developing or enhancing business relationships in the stormwater industry, then an exhibition or sponsorship at the 2015 Stormwater Conference is a great opportunity.

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

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Conference Partner

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For further information on the Conference visit
stormwaterconference.org.nz

Board Profiles – Helen Atkins and Dukessa Blackburn-Huettner

Helen Atkins

I have been on the Board for just over one year, having been appointed as one of the two co-opted Board members after the AGM in 2013. I am a regular contributor to the Water journal – including in this edition.

Currently I am a Partner and co-owner of specialist Public and Environmental Law Firm, Atkins Holm Majurey. My business partners are Mike Holm, Paul Majurey and Tama Hovell.

On graduating from Canterbury University in Law in the mid to late 1980s, I spent most of my time in the UK working for the Oxford City Council, a large, primarily urban, local authority. I returned to New Zealand in the early 1990s when the RMA will still in its infancy and was fortunate to spend a couple of years at the Ministry for the Environment where I was mostly involved in answering a myriad of questions about what provisions in the RMA meant.

On leaving the Ministry, I worked in Wellington at Kensington Swan and then at Russell McVeagh. I joined DLA Phillips Fox as a partner in 1999 before leaving in 2009 to set up my current firm, Atkins Holm Majurey.

In my day-to-day legal work I am involved in a variety of matters for a range of clients, many with a focus on water matters. These matters range from asset management issues for local authorities, to water quality and quantity issues for government (central and local) or the private sector (industrial and rural interests).

Over the last year or so I have been involved in matters including water management policy reviews in Auckland (Proposed Auckland Unitary Plan), Manawatu-Wanganui (Horizons One Plan), Canterbury (the Land and Water Regional Plan and its variations), Hawkes Bay (Tukituki catchment and Ruataniwha Dam project), and advising various local authorities on utility service matters associated with waste water, water supply and stormwater infrastructure.

I have a keen interest in general planning and environmental matters and have held active roles in both the New Zealand Planning Institute and the Resource Management Law Association of New Zealand Inc (the latter as President from 2009 to 2011). In terms of water management in New Zealand, I am very excited about being on the Board of *Water New Zealand* where we have the opportunity to make a significant contribution to the discussion on how New Zealand manages its water resources into the next century. It is clear to me that New Zealand is at a cross roads where it can no longer proceed on the basis of business as usual. As a country, we need to step up to the challenge of meeting the economic growth aspirations we all have, while ensuring that our environmental aspirations are not undermined.

In the water sector the drive is to improve the delivery of water services to customers without significantly increasing costs, while managing what is, in some cases, aging and out of date infrastructure.

This year we are going to see amendments to the RMA around water and other matters and that will have a bearing on us all. Local Government will continue to face pressures, whether that be from legislative change or not and this is an area I have a keen focus in.

I look forward to working with the Board and the Executive team at *Water New Zealand* on all these issues over the coming months.

Dukessa Blackburn-Huettner

I was born in Munich and moved to New Zealand when I was 10 years old. I studied engineering at the University of Canterbury, graduating with a Bachelor of Engineering with first class honours. After several years working in New Zealand, I moved to Europe.

I spent three years in Dublin working as a civil design engineer on several large projects including a €850 million shopping centre development. Working in Europe was very interesting, particularly the knowledge gained by being exposed to European legislation and codes, often very different from our own. Returning as a consultant to New Zealand in 2004 I continued consulting internationally alongside a wide range of local and national entities on mainly three waters infrastructure projects.

I am passionate about raising the profile of the issues surrounding stormwater management and the emerging challenges around stormwater. I am currently the Stormwater Operations and Planning Manager for Auckland Council.

In this role I lead three asset planning groups focusing on growth and renewals, flooding and waterways planning; and four regional operational teams responsible for operating and maintaining the stormwater network. I'm also responsible for all stormwater asset data management and systems used by the Council.

One of the biggest challenges I have faced in this role was the amalgamation of the Auckland councils at the end of 2010, where I brought together and realigned the teams from eight organisations, while still retaining service continuity and critical response.

Prior to joining the Board my involvement with *Water New Zealand* was on the Technical Committee for seven years – which I am still part of. I chaired this committee for three of those years. I was one of the Board members instrumental in setting up *Water New Zealand's* Rising Tide group and am now the Board representative. This group encourages young people to join our industry and to make it more attractive to them. I am keen to see this group grow and expand to the other main centres.

I've been a Board member of *Water New Zealand* since 2012. I bring a unique mixture of expertise to the Board. My experience traverses international boundaries, and includes both management and technical experience. I have experience across small and large councils in local government, central government and our private sector. I have extensive experience in leading planning, development, operation and management, mainly with three waters infrastructure.

When I joined the Board I wanted *Water New Zealand* to have a stronger emphasis on providing technical leadership. I am pleased to see that this has been achieved and one of the Board's focus areas in the 2014 strategic plan is to enhance the technical support we provide to members. The Board has backed this by increasing the technical support resourcing within the organisation.

My vision for *Water New Zealand* is to continue developing our technical leadership to support our members, drive excellence in the water sector, and further develop and grow our younger members. ■

Variation will Enable Wetlands Trial

Gisborne District Council's engineering and works department has lodged an application to amend the disinfection clause in its wastewater treatment plant consent, and from today is calling for community feedback.

The proposed amendment will enable a wetlands option to be further investigated as a viable alternative to disinfection.

The disinfection clause (Clause 4) required council to install wastewater disinfection to its treatment process no later than 31 December 2014.

> "We believe discharging treated wastewater to a wetlands is financially and environmentally better – and more sustainable long-term – than the originally proposed ultraviolet disinfection."

Deputy chief executive and engineering and works manager Peter Higgs says the variation sought is an operational change to Gisborne's wastewater treatment system. It includes two-year milestones for confirming, designing and building an alternative wastewater management system. If these are not met, the default position would be to install disinfection.

"We believe discharging treated wastewater to a wetlands is financially and environmentally better – and more sustainable long-term – than the originally proposed ultraviolet disinfection."

Mr Higgs said the effectiveness of ultraviolet disinfection and the likely $85 million cost was not what was anticipated; neither did it meet the expectations of the community.

"Disinfection would not meet the consent requirement to remove human wastewater from the bay by 2020. Further treatment and disposal options would still need to be progressed to meet consent requirements.

"Over the past few years, the Wastewater Technical Advisory Group – comprising representatives of tangata whenua, interested parties, the community, scientists and council – has been working hard towards various alternative use and disposal options for the city's treated wastewater. It has come up with a wetlands option worth investigating, hence the request for further time."

"We acknowledge the hard work of this group which has led to this application," Mr Higgs said.

The group determined that a wetland complex is a cost-effective and sustainable wastewater treatment option that could be successfully delivered by 2020 and comply with consent conditions. The estimated cost is $10m to $12m. On the group's advice, the Wastewater Management Committee recommended Council endorse a variation to Clause 4.

"If we don't act, we could end up implementing the more expensive default condition of wastewater disinfection. Council has elected to notify the application to ensure the opportunity for public input, even though significant work has been put in to find the best wastewater option for the community."

The application will be heard by a panel of commissioners. ■

Water New Zealand Modelling Group Modelling Symposium 2015

The *Water New Zealand* Modelling Group is holding its first Modelling Symposium at the West Plaza Hotel, Wellington on 18–19 March 2015. All Modellers, engineers and environmental practitioners in the fields of stormwater, wastewater and water supply are encouraged to attend this non-software specific event.

The Modelling Symposium offers delegates the opportunity to expand their knowledge in modelling related fields through keynote speakers, presentations and forums. An event will be held at the conclusion of Wednesday's sessions which will allow delegates to network and connect with their peers.

"All Modellers, engineers and environmental practitioners in the fields of stormwater, wastewater and water supply are encouraged to attend this non-software specific event."

The Modelling Committee are proud to announce Keith Woolley, Chief Advisor – Potable Water, Wellington Water will be giving a Keynote presentation on 'Seizing opportunities to make a difference' and Haydn Read, Manager Strategic Asset Management Planning, Wellington City Council will be giving a Keynote presentation on 'Applied Capacity Modelling'.

Registration information and a draft programme are available at www.waternz.org.nz/modelling

Special thanks to AECOM, Jeff Booth Consulting Limited, DHI and Watershed Engineering for their support with sponsorship.

We look forward to seeing you at the Modelling Symposium in March. ■

Water New Zealand Backflow Group Backflow Training Seminar 2015

The *Water New Zealand* Backflow Group is rebranding their bi-annual conference. The first Backflow Training Seminar 2015 will be held at the Mercure Resort, Queenstown from 23–24 April. The Backflow Committee invites anyone with an interest in backflow to attend.

The rebranding of the Backflow Training Seminar also brings some new features to the event. This year the Backflow Committee have been working hard to introduce CPD points, a welcome function and a Backflow focused pub quiz to close the training seminar. The day sessions and Awards dinner will operate as normal, however the introduction of the additional functions allow delegates plenty of opportunities to network with peers.

A draft programme and registration information is currently available at www.waternz.org.nz/backflow

We hope to see you at the Backflow Training Seminar in April. ■

Michael, a student at Napil RTC, with his kava

Watercare Make a Difference in the Pacific

Hannah Davies – Relationships Fundraising Manager, Oxfam New Zealand

The story began in September 2013, at 'Misty Mangere Mountain', where four hobbits decided to change the face of the world. Gathered together by their common passion, caring for water, they saw Oxfam's fundraising event "The Ripple Effect 2014" as the perfect way to focus their energy and fight for a good cause: to ensure that fresh water is available to small communities in the Pacific and joined forces to become the H20bbits.

Not only did they take on the challenge, they also won it by raising the most money to contribute to getting a Water, Sanitation and Hygiene Education (WASH) project off the ground. The prize for this winning team, the H20bbits, who were representing Watercare, was a trip accompanying Oxfam to Vanuatu to see first-hand the incredible difference clean water can make to those living in poverty.

"The Oxfam Water Challenge will see 20 teams of four people fundraising and pitting their wits against each other to design, plan and construct a solution to a water-based challenge..."

When asked why they took part, the team said, "We wanted to be part of something that could make changes for a more sustainable way of living. Oxfam is a great way to do it and meet that goal, and shares the same vision we have."

Clemence Carlinet, a Process Engineer at Watercare describes her trip to Vanuatu as unforgettable. "I'll come back to New Zealand much more humble and richer of knowledge." she said.

During the trip, Clemence Carlinet, Daniel Leighton, Maria Eliza and Sanjay Kumarasingham visited three Rural Training Centres (RTCs), run by the Vanuatu Rural Development Training Centres Association (VRDTCA) and supported by Oxfam. It was at these centres they got to see the stark difference clean water makes, the huge health improvements that sanitation and hygiene education brings to communities and they got to speak to local people to see how their lives were being turned around by VRDTCA and Oxfam.

"We saw so many things in a few days! Villages and locals, farms, water and wastewater installations. It was amazing to see what can be done with constraints (budget, location, climate conditions). These people were all amazing, passionate people who are always thankful."

It was at a RTC on Tanna Island where they met Michael. Michael, aged 15 had been kicked out of formal education two years earlier as his parents could not afford the school fees. Having heard about Napil RTC, Michael's parents enrolled him in our Young Farmers Programme. Michael is deaf and unable to talk but learns well by watching others. He's been involved with the programme for two years now and has a field full of 600 kava plants which, when they are fully grown, will sell for 200 Vatu each. Michael's training not only gives him the knowledge of how to grow these plants, but he's also taught what crops to plant and when, how to grow different varieties, and how to ensure his seeds flourish in the future.

But none of this would have been possible were it not for the WASH project which

Oxfam led. Thanks to Oxfam supporters, Napil now has a simple rainwater harvesting system hooked up to a 5,000 litre tank and toilets. The water is used for everything – from drinking and washing, to preparing food and watering crops during the dry season, thus highlighting that clean water really does underpin sustainable development.

"The prize for this winning team, the H20bbits, who were representing Watercare, was a trip accompanying Oxfam to Vanuatu to see first-hand the incredible difference clean water can make to those living in poverty."

Later in the trip the team got to briefly put their expertise into practice when speaking to Kathy Solomon, the Founder and Director of VRDTCA. Whilst talking to Kathy and her team, the H20bbits began thinking about different designs for toilets which would use less water and could see the stark difference between the issues Kiwis face, as opposed to the daily struggles of the people living in Vanuatu.

Having seen the incredible difference that even the most basic water and wastewater treatment and supply technology can make to people's lives, the team returned to New Zealand full of enthusiasm for the work that Oxfam does in the Pacific. With the backing of Watercare's Chief Executive, Raveen Jaduram, team members have told the story of their Vanuatu experience to many of their Watercare colleagues and supporters, and are determined to continue their involvement in this work.

This year's challenge sees the new Watercare team aiming to defend their title in the revamped Oxfam Water Challenge!

The Oxfam Water Challenge will see 20 teams of four people fundraising and pitting their wits against each other to design, plan and construct a solution to a water-based challenge – it will be a fun day where teams will be able to put their expertise to use and compete to be the best in the business. Not only will it be a great team-building challenge, but they will be showcasing their company's talent, networking and more importantly raise money to make sure we can deliver clean water, sanitation and hygiene education to a rural village in Melanesia.

The Watercare and Oxfam team with the students of Napil RTCplants

The Watercare team making a splash!

If you want to make a donation to a team and support the Challenge, you can do so here: www.oxfam.org.nz/OWC/donate

Team places are full for the 2015 event, but to register your interest for the 2016 event, check out www.oxfam.org.nz/OWC or give Emily a call on 09 355 6501 or email her on emily.pavey@oxfam.org.nz

The New Zealand Water sector and Oxfam – coming together to make a splash for rural communities in the Pacific!

"Thanks to Oxfam supporters, Napil now has a simple rainwater harvesting system hooked up to a 5,000 litre tank and toilets."

Problems with Flushable Wipes

Nick Walmsley – Technical Manager, Water New Zealand

Flushable wipes are one of the fastest growing categories of consumer products. Increasingly, wipes are causing serious and costly maintenance issues for wastewater systems. Many of the wipes entering the sewerage system are not dispersible and technically not flushable.

Recently there has been an alarming marketing exercise aimed at significantly broadening the use of flushable wipes by replacing (or at least providing an alternative to) dry toilet paper. This encourages bad consumer behaviour.

At this point we should stop calling these products 'flushable wipes' as there is no science behind calling them 'flushable' – it's merely a term a vendor started in the US and it has taken on a life of its own since. Wipes do not break down in the waste system like toilet paper; they also contain plenty of chemicals that add to contamination.

The term "flushable wipes" was spawned in the 1980s, when a consumer products company brought a latex bonded wet wipe with polyester fibers onto the market. The wipe was considered "flushable" since it could transit through the toilet, but with all those polyester fibers it was not dispersible. Today they are made from nonwoven fabrics and the disposable type has been around since the early 1990s.

Wipes seem to be clogging up drains and sewers and wasting customers' money in maintenance bills

Wipes use is widespread in the U.S., Western Europe, Japan and Israel, but is expanding on a global scale. In addition, the definition of what is flushable is not subject to industry guidelines, consumer instructions, or government oversight. With the explosion of wipes on the market there is significant consumer confusion about what is and is not flushable.

International experience suggests New Zealand water authorities should take a proactive approach to managing the risk before the flushable wipe market is established and significant negative maintenance impacts are experienced.

Flushable wipes are currently marketed in the following categories:

- Adult moist toilet tissue
- Toddler toilet care wipes
- Feminine hygiene wipes
- Cosmetic/facial wipes
- Bathing and adult incontinence wipes
- Other personal care wipes
- Medicinal wipes
- Skin soothing wipes
- Multipurpose wipes
- Bathroom cleaning wipes
- Industrial wipes

To date, only a limited range of flushable wipes are marketed in New Zealand.

Market Growth

Market research firms forecast that the total demand for wipes in the USA will increase to $US2.5 billion by 2016 (ICT, 2014) and over this period, globally the total consumer wipes market is forecast to increase to around $US12.6 billion (Hill, 2014). The flushable category of the wipes market is a significant growth component of the total wipes market, with a UK based Market research firm predicting that the flushable market will grow 12.1% annually to reach $2.4 billion by 2018 (Smithers Apex, 2013). At this rate of growth, sales (and hence volumes) would double every six years.

Recent marketing effort in New Zealand and Australia of flushable wipes suggests local market growth rates may be similarly robust.

A cause for even greater concern is the high-volume use in industry – by motor mechanics, in surgeries and hospitals, in child care facilities and in aged care. Most manufacturers describe these products as 'safe for sewers and septic systems'; even going so far as to claim their wipes 'break up like toilet paper after flushing'. However the US ConsumerReports.org does not agree; while ordinary toilet paper disintegrates in seconds after flushing, some flushable moist wipes failed to disintegrate after 30 minutes. This alone is enough to cause problems for your sanitary plumbing and septic system, as well as water utilities sewerage. The Consumer Report recommendation is not to flush these wipes!

Flushability Protocols

What's a flushable wipe? What deems a product as a truly flushable wipe? Well for starters, it should easily disintegrate when flushed.

In 2003 WERF published a document, "Protocols to Assess the Breakdown of Flushable Consumer Products", which describes a scientifically sound approach for assessing compatibility of flushable consumer products with plumbing fixtures and sewage disposal systems. This report represented the first comprehensive guide of methodologies for assessing the fate and biodegradability of flushable consumer products.

Drinkwater and Galletti (2008) undertook a review of the WERF protocol and developed a revised test protocol to determine the flushability of disposable products as part of a WrC research project in collaboration with seven UK water authorities. The test protocols covered a wide range of likely blockage scenarios throughout a sewerage system.

Unfortunately, widespread adoption of this test protocol by industry has not occurred.

INDA is the "Association of the Nonwovens Fabrics Industry" (previously International Nonwovens and Disposables Association) and represents the North American industry. EDANA is the European based international association serving the nonwovens and related Industries. Together, both organisations have developed Guidelines for Assessing the Flushability of Disposable Nonwoven Products (INDA, 2013). Now in its third edition, it requires that seven specific tests must be passed to make a flushable claim.

In 2007 The Netherland government threatened to ban the sale of flushable wipes due to potential pump station blockages, and as a result a pump test was incorporated into the second edition of the EDANA/INDA protocol (Ogle, 2011). The pump test suggested that a network wide increase in pump station power consumption may be noticeable if flushing of wipes in sewer catchments increases significantly.

Whilst there is a high degree of commonality in the approach taken by the WrC and EDANA/INDA protocols, the latter does not address the issue of snagging of products in the sewer.

Whilst INDA and EDANA represent the nonwoven and related industries, not all flushable wipes are produced in accordance with this guideline. The latest edition recommends a universal 'do not flush' logo be prominently displayed on nondispersible products (refer Figure 1), but the logo is not used on New Zealand products.

Figure 1: Do not flush logo

Packaging

In New Zealand and Australia, none of the flushable wipes products are affiliated with any recognised standard and simply state that they are flushable, dispersible and/or biodegradable.

Class Action Lawsuit

In the US, whilst proposed legislative changes (in Maine, California and New Jersey) have not progressed rapidly, litigation may soon change the industry. A class action lawsuit filed by a resident of Brooklyn, New York in February 2014, cites Kimberly-Clark and Costco Wholesale corporations and seeks damages of at least $US5 million stating "The defendants should have known that their representations regarding flushable wipes were false and misleading."

The lawsuit represents 100 people and claims that consumers around the country have suffered through clogged pipes, flooding, jammed sewers and problems with septic tanks due to the use of flushable wipes (ABC News, 2014).

Sewer Network Problems

Water authorities in New Zealand and Australia (WSAA, 2014) have reported the following impacts on sewer networks:

- blocked sewer pump stations
- clogged wet wells
- fouling of remote telemetry units in sewers that monitor increased rainfall
- sewer overflows due to fouling on tree roots and other obstructions

These impacts can be largely attributed to an inability of the flushable wipes to disintegrate prior to reaching the downstream pump station and/or a tendency to snag.

A cluster of wet wipes removed from Sydney's sewage pumping stations.

In Kingston, London, Thames Water found a widely publicised 15 tonne "fatberg" (sewer blockage) in August 2013. That's enough "wrongly flushed festering food fat mixed with wet wipes" to fill a double-decker bus, the company said (Metronews, 2013). Kimberly Clark (2013) and others in the nonwoven industry argue that the majority (circa 90%) of sewer issues are attributed to products that are non-flushable. This statistic was derived from a study conducted by INDA in Maine, USA as a result of proposed legislative changes to require any flushable product to be labelled properly and meet industry guidelines (Firmin, 2014).

Don't Flush It

The water utilities, plumbing and drainage industries need to band together to lobby against the use of flushable wipes. This is a growing problem in need of intervention. If any plumbers have had to deal with problems caused by flushable wipes, they should let their local water utility know, contact media organisations and make it clear to the consumer or building owner that the effect of flushing wipes has infrastructural and economic problems. ■

References

Ochre P, "Coming to a sewer near you: flushable wipes", AWA Biosolids Conference 2014

Plumbing Connection,"Wipeout! What's Killing Our Drains", Winter 2012 issue

The Sunday Telegraph, "Wet wipes blocking Sydney sewers as more men flush them down the toilet", December 07, 2014


Precious.

Water Law – Recent and Upcoming Developments

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

Introduction

Happy New Year! 2015 has arrived and looks set to be another busy one in the environmental and water law sphere. Further, fairly substantive reforms to the Resource Management Act 1991 ("RMA") have been signalled (including to sections 6 and 7), and we provide a brief overview of these changes in the first section of this article. We then move on to discuss the further guidance which has now been provided on both the application and meaning of the National Policy Statement for Freshwater Management 2014 ("NPSFM 2014"). Next up is a brief note about water fluoridation and in particular the release of a Code of Practice for Fluoridation of Drinking Water Supplies. We end this article with a summary of the High Court's decision in the Tukituki case.

RMA Reform

The Government recently announced that it intends to continue on with its RMA reform program apace.

In describing the need for and general nature of the reforms Hon Dr Nick Smith stated[1]:

> *"…[T]inkering with the RMA won't do…*
>
> *The Act has some fundamental design flaws that require substantial overhaul. The purposes and principles are outdated and ill-matched with the reality of the issues it manages, like housing development. The plan-making process is too cumbersome and slow. The Act needs re-engineering away from litigation towards collaboration. Property owners need stronger protection from unnecessary bureaucratic meddling. We need stronger national consistency and direction. We need to redesign the paper based planning and consultation systems for today's age of the internet."*

While not proposing to amend the over-riding purpose of sustainable management, the Government is proposing significant changes to sections 6 and 7 to address the following matters:

- The management of significant natural hazards;
- The urban environment;
- The need for more affordable housing; and
- The need for good infrastructure.

Dr Smith also noted that in his view economic growth, jobs and exports need recognition in these sections[2]:

> *"The idea that the only consideration in resource consenting is protection of nature is naïve. This is not the National Parks Act. When consideration is being given to allow a new factory, a new road, a new marine farm, a mine or a new tourism attraction we need to carefully weigh up the effects on the environment alongside the benefits of economic growth and jobs."*

In terms of other parts of the RMA changes were required to:

- Provide more explicit recognition of property rights;
- Introduce and compel the use of standard planning templates;
- Speed up plan-making processes;
- Encourage the use of collaborative resolution techniques – such as occurred with the Land and Water Forum;
- Strengthen and speed up the implementation of national regulation (such as national policy statements and national environmental standards)
- Update the Act to provide for electronic communications and greater use of the internet.

"For those of us who participate in RMA planning processes one of the key questions we often have to address is, what are the relevant statutory instruments that must be considered and what weight should be given to those instruments."

To the extent that the proposed reforms attempt to increase efficiencies and cut red tape, they have been largely welcomed by most sectors. However, some specific changes, such as giving greater weight to private property rights has been flagged as a concern by some commentators who anticipate that this could lead to environmental decline[3].

In terms of timing, the Government has indicated that it intends to introduce a Bill setting out the detail of the changes in the first half of this year, and have it enacted prior to Christmas.

NPSFM 2014

Guidance on Application to Current Planning Processes

For those of us who participate in RMA planning processes one of the key questions we often have to address is, what are the relevant statutory instruments that must be considered and what weight should be given to those instruments.

The issue can become particularly tricky, where the relevant statutory instruments are amended or replaced part way through an RMA process. In the context of Freshwater Management, the replacement of the NPSFM 2011 with the 2014 version, has raised those issues for RMA processes which were in train (but not finally concluded) in August last year.

The High Court has now had cause to consider this issue in the context of appeals from the Board of Inquiry's decision in the Ruataniwha Water Storage Scheme ("Tukituki case")[4]. In that case (which we report on more fully later in this article), the specific question before the High Court in relation to the NPSFM was:

> *"[W]hether the Board should, when reconsidering Rule TT1(j) give effect to the Freshwater Policy Statement 2014 or the Freshwater Policy Statement 2011 that was in effect at the time the Board made its decision."*

The Court after traversing the fairly limited case law on the issue came to the conclusion that it was the NPSFM 2014 that must be given effect to. The Court specifically acknowledged that the Board in preparing its original report did not err in not giving effect to the NPSFM 2014 as it was not in force at that time. However, for any rehearing, the Board was required to give effect to the NPSFM 2014. This was because the implementation provisions of the policy indicate that it is to be given effect to as promptly as possible[5], and also because this approach best reflects the requirements in s 67(3) to give effect to any national policy statement[6].

What this means in terms of the Board's decision making is that while for most of the components of the decision the Board has to give effect to the NPSFM 2011 for rule TT1(j) it is the NPSFM 2014

"By way of brief recap, the Board had been established to consider and determine proposed changes to the Hawkes Bay Regional Management Plan – Tukituki catchment as well as consent applications for the Ruataniwha water storage scheme. The Board's final decision, which was released on 18 June 2014, ultimately approved the plan changes and consent applications, but with some key amendments to the regimes for managing phosphorous and nitrogen."

that has to be given effect to. The Court acknowledged that this outcome wasn't ideal but was a product of the circumstances[7]:

> *"Accordingly, the Board should, as part of its reconsideration of Rule TT1(j) invite the parties to make submissions on the meaning and effect of the Freshwater Policy Statement 2014. I appreciate that this direction will mean the Board will have given effect to its Freshwater Policy Statement 2011 in relation to those parts of its report that have not been challenged and give effect to Freshwater Policy Statement 2014 when re-writing Rule TT1(j). This unfortunate but unavoidable consequence arises from the fact the appeal I have had to consider focuses primarily on Rule TT1(j)."*

Freshwater Accounting – Draft Guidance for Regional Authorities

In December 2014 the Ministry for the Environment ("MfE") published a document entitled "Freshwater accounting: Draft guidance for Regional Authorities". Its purpose is to provide information to help Council's implement the NPSFM 2014 requirement to establish freshwater accounting systems for both water quantity and quality. The document sets out common principles and key components of such accounting systems but does not prescribe use of any particular system so that Councils have the flexibility to adopt a system that works for them and their particular regions.

Submissions on the document closed on 5 February 2014 so we will report on the provisions of the final guidance document in a future article.

The Fluoride Debate

While the debate still rages in some quarters as to whether or not fluoride should be added to drinking water (given there is no legal requirement either way), it is pertinent to just briefly note that some guidance has now been released as to what constitutes good practice for those suppliers who choose to fluoridate.

The Code of Practice for Fluoridation of Drinking-water Supplies in New Zealand was issued by the Ministry of Health in December last year. This code, while not mandatory, aims to assist water suppliers in designing a new drinking water fluoridation system or upgrading an existing system to ensure the safety of its consumers.

A copy of the code can be accessed from the Ministry of Health website www.health.govt.nz/publication/code-practice-fluoridation-drinking-water-supplies-new-zealand.

Case Update

Tukituki case

As noted above, the High Court has recently released its decisions on appeals from the Board's decision in the Tukituki case.

By way of brief recap, the Board had been established to consider and determine proposed changes to the Hawkes Bay Regional Management Plan – Tukituki catchment as well as consent applications for the Ruataniwha water storage scheme. The Board's final decision, which was released on 18 June 2014, ultimately approved the plan changes and consent applications, but with some key amendments to the regimes for managing phosphorous and nitrogen.

Appeals were brought by Fish and Game, Forest and Bird with a cross appeal by the Environmental Defence Society. The common theme of all the appeals was the Board's approach to managing nitrogen levels in the Tukituki catchment area. Of particular concern were the changes the Board had made to rule TT1(j) by introducing a factual deeming provision so that farms over four hectares in size would no longer have to comply with the DIN (dissolved inorganic nitrogen) limits provided they complied with the LUC (land use classification) leaching rates. In other words farms over four hectares that were not complying with the DIN limits would be treated as if they were complying provided they complied with the LUC leaching rates.

The High Court found that this was a material change to Rule TT1(j) as it significantly altered the ability of the Council to control nitrogen in waterways in the Catchment Area. Consequently, and in the interests of natural justice, those parties affected by the change should have been given an opportunity to comment before the Board issued its final decision[8]. While acknowledging the Board was subject to strict legislative timeframes the Court did not accept that compliance with those timeframes meant such consultation was impossible. Indeed the Court noted that following the release of the Supreme Court decision in King Salmon the Board gave the parties an opportunity to comment before the Board issued its final decision, and the Court considered the same approach should have been followed for rule TT1(j)[9].

In terms of the substance of the rule itself the Court considered there were three questions to answer: whether the Board properly applied Part 2 of the RMA; whether the Board properly applied the NPSFM 2011; and more broadly whether the Board made any other legal error when it inserted the factual deeming provision into rule TT1(j).

In relation to the whether the Board properly applied Part 2, the Court found that:

> *"[154] … the factual deeming provision in Rule TT1(j) undermines the Regional Council's ability to effectively monitor water quality*

in the Catchment Area. In particular, a consequence of the way Rule TT1(j) is framed is that if a farm owner causes or contributes to the specified DIN limits being exceeded but nevertheless complies with the leaching limit set in Table 5.9.1D of the Regional Plan then the Regional Council will be unable to require farm owners to avoid, remedy or mitigate their contribution to DIN entering waterways in the Catchment Area.

[155] This consequence is not consistent with the Regional Council's obligation under s5(2) of the RMA."

In relation to whether the Board had properly applied NPSFM 2011, the Board found that while the DIN limits set by the Board in its draft report would have given effect to the NPSFM 2011, the subsequent introduction by the Board of the factual deeming provision in rule TT1(j) "substantially dismantled the effectiveness of the DIN limits as a means of giving effect to" the NPFSM 2011, and was "difficult to reconcile with the objectives and policies" of the NSPFSM 2011[10]. The Court also then went on to make the finding (noted above) that as the NPSFM 2011 had been replaced by the NPSFM 2014 it was this later version which the Board had to give effect to when it was reconsidering rule TT1(j).

In terms of whether the Board had made any other legal error when inserting the factual deeming provision into rule TT1(j), the Court found that the rule created a factual fiction, which while possibly not amounting to an error of law, still created "an unsatisfactory state of affairs". The practical effect of the rule was that the Council lost an important tool to control further degradation of a significant portion of the Tukituki catchment (some 615 farms) and that this was "difficult to reconcile with the Board's desire to impose controls over the discharge of nitrogen in order to manage the ecological health of the Catchment Area". Accordingly the Court directed that when the Board reconsidered the rule it should strive to avoid such factual fictions and not treat farmers who contribute excessive quantities of DIN's as compliant[11].

Overall the Court concluded that the Board had made a material error of law when it inserted the factual deeming provision into Rule TT1(j) and directed that the Board reconsider the relevant part of its report in light of the above findings. ■

Footnotes

[1] Hon Dr Nick Smith, Speech to Nelson Rotary Club, "Overhauling the Resource Management Act", 21 January 2015, available from http://beehive.govt.nz/speech/overhauling-resource-management-act.

[2] Ibid, page 8.

[3] Refer Environmental Defence Society Media Release, "EDS Responds to Hon Dr Nick Smith's speech", dated 21 January 2015 and available from www.eds.org.nz.

[4] Hawke's Bay and Eastern Fish and Game Councils v Hawkes Bay Regional Council [2014] NZHC 3191.

[5] Refer paragraph [182].

[6] Refer paragraph [183].

[7] Refer paragraph [184].

[8] Refer paragraph [130].

[9] Refer paragraph [132].

[10] Refer paragraphs [176] and [177].

[11] Refer paragraphs [195] and [196].

Design of Liners for Deteriorated Sewers – Latest Research to Make it More Efficient

John Monro – Interflow Pty Limited

Abstract

Since the start of the Trenchless Technology industry, liners for deteriorated sewers have been structurally designed by applying Standards and methods that apply to flexible pipes installed by traditional trenching. It has always been known that there are large gaps in the logic of doing this, but in the absence of consensus on any alternative design method it has become the norm.

The load carrying capacity of a flexible pipe requires consideration of its strength and the support it receives from its surroundings. The situation is more complicated for a liner as the deteriorated condition of the host pipe means that the support for the liner cannot readily be determined.

"The research aimed to quantify by how much grouting increases the load carrying capacity of a spiral wound liner compared to an ungrouted liner and also to an unsupported liner inside a rigid host pipe."

This Paper details research to determine the load bearing capacity of grouted spiral liners installed in deteriorated gravity pipelines. The research aimed to quantify by how much grouting increases the load carrying capacity of a spiral wound liner compared to an ungrouted liner and also to an unsupported liner inside a rigid host pipe.

The results of testing have shown that the effect of grout is far greater than previously considered. The implication of this work is that the cost and feasibility of structural renewal of pipelines can be greatly reduced. The research is particularly relevant to earthquake zones, and also allows more efficient design of liners for larger diameter pipelines.

Keywords

Sewer rehabilitation, relining, spiral wound liners, grouting, structural liner design

1. Introduction

Since the start of the Trenchless Technology industry, liners for deteriorated sewers have been structurally designed by applying Standards and methods that apply to flexible pipes installed by traditional trenching. It has always been known that there are gaps in the logic of doing this, but in the absence of consensus on any alternative design method it has become the norm.

Despite these anomalies liners are performing well. We seemingly never hear of properly installed liners failing when subjected to the loads for which they have been designed.

But are these design methods efficient? Are current Specifications resulting in overdesigned sewer liners that are unnecessarily expensive to provide?

"Structural design to determine whether the proposed liner has sufficient strength to carry applied loads obviously requires consideration of the liner characteristics and the support it receives from its surroundings."

Structural design to determine whether the proposed liner has sufficient strength to carry applied loads obviously requires consideration of the liner characteristics and the support it receives from its surroundings.

The situation is more complicated than for the design of buried flexible pipes as the deteriorated condition of the host pipe means that the support for the liner cannot readily be determined. Deteriorated sewers, typically rigid pipes, may be cracked, corroded, displaced or partially collapsed. They come in an infinite range of conditions and internal shapes. Support provided to the liner may not be uniform along its length and around its circumference, meaning a fundamental assumption applied in flexible pipe design is invalid.

Most research has focussed on cured-in-place liners that are installed in a soft condition, moulding to the shape of the host pipe as they are internally pressurised and cured. Liner design methods have been adapted using this research.

Spiral wound or wound-in-place liners provide a circular cross section and uniquely allow the possibility of encasement with cementitious grout after installation. Clearly this grout encasement strengthens and supports the liner, increasing its load carrying capacity. Assumptions are typically applied to account for this strength increase, but research to provide validation has not been carried out until now.

2. Issues with Design Methods

Two design methods are routinely applied in sewer lining Specifications in Australia and New Zealand, depending on the assessed condition of the host pipe.

2.1 Fully Deteriorated Design

The "fully deteriorated" design method assumes that the host pipe has no remaining load carrying capacity and so all loads from soil, groundwater, vehicles etc must be taken by the liner.

The equations used to determine the liner's load carrying capacity are taken from either AS/NZS 2566.1:1998 Buried Flexible Pipes – Part 1: Structural Design or the ASTM Standard Specification for the type of liner proposed.

These two Standards use differently formatted equations, but basically agree that the load carrying capacity of a flexible pipe is a function of the combination of the pipe stiffness and the strength of the embedment surrounding it.

When applied to liner design, no consideration is made of the host pipe surrounding the liner. It is not only assumed that the host pipe has no remaining strength, but also that the host pipe has completely disappeared. It is assumed that the liner is surrounded and supported only by the embedment that originally surrounded the host pipe.

The design method calculates deflection and wall strain in the liner and determines the factor of safety against buckling under full soil and water loads.

There are very few situations where this scenario realistically applies because:

1. The host pipe, while deteriorated, has not collapsed, so is therefore withstanding the applied loads, although with a reduced factor of safety. Assuming the liner takes all applied loads is therefore obviously conservative.
2. Flexible pipe design theory concludes that the stiffness of the embedment around the pipe has the greatest influence on its load carrying capacity. This does not directly apply to liners as the host pipe effectively confines the liner, isolating it from the surrounding embedment.

2.2 Partially Deteriorated or Intact Design

The "partially deteriorated" or "Intact" design scenario considers that the host pipe confines the liner. The host pipe is considered capable of supporting loads from soil and vehicles, so that the load on the liner is only from groundwater infiltration from cracks or leaking joints.

Confining the liner prevents it from deflecting, but as the applied load leads to wall compression, it can fail by buckling.

The Partially Deteriorated design scenario adapts the Timoshenko equation for the buckling resistance of a cylinder subjected to uniform hydrostatic pressure.

This design method can be considered more realistic for liner design as it as it acknowledges the role of the host pipe in confining the liner and isolating it from the surrounding embedment.

Timoshenko's equation for the buckling capacity of a cylinder can be written as:

$$q = \frac{24 \times S}{\left(1-\upsilon^2\right)} \quad \ldots (1)$$

Where: q = applied load

S = Stiffness of the flexible pipe, determined by calculation or testing

υ= Poisson's ratio for the pipe material

For liner design Specifications the equation is modified with additional terms added:

$$q = \frac{24 \times C \times K \times S}{N \times \left(1-\upsilon^2\right)} \quad \ldots (2)$$

The additional terms in this equation that specifically apply to liner design are:

C = a factor to account for ovality of the liner, noting that a cylinder with an oval shaped cross-section has reduced buckling capacity compared to a circular cylinder.

K = a factor to account for the enhancement to the buckling capacity of the liner due to the the restraint provided by the rigid host pipe. The value of K is dependent on how tightly the liner is held by the host pipe. It is varied to account for any gap between the liner and the host pipe, noting that the smaller the gap, the more enhancement is provided against buckling.

N = Factor of safety. Typically a value of 2 is specified.

The ovality factor C is determined from the following equation given in the relevant ASTM Standard Specifications and Australian and New Zealand Water Authority Specifications:

$$C = \left(\frac{1-\Delta}{[1+\Delta]^2} \right)^3 \qquad \ldots (3)$$

Where: Δ = ovality of the liner = (Mean inside diameter – minimum inside diameter) / (Mean inside diameter)

Typically Australian and New Zealand Water Authority Specifications require the value of K to be equal to 4, or 7 when the liner is grouted.

The above design equation has been modified by research conducted mainly in Europe which, while including terms for ovality and degree of fit as above, also includes a load capacity reduction factor to account for a "wavy imperfection" which is considered to be an inherent feature of liners which are installed in a soft state. Testing has shown that even a small "wavy imperfection" can cause a major reduction in load carrying capacity. This factor is not considered in Australian and New Zealand Water Authority Specifications, even though this defect is prevalent in cured-in-place liners.

3. The Test Program

3.1 Aims of the Test Program

Testing has previously been carried out to determine the support provided to cured-in-place liners and the results have generally been applied to the design of all liners.

"The above design equation has been modified by research conducted mainly in Europe which, while including terms for ovality and degree of fit as above, also includes a load capacity reduction factor to account for a "wavy imperfection" which is considered to be an inherent feature of liners which are installed in a soft state."

Until now there was little understanding of how restraint by the host pipe affects spiral wound liners. In particular no attempt had been made to quantify the increase in enhancement provided by grouting.

The testing carried out by Interflow aimed to compare the load carrying capacities of a spiral wound liner in 3 scenarios:

1. Unsupported – not in a host pipe
2. Liner in a host pipe, spirally wound to contact the host pipe wall – not grouted
3. The same liner in 2 (above) but grouted

The load carrying capacities obtained would be compared with calculated values, with back calculation being used to determine

realistic values of enhancement (K) which could be applied in the liner design equation (Equation (2), above).

3.2 Testing Procedures

3.2.1 Theory Behind the Testing

Testing was carried out on a Rotaloc spiral wound liner made with 91-37 UPVC profile. Rotaloc liners have been installed by Interflow in deteriorated sewers with diameters from 1,050mm to 1,800mm.

For the purposes of this testing the Rotaloc liner was wound at an external diameter of 1,200mm. The stiffness of a 91-37 Rotaloc liner wound at a diameter of 1,200mm has previously been tested in accordance with ISO 9969 and found to have a value of 1,559 N/m/m.

Poisson's Ratio (υ) of UPVC is given in Table 2.1 of AS/NZS2566.1 as 0.38.

These values can be substituted in Equation 1 (above) to calculate the expected load that would cause the liner to buckle, as follows:

$$q = \frac{C}{N} \times \frac{24 \times K \times 1{,}559}{\left(1 - .38^2\right)} \times 10^{-3}\ \text{kN/m}^2 \qquad \text{.... (4)}$$

For an unsupported liner, the appropriate value of K = 1. Applying a factor of safety N = 1, bucking can be expected to occur at the following loads when the liner has the ovalities shown in Table 1.

Table 1 – Load to cause full buckling, calculated in accordance with Equation (4) above

% Ovality	Calculated "C"	Calculated Buckling Load
0%	C=1	$q = 43.7$ kN/m^2
2%	C = 0.84	$q = 36.7$ kN/m^2
5%	C = 0.64	$q = 28.0$ kN/m^2

3.2.2 Testing the Unsupported Liner

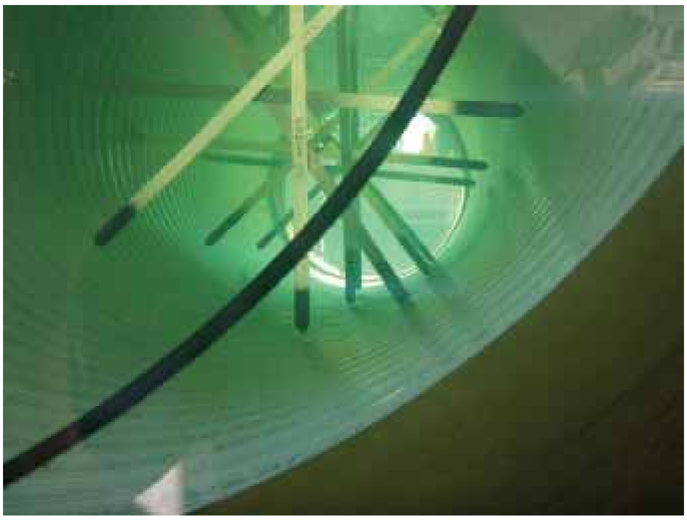
The "Unsupported test" proceeded as follows:

1. A cylindrical "pressure vessel" was fabricated with:
   - Internal diameter = 1,500mm
   - Length = 6,000mm
   - Wall thickness = 12mm
2. A Rotaloc liner with an external diameter of 1,200mm was wound into the pressure vessel. The liner was centred in the pressure vessel, supported by 2 wooden rails running along its length.
3. Steel end rings were placed around the ends of the Rotaloc liner to allow assembling of the sealing bungs. (See Pictures below)
4. The sealing bungs were placed around the ends of the liner, bolted to the flanges on the pressure vessel. This provided a water-tight space between the outside of the liner and the inside of the pressure vessel.
5. Indicator bars were hung inside the liner in 3 positions and in 4 planes at each position. The bars were hung so that the liner would contact the end of one of these bars when its deflection reaches 3%. See Picture 3. This 3% deflection was taken as "buckling failure" to provide a consistent point for comparison in each of the test scenarios.
6. The space between the outside of the liner and inside of the pressure vessel was hydrostatically pressurised.

Pressure was increased until deformation in the liner reached a stage where the inner surface just touched an indicator bar. This occurred at a pressure of 30 kPa.

Picture 1 – Assembly for the unsupported liner test, prior to placing the end sealing bungs. The Rotaloc liner is located centrally in the cylindrical pressure vessel.

Picture 2 – Installing the sealing bungs at the end of the liner



Picture 3 – The inside surface of the liner is just touching the indicator bars, showing that the liner has deflected by 3%. For the purposes of the test, this was taken to indicate that the liner had buckled.

It should be noted that the aim of this test was not to determine the ultimate buckling capacity of the liner. The aim was to test until buckling had reached a particular point, well before buckling failure. The testing could then be repeated for the same liner in confined and grouted conditions, and measurement made of the loads needed for the liner to reach the same point. The difference in load could then be used to calculate the enhancement provided by the confinement and buckling.

By back-calculating, applying 30 kPa as the value for "q" in Equation 2 (above), with N = 1 and K = 1 (as it was unsupported), it can be determined that the appropriate value of "C" was 0.69. This equated to an ovality of 4.2%.

"It could be surmised from the "C" value obtained, that approximately 30% of additional load would need to be applied to reach full buckling of the liner. This is in the order of what would be expected and so provided confidence that the test method was valid."

It could be surmised from the "C" value obtained, that approximately 30% of additional load would need to be applied to reach full buckling of the liner. This is in the order of what would be expected and so provided confidence that the test method was valid.

The precise test method could then be repeated identically until 3% deflection was reached, with the value of C = 0.69 used in calculation to determine values of the Enhancement Factor "K" in Equation 4 (above).

3.2.3 Testing the Supported Underground Liner

A steel tube with an internal diameter of 1,200mm, composed of 6mm steel plate was fabricated in a length of 6 metres. Slots were cut into the tube running longitudinally and spaced around its circumference. (See Picture 4)

The tube was required for use in both the ungrouted and grouted liner testing, with the slots allowing hydrostatic pressure to be applied to the liner.

The inside of the steel tube was heavily greased with a de-bonding agent and tested to confirm that grout would not bond to it.

The Rotaloc liner was wound into the tube, fitting tightly against its inner surface. The tube with the Rotaloc liner inside was inserted into the cylindrical pressure vessel, and centred with wooden rails. (See Picture 5)

The ends of the annulus between the outside of the steel tube and the inside of the pressure vessel were then sealed, and hydrostatic pressure applied.

The inside of the Rotaloc liner touched the 3% deflection indicators at an external hydrostatic pressure of 150 kPa, indicating that the support provided to the liner increased its load carrying capacity by a factor of five (K = 5 in Equations 1 and 2, above)

This compares with a value of C = 4 typically specified for Equation 2 by Australian and New Zealand Water Authority liner design Specifications.

3.2.4 Testing the Supported, Grouted Liner

Following the testing of the ungrouted liner, the steel tube was removed and the slots covered.

Picture 4 – Steel tube fabricated to support the Rotaloc liner to be wound inside it. Slots were cut in the tube to allow hydrostatic pressure to be applied to the liner.

The ends of the liner were sealed with expanding foam and the liner grouted with the normal type of grout and by the normal process used by Interflow to grout spiral wound liners.

Following curing of the grout, the covers over the slots were removed and the liner and its steel tube were re-inserted and re-centred in the pressure vessel. Removing the covers from the slots was necessary to allow the hydrostatic pressure to be applied to the grouted liner.

The annulus around the steel tube was then sealed at the ends and pressure applied.

The maximum hydrostatic pressure available from the pump was 600 kPa. This pressure was reached with no evidence of any deformation of the liner. It was obvious that the pressure carrying capacity of the grouted liner was considerably greater than 600 kPa.

Nevertheless this test showed that grouting of the liner increased its load carrying capacity by a factor greater than 4 compared to an ungrouted liner, and by a factor greater than 20 compared to an unsupported liner.

This factor of 20, which can be applied as the "C" value in Equations (2) and (4), above, compares with a value of 7 for grouted liners commonly specified by Australian and New Zealand Water Authorities.

Picture 5 – Rotaloc liner wound inside the steel tube, and centred in the pressure vessel prior to end sealing of the annulus and hydrostatic testing

Picture 6 – Slots in the steel tube covered while the liner is grouted. The covers were removed prior to it all being inserted into the pressure vessel for testing.

4. Conclusions

This testing has shown that grouted spiral wound liners have much greater load carrying capacity than has previously been assumed by commonly accepted liner design Specifications.

In summary the testing has returned the following results.

Table 2 – "K" Factors from Testing

Liner Support	Test load carrying capacity	"K" from testing	Current "K" design value
Unsupported	30 kN/m^2	1	1
Supported by host pipe	150 kN/m^2	5	4
Supported by host pipe and grouted	+600 kN/m^2	+20	7

The result obtained for the ungrouted liner is consistent with results from previous testing carried out by others on spiral wound and CIPP liners. This provides confidence that the testing method is valid.

It is understood that this is the first comprehensive testing carried out on grouted spiral wound liners. While the magnitude of the result obtained could not be confidently predicted prior to testing, the "K" factor obtained is not unexpected. Grouting can be considered to not only support the spiral wound liner, but also provide it with increased stiffness because of the grout filling in and supporting the tees.

While the testing did not expose the limit of the liner support value provided by grouting because of the limitations of the test equipment, using the value of enhancement factor of K = 20 means that it is valid to conclude that a grouted liner can support far greater loads than previously considered.

The implications of these results are far reaching, particularly for large diameter sewer and stormwater pipelines. While it can result in significant reductions in the cost of pipeline rehabilitation, it makes lining possible in many circumstances where current systems are not able to meet the required stiffness. There are many markets and applications where a change in the cost and engineering dynamics mean the difference between whether or not a viable rehabilitation solution can be provided. ■

The Use of Hydraulic Transient Modelling in the Design of Resilient Pipelines

Alistair Hancox and Grant Pedersen – Harrison Grierson Consultants Limited

Abstract

Pressure surges during the start up, shut down, or sudden power failure of a pipeline can cause operational problems if a pipeline is not designed properly. The issues of buckling under negative pressure and positive pressure peaks which exceed rated pressures can cause a pipeline and its mechanical components to fail much sooner than necessary. The technical challenges encountered when configuring a pipeline for efficient and resilient operation will be looked at.

A long, large diameter polyethylene pipeline exhibits different behaviour to a shorter thin walled mPVC pipeline. The paper will discuss the Surge Analysis of a range of pipelines, solutions to mitigate large surges in pressure, and the analysis and reduction of fatigue loading to extend asset life.

Modelling of such pipelines will be demonstrated through on screen animations and the results of which will be discussed in depth.

Thus, it will be shown how hydraulic transient modelling can be an effective method in identifying problems and developing solutions to ensure pipelines can be designed with resilience in mind and can extend the life of existing assets, saving considerable expenditure.

Keywords

Surge Analysis, Water Hammer, Hytran Modelling, Transients

1. Introduction

Water hammer can occur in pressure pipelines when there is any change inflicted on the fluid being pumped. This can occur during pump start up, change in pump flows, or when pumping stops. Usually, the most severe water hammer can occur when power to a pumping station is switched off suddenly. The momentum of the pumped fluid can cause pressure waves to propagate back and forward along the pipeline. The result of which, are large spikes in positive and negative pressures experienced at particular locations along the rising main.

Hydraulic Transient Modelling is an effective method in highlighting potential problems with newly designed pipelines and can help identify the reasons why an existing pipeline may not be performing adequately. Although a large number of proprietary software packages are available on the market, projects discussed in this paper have been modelled using Hytran water hammer software from Hytran Solutions (NZ).

1.1 Technical Issues

1.1.1 Positive Pressures

When modelling the surge performance of a pipeline, peak positive pressures are one of the key aspects to review. The rated pressure of a pipeline is a maximum pressure which the pipe can be subject to, as specified by the pipe manufacturer. As rising mains are subject to varying degrees of water hammer, it is common practice to design a pipeline so that the normal operating pressure is well below that of the rated pressure of the pipe material used. If specific water hammer modelling is not done, the hydraulic engineer cannot be certain of the magnitude of peak pressures within the pipeline.

Should the rated pressure be exceeded, the rising main's useful life could be reduced, leading to failure.

1.2 Negative pressures

Negative pressures within a pipeline cause buckling of the pipeline and/or cavitation.

A pipeline can buckle if the negative pressures experienced within the line are greater than the structure of the pipe can tolerate, and the pipe will collapse in on itself. This usually only occurs with high negative pressure and relatively thin walled pipes. If surge modelling of a pipeline shows that significant negative pressures are likely, it is prudent to conduct a specific buckling calculation.

Cavitation occurs when the pressure within a pipeline approaches negative 10m head. It is very important that negative surge vacuums of this magnitude be avoided. If cavitation is left to occur often, the fluid can vaporise and condense very rapidly. This will lead to unnecessary degradation to the surrounding pipe and fittings. If cavitation does occur, excessively high positive pressure can be generated when the water columns re-join.

1.3 Fatigue Loading

When some pipe materials are subjected to repeated cyclic loading, which occurs with water hammer, the material can weaken due to fatigue. This type of failure should be checked for, during the design phase, when a large number and/or high amplitude of stress cycles are anticipated. The amplitude or pressure range considered when checking for fatigue loading is defined as the maximum pressure minus the minimum pressure, experienced within a pipeline, during its day to day operation.

For the purpose of pipeline design, if a large pressure range is observed during transient modelling and a pipe material susceptible to fatigue failure is being used, then a fatigue calculation should be done. An illustration of how cyclic loading affects PVC pipe can be seen below in Figure 1.

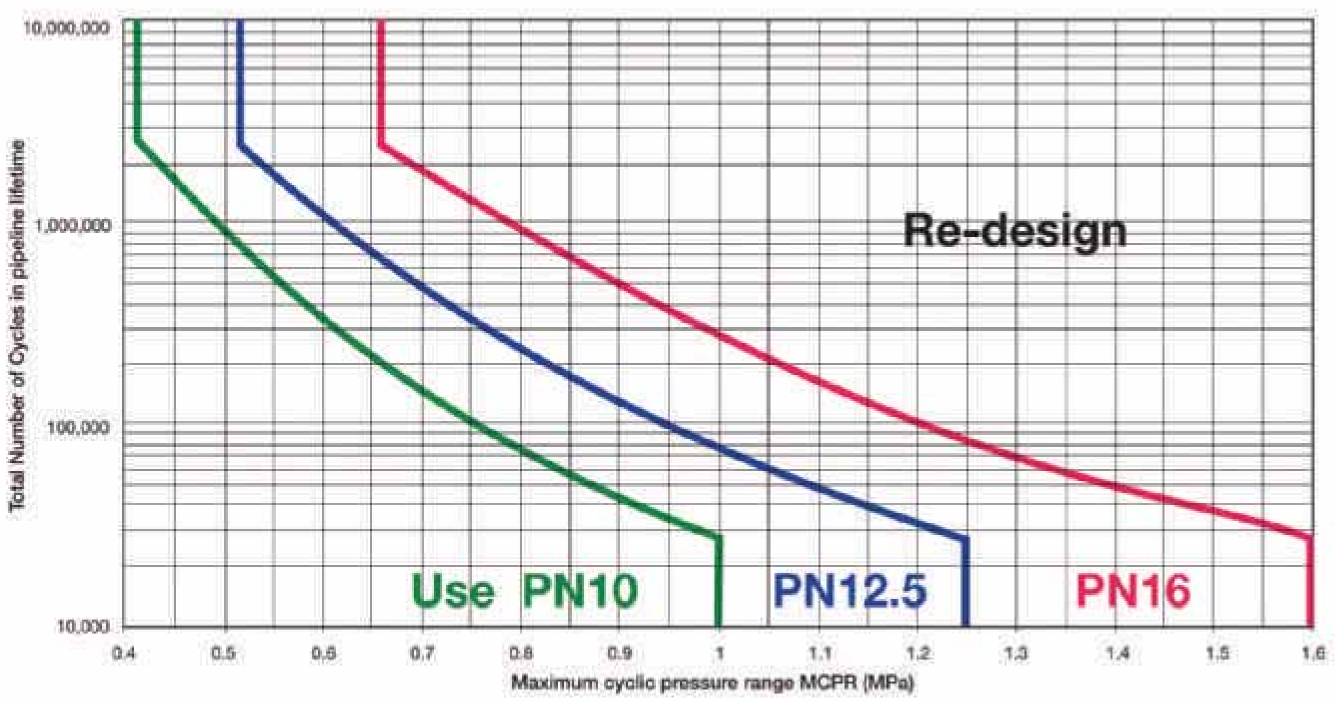


Figure 1 – Re-rated Performance of PVC Piping under Cyclic Loading (Iplex)

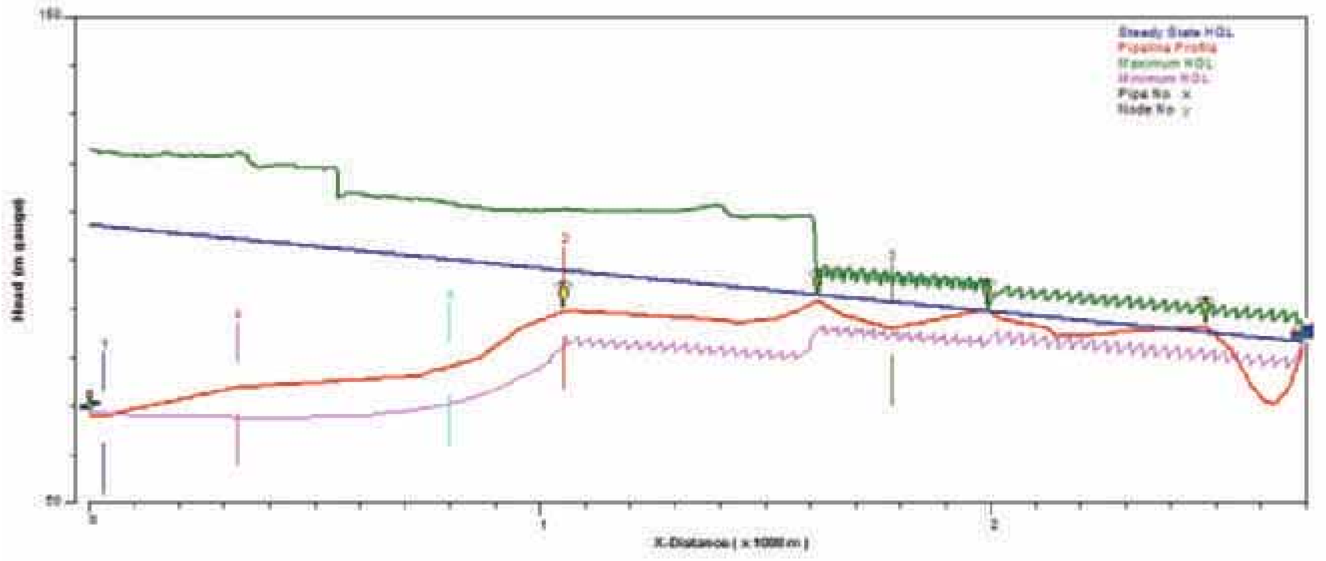
> "Usually, the most severe water hammer can occur when power to a pumping station is switched off suddenly. The momentum of the pumped fluid can cause pressure waves to propagate back and forward along the pipeline. The result of which, are large spikes in positive and negative pressures experienced at particular locations along the rising main."

2. Example Projects

2.1 Mine Process Water Supply – Queensland Outback

The design of a 15.7km rising main, laid mostly above ground, to service the non-potable water requirements of a Queensland mine, resulted in Harrison Grierson being engaged to conduct a hydraulic surge analysis of the project. Due to the semi-arid climate, the pipeline can draw water from two sources, potable water or treated sewage effluent. The layout of the pipeline is shown below in Figure 2.

Figure 2 – Schematic Depiction of Mine Water Pumping System



The main source of water will be the Water Treatment Plant (WTP) pumping station, which takes from the same source as the town's water supply. The secondary source, which will be utilized during dry periods, will be the Sewage Treatment Plant. The specific characteristics of the pumping system are listed below:

Combined Design Flow	=	23.0 l/s
Pipe Material	=	250 OD PE100 SDR 13.5
Length	=	15.7km

The nature of this investigation was to determine whether or not the pipe material, alignment, air valves specified, and air valve locations were all suitable and did not cause any undesirable affects to the pipeline during its everyday running and during sudden power failure.

2.1.1 Modelling Analysis

The rising main was modelled to determine the effects of a sudden power failure would have on the system. Figure 3, below, shows the steady state hydraulic grade line (HGL) for the scenario of when both pumping stations producing the combined flow of 23.0 l/s, shown from the WTP pumping station to the discharge point.

When a water hammer model is run, there are two significant ways to view the output data. Firstly, a pressure envelope is produced which shows the maximum and minimum pressures experienced at every location along the pipeline, during a surge event of a specified time duration. The other way is to view the transient data with respect to time at key locations along the pipeline. The transient data locations for this model can be seen above in Figure 3 as the vertical lines labelled 1, 2, and 3. At these locations, the instantaneous pressure is plotted against time to show the analyser exactly when, and to what magnitude, pressure spikes are experienced. Figure 4 and Figure 5 show the Hydraulic Grade Line Envelope and the Transient plots for this model.

> "A pipeline can buckle if the negative pressures experienced within the line are greater than the structure of the pipe can tolerate, and the pipe will collapse in on itself."

Figure 3 – Mine Water Rising Main – Steady State Hydraulic Grade Line

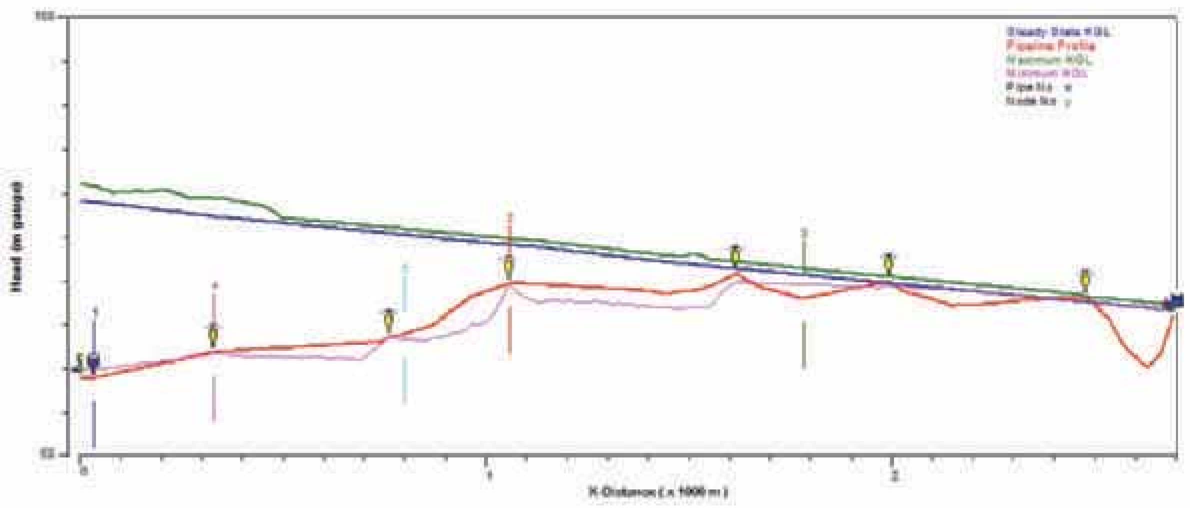


Figure 4 – Mine Water Rising Main Power Failure – HGL Envelope

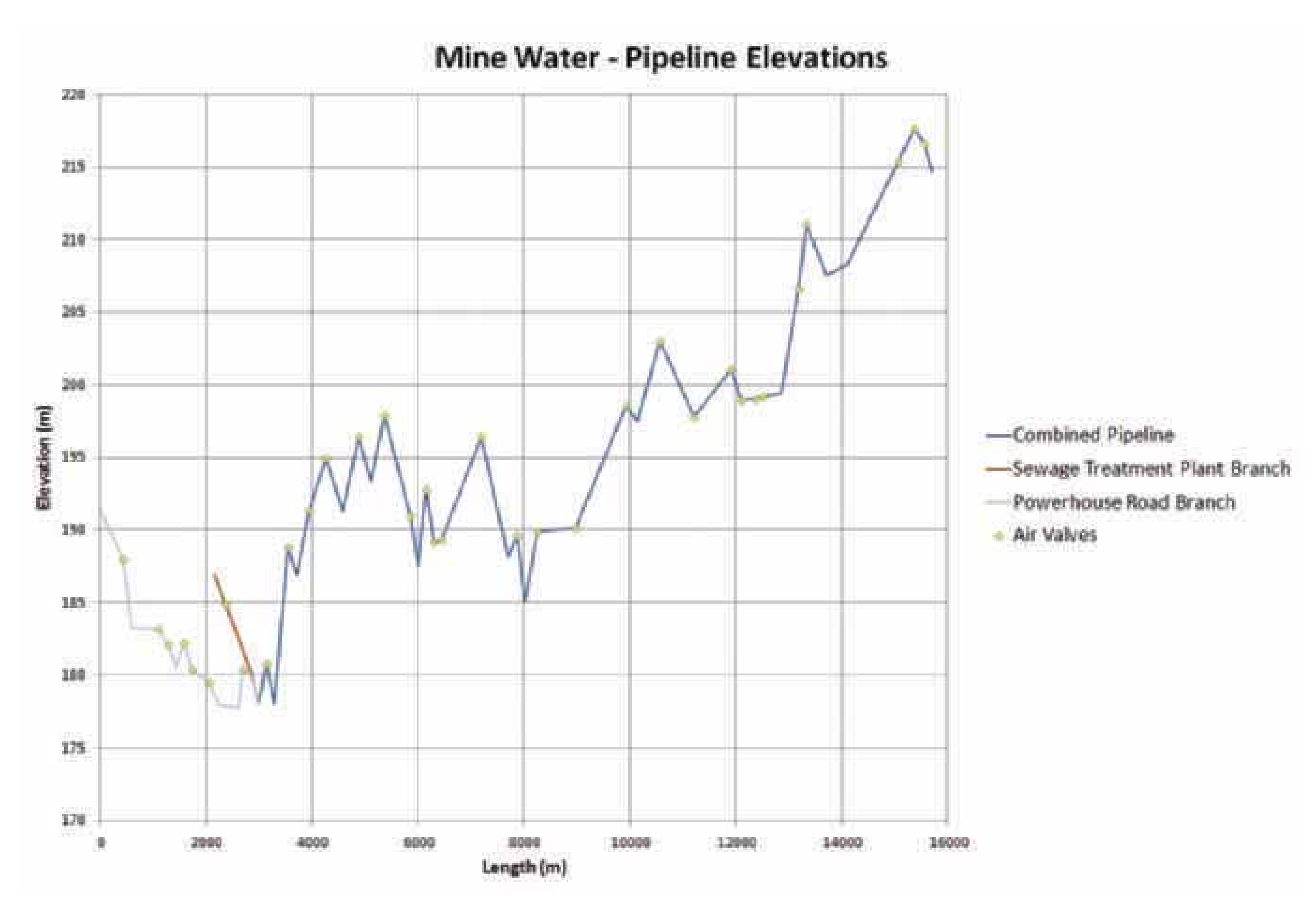
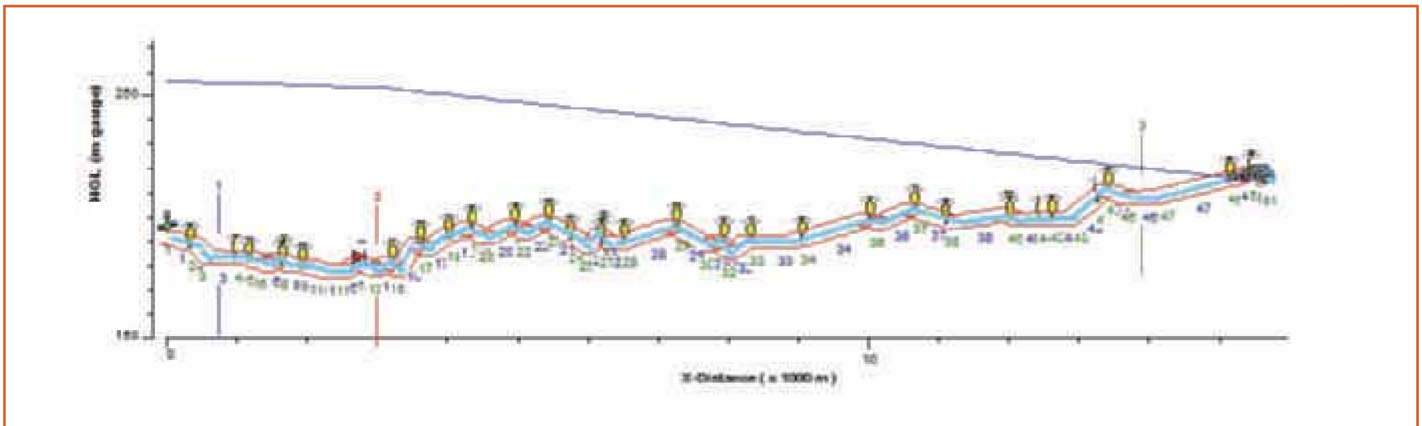


Figure 5 – Mine Water Rising Main – Transients Plot



What can be observed from looking at the HGL envelope in Figure 4 is that nowhere along the rising main do significant pressure fluctuations appear to be present. The steady state HGL follows the profiles of the maximum HGL quite closely, with no clear spikes.

The transient plot locations were chosen as they are points where large fluctuations in pressure can commonly occur during a surge event. Some of the maximum pressures experienced in a pipeline during a sudden power failure will be at the pumping station itself.

In this case, the results show that upon power failure, there is a gradual fall in pressure at all three locations, with no significant pressure fluctuations observed. This is often the case in long rising mains with relatively low flows.

2.2 Wastewater Rising Main – New Zealand

For this project it was necessary to investigate the expected surge within this wastewater rising main produced by two pumping stations, named PS2 and PS3. Both pumping stations will operate independently and therefore, could be pumping on their own or simultaneously. The intended pipe material for this project is polyethylene. The calculated flows expected can be seen over page in Table 1.

Table 1 – Pump Flows – PS2 and PS3

	PS2	PS3	Combined Flow
Calculated pump flow with pump running at PS2	39	0	39
Calculated pump flow with pump running at PS3	0	62	62
Calculated pump flow with pump running at PS2 and PS3	33	58	91

The layout of the rising main network is shown in Figure 6.

"These pumping stations and pipelines had been designed but had not yet been constructed. It was anticipated that water hammer was going to be an issue with this pumping system as the flows are relatively high for such a short rising main."

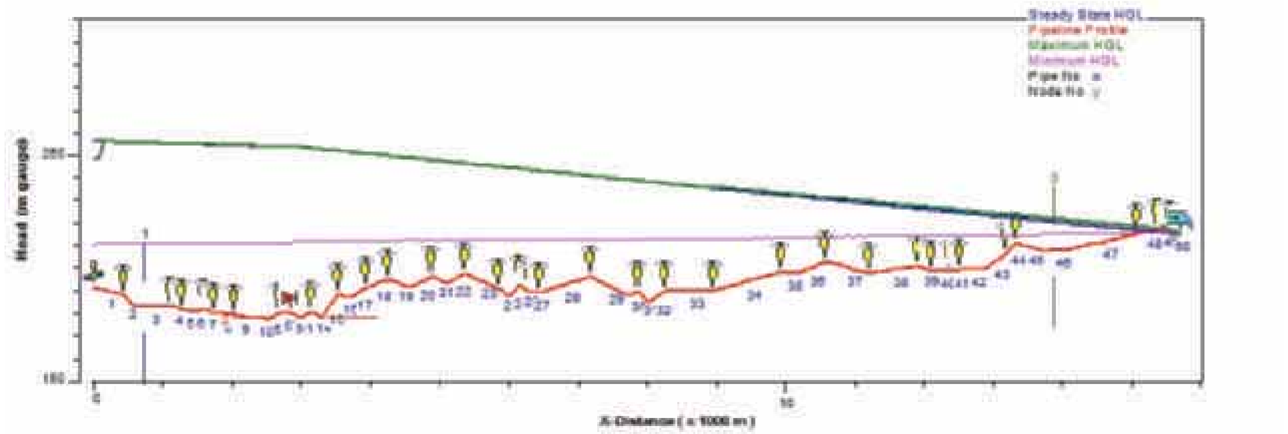


Figure 6 – Schematic Depiction of PS2 and PS3 Rising Main

These pumping stations and pipelines had been designed but had not yet been constructed. It was anticipated that water hammer was going to be an issue with this pumping system as the flows are relatively high for such a short rising main.

This system was analysed using anti-slam air release valves located at each pumping station and at the intermediate high point. Non-return valves were proposed at each pumping station (on the pump discharge pipes) and also on each pipe at the junction, where the rising main from PS2 joins the larger rising main from PS3.

2.2.1 Modelling Analysis

The cases considered for water hammer modelling were;

a. PS2 operating, normal shut down by soft stop controller
b. PS3 operating, normal shut down by soft stop controller
c. Sudden power failure, PS2 operating
d. Sudden power failure, PS3 operating
e. Sudden power failure, both PS2 and PS3 operating simultaneously.

Cases a) and b) are likely to occur several times per day. It is important that these occur without putting undue stress and cyclic loading on the pipeline. As the flow through PS3 is larger than that of PS2, case b) was modelled to show the everyday stresses on the pipeline.

Cases c) and d) will occur relatively infrequently. Power failures to either pumping station may only occur once every year or so. Case e) is an unlikely "worst case" scenario, and would only be expected to happen once every 5 to 10 years. Though the stresses exerted on the pipeline for these three cases are expected to be of a higher magnitude than that of cases a) and b), the events will occur only seldom, and therefore this higher level of stress should be acceptable and not result in material fatigue over the life of the pipe. In all cases, the maximum working pressure of the pipe must not be exceeded, and the pipe must not collapse under a vacuum. Fatigue will not be an issue for cases c), d), and e) as the frequency levels are very low.

Case b)

The soft stop for PS3 was set at 60 seconds. This was adequate to slow down the momentum of the pumped fluid sufficiently to reduce any severe spikes in pressure. Figure 7 shows the HGL envelope for this scenario. Here we can see that nowhere along the pipeline does the pressure spike to above that of the steady state HGL and that the minimum HGL never drops below the profile of the pipeline, which would indicate a vacuum.

It should also be noted that the largest pressure range seen in this scenario occurs at the pumping station, measured by transient 1. The fluctuations in pressure deviate from 10m head up to 28m head. This cycle of 1.8bar is significantly low enough that this pipeline will not be affected by fatigue.

Case e)

The worst case scenario of case e) was modelled to find the maximum stresses which are likely to occur within the pipeline. It is clearly shown in Figure 8 and Figure 9 that when there is a sudden power failure while both pumping stations are running, large down surges are produced in the rising main.

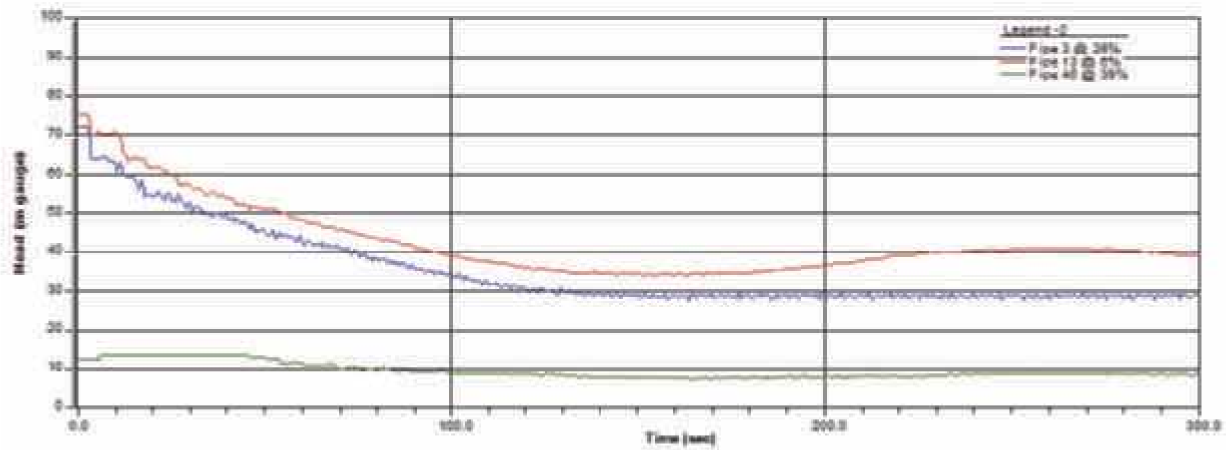


Figure 7 – PS3 Soft Stop – HGL Envelope

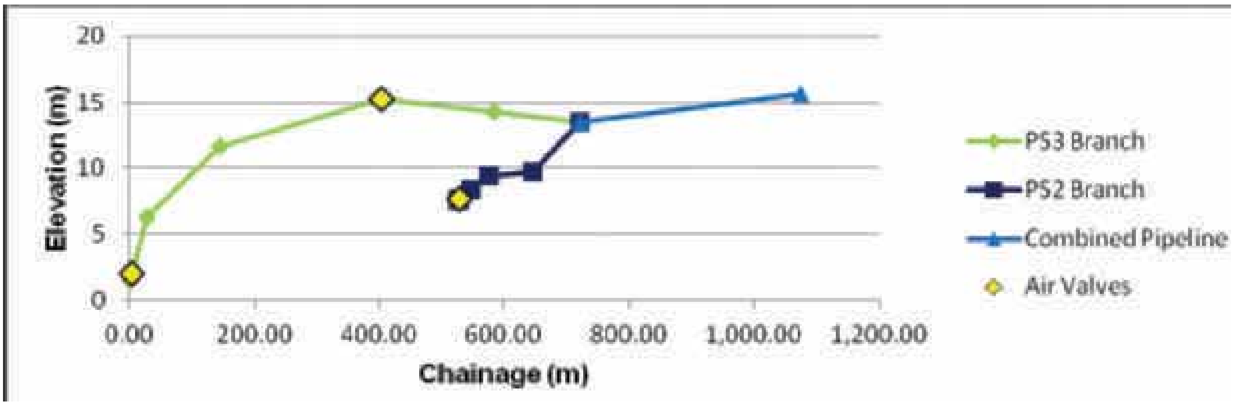


Figure 8 – PS2 and PS3 Power Failure – HGL Envelope

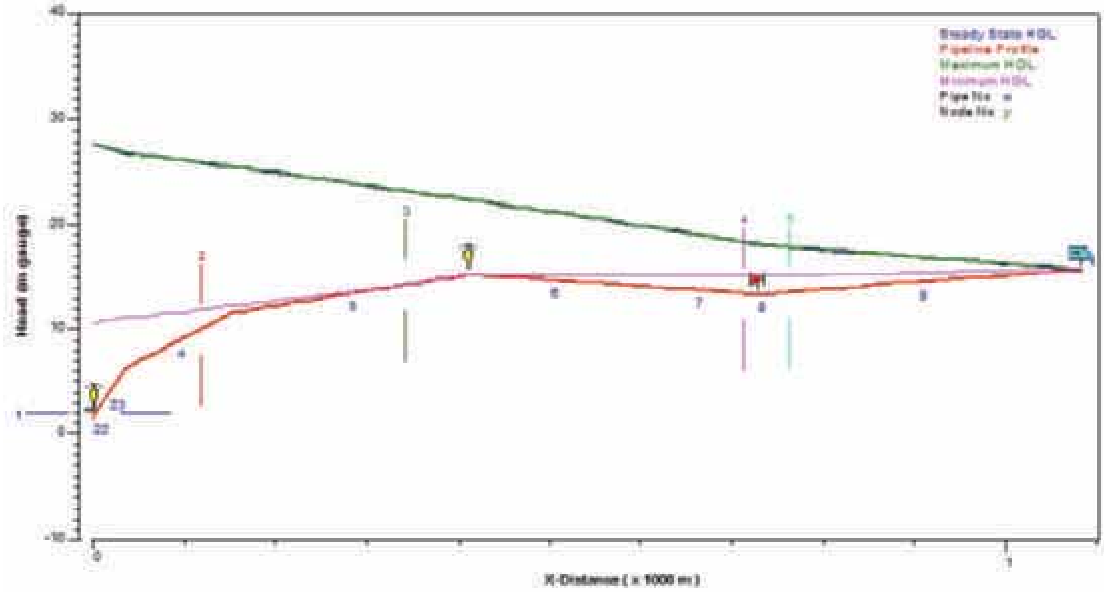


Figure 9 – PS2 and PS3 Power Failure – Transient Plot

The model for case e) was run for 60 seconds. The surge which appears to reverberate in the pipeline has a maximum pressure observed of around 4 bar. The pipe materials being considered for this project all have a rating of at least 10 bar, therefore the maximum upsurge pressure is not a design constraint.

> "When modelling the surge performance of a pipeline, peak positive pressures are one of the key aspects to review."

The maximum downsurge pressures, however, are a point of concern. Transient 3 shows pressure within the pipeline dropping, virtually to -10m head, almost a complete vacuum. This finding highlighted the need to check the pipe specification for buckling.

The pipe buckling calculation was conducted in accordance with AS/NZS 2566. It was found that PN10 pipe was theoretically non-compliant under the imposed vacuum of -10m, whereas PN12.5 pipe was compliant. Therefore, PN 12.5 polyethylene pipe was selected as the pipe material for this project as part of the detailed design.

It is acknowledged that at negative pressure of -10m, cavitation could occur. However, due to the infrequent occurrence of this event, it is unlikely to result in damage or fatigue of the pipeline.

2.3 Treated Effluent Pumping – New Zealand

Harrison Grierson was commissioned to prepare a report to identify concept design solutions for increasing an effluent pumping station capacity from 420 m^3/h, up to 700 m^3/h. The existing rising main is a 2.7km long, 375mm mPVC class C pipeline delivering effluent from the oxidation pond to a marine outfall.

It was found that the maximum pressure which could be expected upon power failure would be around 63m at the pumping station, decreasing rapidly along the line. As this pressure was marginally over the de-rated pressure rating of 6 bar for the pipe, it was recommended that the first 200 to 300m of the pipeline be replaced with 10 bar rated PE pipe. Figure 10, below, shows the system pumping at 700 m^3/h and reacting to a sudden power failure.

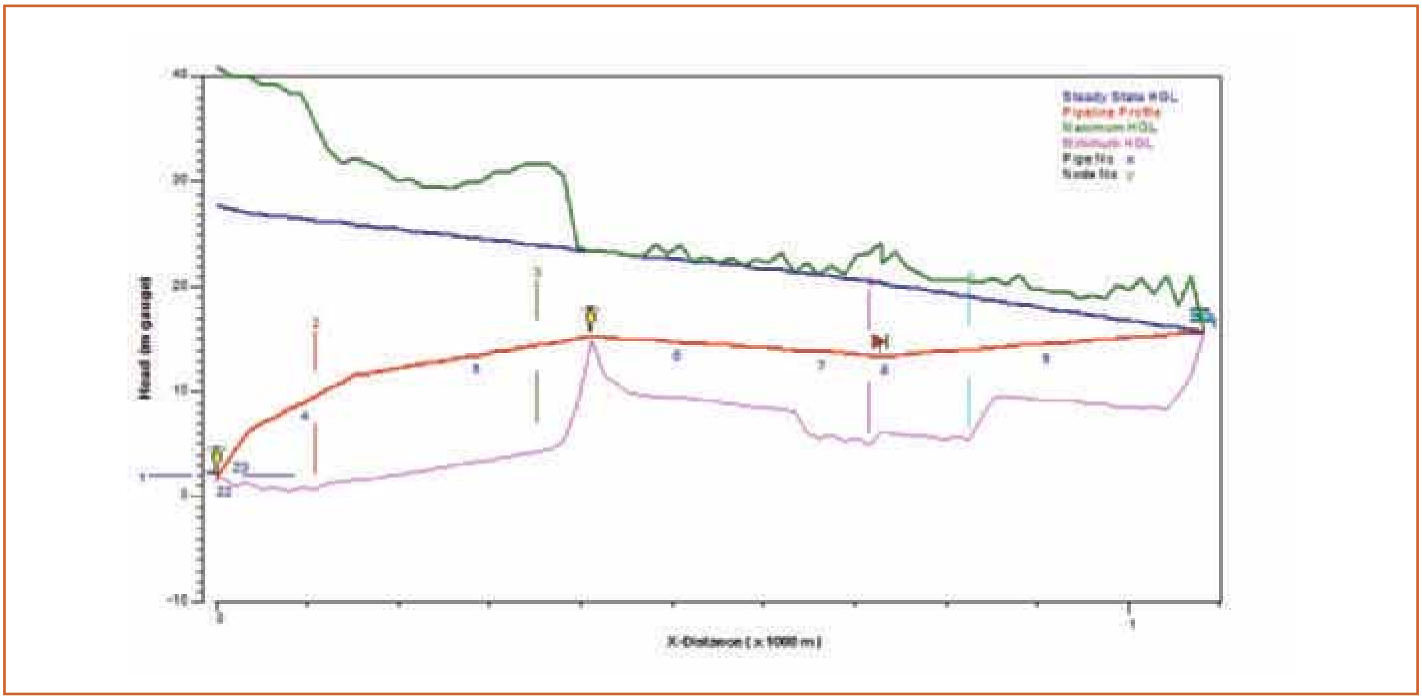


Figure 10 – Effluent Pumping Power Failure – HGL Envelope

A range of pump upgrades were reviewed for this project. It was recommended that a pump with the ability to have the impellor upgraded at a later date would give the client the most flexibility with regards to increasing capacity of the pumping station in the future. Variable speed drive (VSD) units were proposed which would reduce surge effects during normal operation by slowly ramping up and down the pump performance. Under these conditions, maximum positive and negative pressures will be kept well within acceptable limits of the pipe material, and will also reduce fatigue. However, as Figure 10 shows, under the power failure scenario, there are negative pressures of up to -10m in places, which is excessive.

The proposed solution for this was the addition of two air valves situated within the first kilometre of the rising main, and a 2m^3 hydro-pneumatic tank installed immediately downstream of the pumping station. The results were extremely successful. Figure 11 shows how the maximum negative pressures were reduced considerably, as well as reducing the maximum positive surge spikes to only slightly above the steady state HGL.

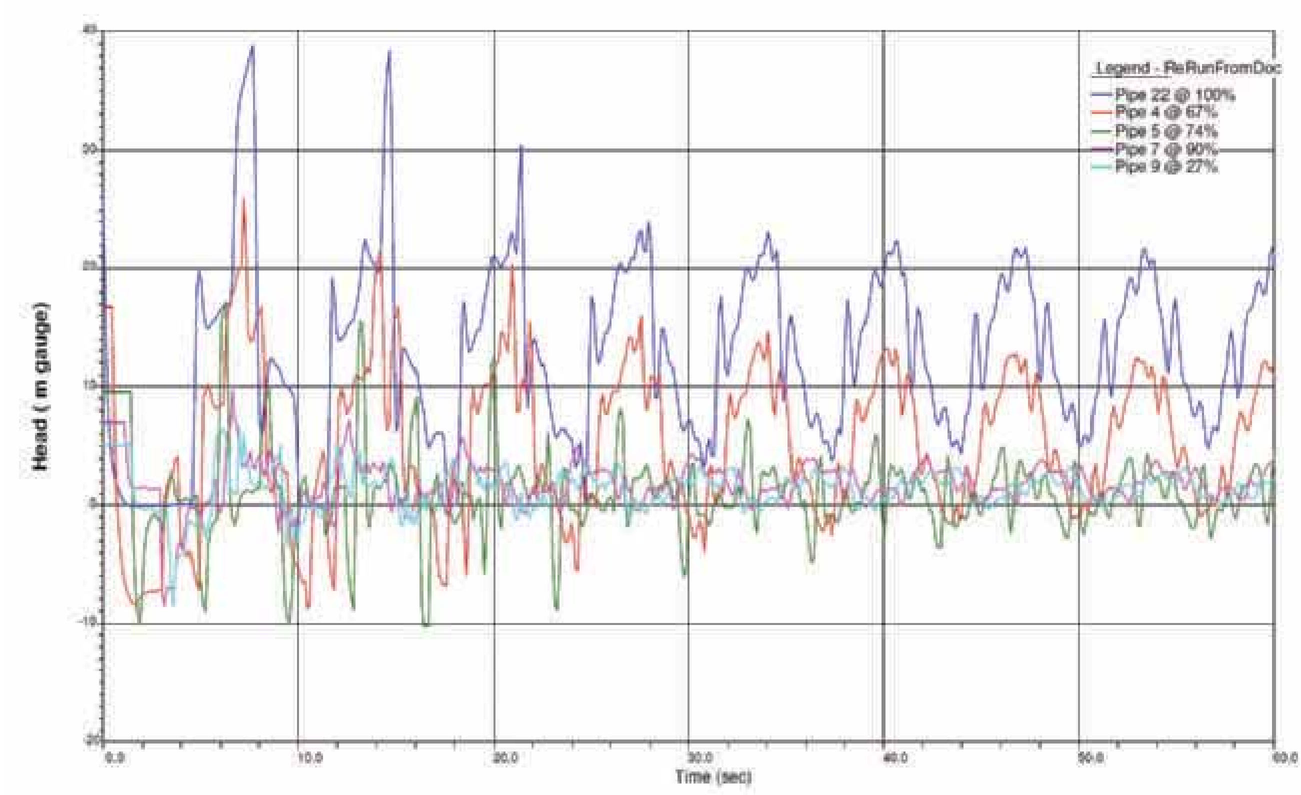


Figure 11 – Effluent Pumping Power Failure (with a Hydro-Pneumatic Tank Installed) – HGL Envelope

2.4 Meatworks Effluent Rising Main – New Zealand

An aging 1.5 km DN 200 asbestos cement (AC) rising main had failed several times and both the council and company were concerned about maintaining operation of this pipe until a new pipeline could be built in about two years time. Harrison Grierson were asked to consider possible causes of the failure and to suggest temporary solutions.

Pressure testing of the pipeline was done during regular start up and shut down. The operating pressure at the pumping station was measured at 53m head. Field testing showed that surge spikes were observed 10 seconds after pump shut down, with pressure fluctuations ranging from 0m to 63m head.

As the budget for this project was limited, specific water hammer modelling was not an option and this field testing of the pipeline was what recommendations needed to be based on. It was assumed that the existing VSD was ramping down too quickly and the suggestion was made to repeat the field testing with the VSD speed ramp down set to a longer period. The results were that surge rebound reduced to 42m, which was less than the 53m of the operating pressure.

After these operational changes were made, no more pipeline failure occurred under normal operating conditions, and the pipeline was decommissioned a few years later. The changes suggested did not require any capital expenditure, an excellent result for both the company and the environment.

3. Technical Comparisons

The technical data associated with the projects discussed in this paper is given in brief below.

Table 2 – Comparison of Pumping Systems

Project	Flow	Maximum Positive Head	Mitigated Maximum Positive Head	Maximum Negative Head	Mitigated Maximum Negative Head	Surge Mitigation Method	Rising Main Length	Pipe Material	Pipe Diameter	Flow Velocity
	L/s	m	m	m	m		m		mm	m/s
Mine Water Supply Pipeline							**15700**			
Water Treatment Plant to Junction	11.5	72	-	-	-		3000	PE100 SDR13.6	250 OD	0.33
Sewerage Treatment Plant to Junction	11.5	75	-	-	-	-	830	PE100 SDR13.6	250 OD	0.33
Junction to Discharge Point	23	76	-	-2	-		12700	PE100 SDR13.6	250 OD	0.65
Wastewater Rising Main							**1080**			
PS3 to Junction	58	40	26	-10	0		404	PE100 SDR17	280 OD	1.32
PS2 to Junction	33	24	17	-7	0	Soft Stop	199	PE100 SDR17	200 OD	1.56
Junction to Discharge Point	91	10	7	-8	0		676	PE100 SDR17	315 OD	1.60
Treated Effluent Pumping Rising Main							**2658**			
Pumping Station to 1000m	194	55	44	-10	-7	Hydro-Pneumatic Tank + 2 additional Air Valves	1000	mPVC	DN 375	1.80
1000m to Discharge Point	194	24	14	-10	-5		1658	mPVC	DN 375	1.80
Meatworks Effluent Rising Main										
Pumping Station to Gravity Wastewater Line	55	63	42	14	-	VSD Re-programmed	1510	AC	DN 200	1.77

4. Conclusions

Many problems can arise when one endeavours to design an efficient and resilient pipeline. A number of technical issues need to be carefully thought through in order for adequate longevity of a pipeline to be achieved. With forward thought at the design phase of a project, it is possible to see the potential problems which could present themselves, and save on costs in the long run.

This paper has shown that hydraulic transient modelling is an effective tool in predicting the behaviour of a pipeline under a range of conditions. It is evident that a lot more thought goes into fixing the water hammer problems of existing rising mains than what is needed at the design phase of a project.

Experienced designers will know when it is important to analyse pipelines for water hammer, fatigue, and buckling. Failure to perform the analysis of these factors can lead to premature and sometimes catastrophic pipeline failure, possibly with serious environmental consequences.

Effective modelling and analysis for water hammer, fatigue, and buckling can avoid costly errors and achieve economic solutions to mitigate serious problems. ■

Acknowledgements

Dr. Norman Lawgun – Hytran Solutions (NZ)

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Hytran Software Manual

"Many problems can arise when one endeavours to design an efficient and resilient pipeline. A number of technical issues need to be carefully thought through in order for adequate longevity of a pipeline to be achieved."

Surfing the Wave: Using Social Media to Gather Usable Data on Flood Extents

A. E. Marburg and R. Orr – GHD Limited and H. Hewson

Abstract

Floods, and other natural disasters, present a challenge to local communities: during a major event, the priority is attempting to reduce the damage; however, knowing exactly how widespread the flooding was is necessary to evaluate computer models and plan work to mitigate further damage during future events. Unfortunately by the time the emergency response has been carried out and attention is turned to data collection, evidence and information is often no longer readily available.

The explosion of social media in recent years has seen a greater number of recorded observations captured by the public during natural disasters that includes precise time and location information with a large geographic distribution. Using social media to solicit photos from the public during a natural disaster provides an opportunity to collect first-hand data that requires minimal effort and financial investment.

Following the widespread flooding in Christchurch on 3–5 March 2014, GHD tested the potential of social media to collect real time data. By using a social media platform, we hoped to reach people where they were – lowering the barriers to participation and broadening the audience.

All photos received through this Facebook page were geocoded, allowing the geographic spread of the data to be easily seen and overlaid with other sources of information. The results show that social media has strong promise in the collection of data during natural disaster events such as major floods.

Keywords

Social Media, Facebook, Flooding, Flood Mapping, Modelling, Data Collection GIS

1. Introduction

On 3–5 March Christchurch received 150 mm of rain (Botanic Gardens Rain Gauge, Harrington 2014). The storm had disparate impacts across the city – in some areas it has been estimated as a 1/100 year event but in others not even a 1/10 (Harrington 2014). Widespread flooding was reported across the city. The Avon and the Heathcote Rivers both burst their banks in multiple places and several major arterials were closed (Christchurch City Council 2014).

The standard approach to understanding the impacts of an event of this magnitude is to mark peak water levels on buildings, fences and other landmarks for subsequent surveying. Christchurch City Council launched a major effort to do just that as soon as council officers could turn their attention from the emergency response – with staff in the field 36 hours after the rain stopped (Colin Forsyth, pers. com). However, by the second day of field work, direct evidence of flood extent was already fading (Kate Dawkings and Jalan McGrory, pers. com). This highlights the central difficulty of natural hazard management: during a major event, the priority is attempting to reduce the damage; however, knowing exactly how widespread the flooding was is necessary to evaluate computer models and plan work to mitigate further damage during future events. Unfortunately by the time the emergency response has been carried out and attention is turned to data collection, direct evidence of impacts is often no longer readily available.

> "Using social media to solicit photos from the public during an event provides a partial solution to these problems. It provides an opportunity to collect needed data with only a small investment of effort and also gives community members a platform to contribute."

An additional challenge for flood modeling in particular is that many streams, even those running through urban areas are ungauged. Due to the nature of its failure mode relative to wastewater and water supply, upgrades to the stormwater network are often deferred – until flooding occurs. In many modeling projects calibration efforts are focused on matching peak flow (e.g DHI 2014, Atiquzzman et al. 2009, but see Horritt and Bates 2002). This puts local authorities in the unenviable position of explaining to ratepayers that they need to wait for the next event to begin planning mitigation options. A richer data set on flood extent could enable model refinement and options testing to begin almost immediately.

Using social media to solicit photos from the public during an event provides a partial solution to these problems. It provides an opportunity to collect needed data with only a small investment of effort and also gives community members a platform to contribute. The explosion of social media in recent years means that there are now many more recorded observations during natural disasters – with more precise time and location information, and greater geographic distribution – than could ever be collected by paid staff, even if they had the time to collect data during the event (Goodchild and Glennon 2010).

In order to leverage these new data sources to full effect, however, they need to be organized into a form that allows both quick overviews and examination of fine detail. The techniques used to interpret these data also need to accommodate their limitations – they are ephemeral, of mixed quality and haphazardly located. Geodatabases are a mature technology well suited to storing and managing these data.

2. Using Social Media

Social media is generally defined as platforms where the audience also creates the content. Facebook is perhaps the most well-known, but other platforms have emerged in recent years (Leverage New Age Media 2014). The large and engaged user base lends itself to crowd sourcing projects. Crowd sourcing is "the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people" (Marchionda 2014); before the invention of the internet, particularly social media, this would have been an arduous, time consuming and costly task.

Social media crowd sourcing can be distinguished from 'crowd sourcing' more generally. Many crowdsourcing projects build a custom application for collecting data and thus depend on an enthusiastic user base to seek them out and fill out data (Gao et al. 2011, Goodchild and Glennon 2010). GeoNet is probably the most well-known example of 'crowd sourcing' natural hazard data in New Zealand. In contrast, crowd sourcing using social media uses an existing platform which lowers development costs and substantially broadens the user base (Marchionda 2014).

Following the widespread flooding in Christchurch on 3–5 March 2014, we were interested in the possibility of crowd sourcing flooding data for use calibrating hydraulic models. Given the reactive nature of this project – we started this pilot project days after the event – we decided to test the potential of social media in the hope that the residents of Christchurch had stored photos that could be uploaded with ease. We chose a fast and low cost approach for this pilot project, both in terms of budget and effort; a Facebook page named "Christchurch Flood Info Collection". The page was leveraged through personal social networks and an investment of $250 in advertising purely through Facebook.

2.1 Why Facebook

In using an existing, broadly popular social media platform, we lowered the barriers to participation and broadened the audience (Marchionda 2014). There are a number of platforms that are popular in New Zealand, and choosing the correct platform was critical to the success of the Christchurch Flood Info Collection campaign (Leverage New Age Media 2014).

When choosing the platform we considered a number of factors including usage in New Zealand, demographics and ease of use. Our knowledge of social media sites was a significant factor as the campaign needed to be started within hours of deciding to attempt data gathering using social media. We considered two platforms, which we believed had the following in New Zealand to be able to deliver the results required: Facebook and Twitter.

Facebook is the most widely used social media platform in New Zealand with 2.4 million users country wide, significantly more than Twitter at 351,845 users (Ad Corp, 2013). We also considered that Facebook had the edge regarding ease of use and a wider demographic. The Facebook page format also facilitates display of photographs, which can both provide useful data and promote interest in the page.

Knowledge of the potential for Facebook advertising was also a significant factor in our decision, as Facebook allowed for the direct targeting of specific communities that were affected. We hypothesized that many Facebook users would be taking photos of surface flooding in their own neighborhoods and on their own properties and sharing it with their friends. By providing a low-effort way to share that information we hoped to broaden the base of information beyond those complaints already gathered by Council through its call center.

Due to the low cost of entry we decided to set up a Facebook page and monitor progress for the weekend to determine if the page would deliver any results.

2.2 Setting up the Facebook Page

The Facebook page "Christchurch Flood Info Collection" was set up in the evening of the 7 March 2014, effectively three days after the event we were seeking information on.

Set up time for a basic page such as "Christchurch Flood Info Collection" is minimal, in this case under half an hour including adding photos, and the first two posts on the timeline. We chose a "Community Page", which is a page about a topic that doesn't have official representation (Facebook, 2014). This was important as it does not require the page to be branded (Figure 2). The merits of branded vs. non-branded campaigns are further discussed in section 2.2.1.

Figure 1 – Social Media Statistics (Data from Ad Corp, 2013)

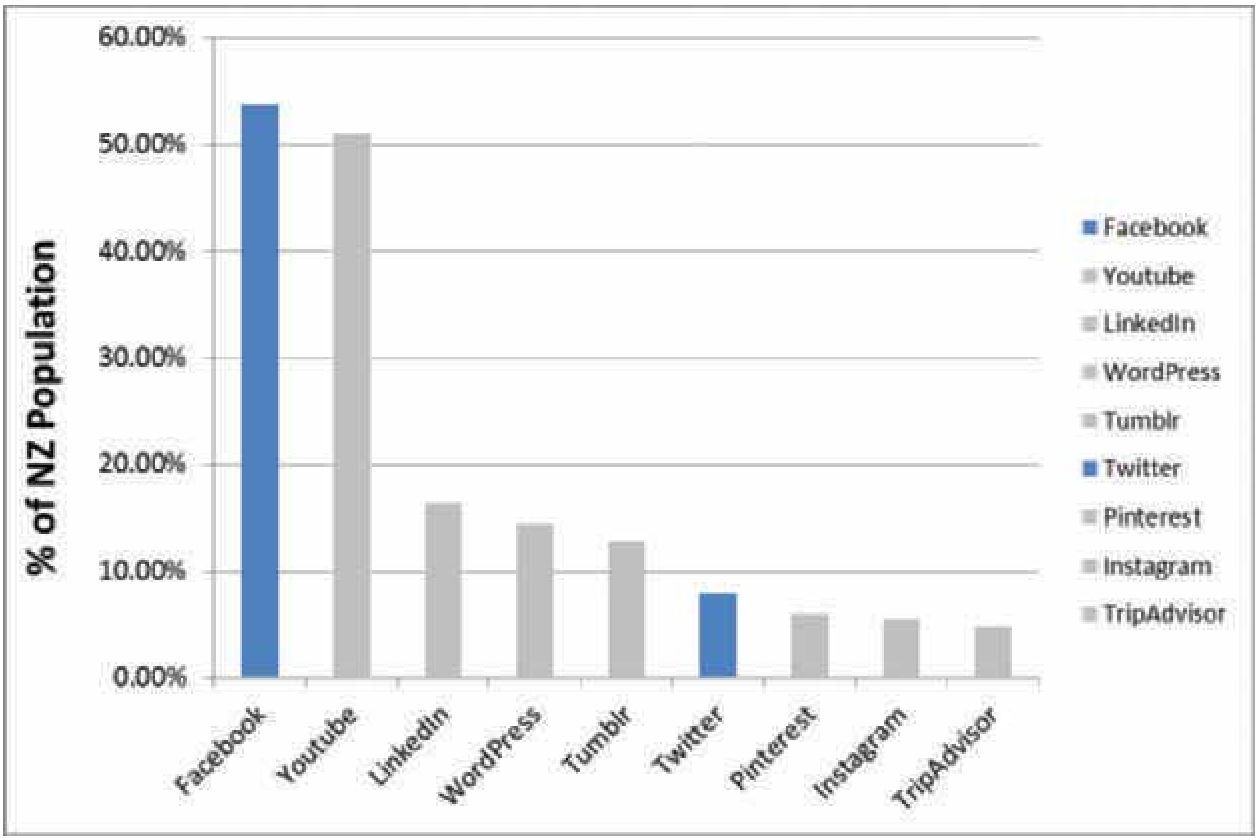


Figure 2 – Christchurch Flood Info Collection Banner (Facebook, 2014)

The page was set up with the description "A place to collect information on the Christchurch flood. This information will help us understand how vulnerable different parts of Christchurch are to flooding." Based on advice from GHD's corporate communications team (Ryan Orr, pers. Com) we also included "If you need emergency assistance please contact emergency services" to reduce the risk of page receiving posts requesting emergency assistance.

The Facebook page allows users to "like" the page, which represents a connection to the page, and to share information on the page's 'timeline' (where the public were asked to post their flooding photos). The page also allowed users to send private messages to the administrators of the page and to view photos uploaded by "Christchurch Flood Info Collection"

As shown in figure 3 our first communication on the page was simple, requesting people comment as to their flooding issues with information on the location and depth along with a hashtag to see if we could start a trending topic on Facebook. As we had minimal page likes at this time the post only reached 563 people.

Figure 3 – Christchurch Flood Info Collection First Post (Facebook, 2014)

Another important aspect of the page set up was leveraging personal connections; the authors of this paper asked personal connections to like and share the page to friends. A large number of GHD staff also shared the page on Facebook. The page was also shared on other social medial platforms including Twitter and LinkedIn, directing people back to Facebook to post their flooding photos.

Following the first post it was decided that relying on flood depth to be reported by the public could be difficult to verify and that we were missing out on potential information that could be gained by asking for photos of the flooding. The post shown in figure 4 was therefore put up on the page on the morning of the 8 March. The post was deliberately humorous as we were attempting to target a younger demographic (ages 18 – 35), making the assumption that this demographic would more likely have photos of the flooding saved with the knowledge of how to quickly upload and share them. This was critical to the success of the page, reaching almost 3,000 people. A weakness of using a humorous image like the one in the advert to the left is that it is not clear that the image is not from Christchurch, and it could be interpreted as making light of a potentially life threatening situation.

Figure 4 – Christchurch Flood Info Collection Second Post (Facebook, 2014)

2.2.1 Anonymous v Branded Page

As time was of the essence when the page was set up, agreement was not sought from the communications teams at Christchurch City Council or GHD to set up the page with branding, therefore the page was set up independently. This approach has its strengths and weaknesses.

Having the page set up without a brand results in no carry over brand association, the strengths of this being that if a Facebook user has had a bad experience with the associated brand than this can result in negative messages being posted to the page. Conversely, a previously positive experience with a brand can result in positive messages being posted to the page with users more likely to promote the page. A weakness of no brand association is that it isn't possible to leverage off existing connections so a page audience needs to be built from scratch. Should a branded page be set up similar to "Christchurch Flood Info Collection" in the future, there is a potential benefit of keeping public informed and also using the page after the event for public relations, posting the results of the photo mapping and any plans to resolve flooding issues.

2.3 Managing the Facebook Page

After reviewing activity over the first several hours, we realised that keeping the page active would be key to achieving the maximum engagement possible in a short timeframe. We also decided that undertaking marketing on Facebook was necessary to grow page likes and page engagement.

2.3.1 Marketing Strategy

In realizing that we had a limited time before interest in the flooding waned we used Facebook's advertising functions extensively to grow page likes and page engagement. Facebook allows users to sponsor posts on Facebook using specifically developed advertising methodologies designed to result in Page Post Engagement, Page Likes, Clicks to a Website, Website Conversions, App Installations, App Engagement, Event Responses, Offer Claims. We focused on building Page likes and Page Post Engagement. Our strategy was to build the Audience of the Facebook page (page likes) then target these people with requests for flooding information.

In the first 2 days the page was live we extensively targeted page likes to build the pages audience. Building the number of likes was important as people who have liked the page see posts from the page in their timelines more frequently, leading to better page engagement. From a total of 850 page likes 132 page likes were derived directly from page advertising, another 300 were derived from friends of the 132 people who liked the page. An example of the sponsored post used to build page likes is shown in figure 5.

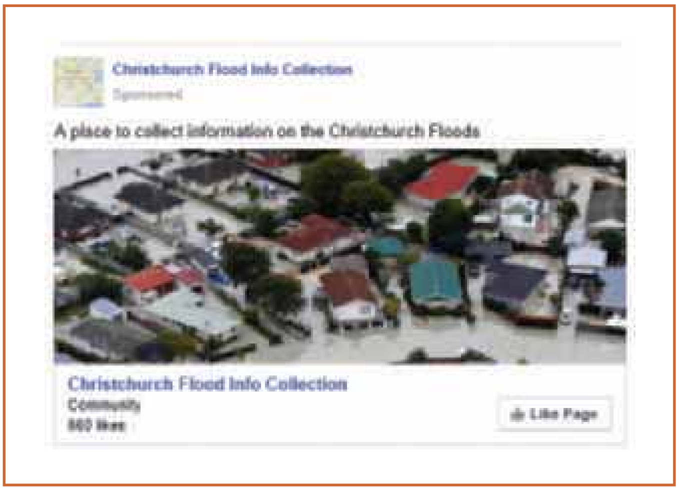


Figure 5 – Christchurch Flood Info Collection Sponsored Post – Likes (Facebook, 2014)

Once the "Christchurch Flood Info Collection" page had greater than 500 people connected to the page via likes we diverted most of our advertising towards building page engagement. Having Facebook users engage with the page was key, given our aim of crowd sourcing flood photos. An example of the post used to build page likes is shown in figure 6. This post was the most successful advertisement, being liked 52 times, commented on 11 times and shared 20 times. Once the public could see photos starting to be submitted page engagement built and further photos were submitted. Often users would submit information more than once following a successful initial post.

Figure 6 – Christchurch Flood Info Collection Sponsored Post – Page Engagement (Facebook, 2014)

The features of Facebook were used to specifically target the 260,000 people who live within a 20km radius of Christchurch who have Facebook accounts (Facebook 2014), making the advertising directly relevant and increasing its efficacy.

2.3.2 Audience Engagement

As collecting flooding data was the aim of the "Christchurch Flood Info Collection" Facebook page, engaging with the audience was important. By keeping the page active potential submitters could see that information submitted was actively being used and appreciated, and this also gave a more personal feel and established a connection between the submitter and the page. Every post or message to the Facebook page was responded to within hours, often within minutes, with both a personalised messaged thanking the supplier of the information and a request for any additional information that may have been missing from the information supplied. A quick response was important especially when a request for further information was required; we found that users responded quickly up to half an hour following their comment or post.

2.4 Results

Although the Facebook page was set up three days after the event it reached 82,000 people and gained 850 page likes. The public submitted more than 70 photos and 3 videos, while 20 comments were made on the page.

2.4.1 Audience

As discussed earlier, our strategy to gain the most information from the Facebook page was to build the audience of the Facebook page (page likes) then target these people with requests for flooding information. Initially the speed of audience (likes) gain was slow, taking half a day to obtain 100 likes. However once this watershed value was reached the speed of audience gain was surprising. Figure 7 below shows the number of likes each day; 700 likes were received in the 24 hours between 8–9 March.

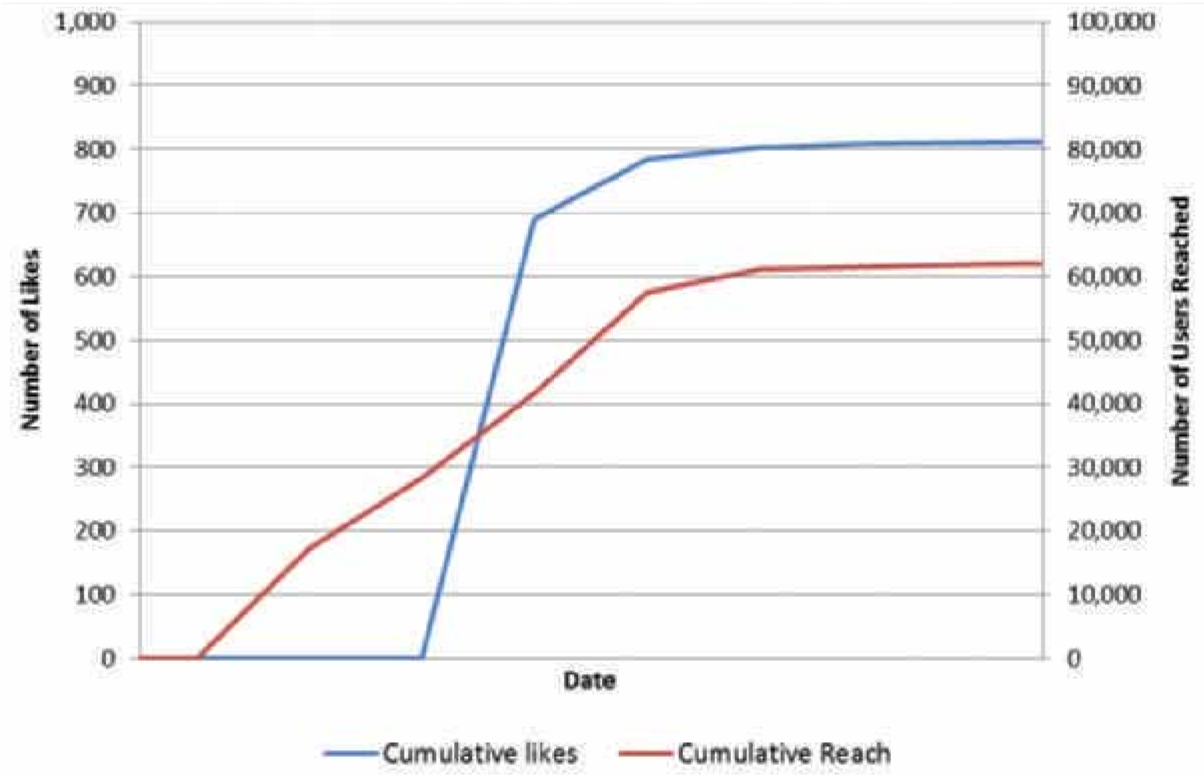
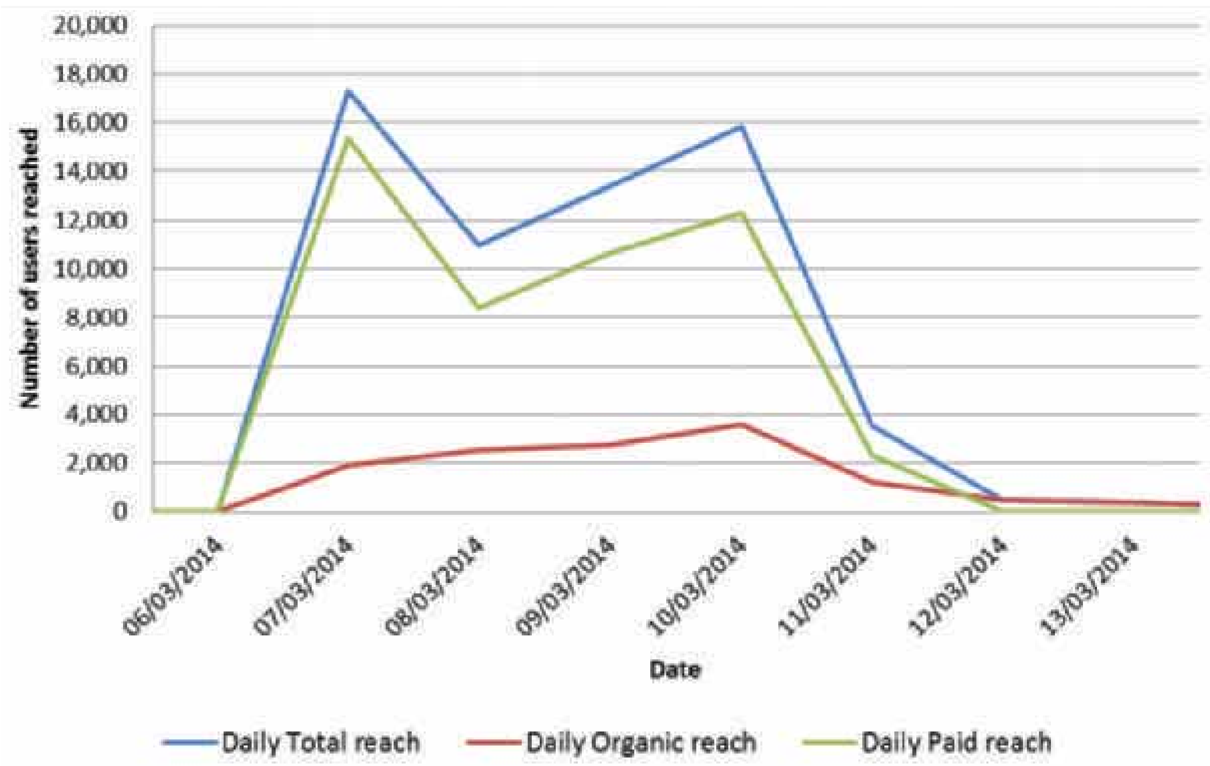


Figure 7 – Cumulative likes and Cumulative reach (Facebook, 2014)

Figure 7 also shows total reach; a staggering 62,000 people had seen the page or a post authored by the page seven days. Facebook advertising was the key driver for the large number of people reached in such a short period of time.

Figure 8 – Number of Users Reached per Day ("Daily Reach" (Facebook, 2014))



The effect of the Facebook advertising in increasing reach is clearly shown in Figure 8. Initially, the daily paid reach was almost equal to the total reach. As momentum built and more users were submitting information to the page the organic reach (non-paid reach) started to build to a maximum of 4,000 users per day. The organic reach reduced slowly as activity on the page reduced, this is in contrast to the paid reach which reduced in line with advertising spending.

The figure below, taken directly from Facebook, shows the demographic data of people who have liked the "Christchurch Flood Info Collection" Facebook page. Our initial assumptions on the demographic we were most likely to reach were proven wrong as only 39% of the people who liked the page were within our target age range of 18 – 35. This suggests that Facebook can be used to gather information from a wider audience and may be more representative of society than originally thought.

2.4.2 Flood Data Submitted

People posted information on the page in the form of text, photographs and video. Although data was slower to be submitted than expected, we received 70 photos and 3 videos which were then able to be geocoded as discussed in section 3.1.1. Samples of the photos submitted are shown in figure 10 below.

We had requested that submitters specify the depth, location and time of flooding shown in the photographs. In general most people provided this information however as discussed earlier some further communication was required with submitters to confirm some details of the submitted information.

2.5 Auckland Flooding Page Results

A similar page was set up for Auckland in an attempt to replicate the Christchurch page, seeking photos from the storm on the 16 April 2014. The page achieved 700 likes in 3 days which compares favorably to the 850 of the Christchurch page, however there were significantly fewer photos submitted to the page. This can be attributed to the localised nature of the flooding in Auckland as flooding was isolated to areas of the coast susceptible to storm surge. There were limited locations of pluvial and fluvial flooding as the Auckland storm was of significantly lower magnitude than in

Figure 9 – Audience demographics (Facebook, 2014)

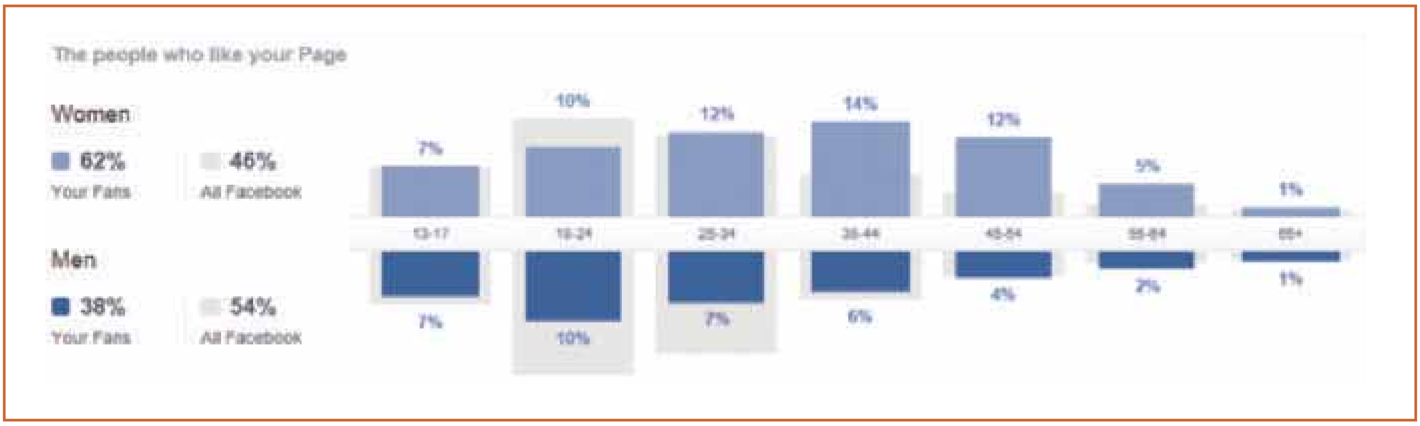


Figure 10 – Sample of photos submitted (Facebook, 2014)

"Set up time for a basic page such as "Christchurch Flood Info Collection" is minimal, in this case under half an hour including adding photos, and the first two posts on the timeline."

Christchurch. This suggests that there is a threshold of storm event below which this approach is not effective.

3. Using the Information Gathered

One challenge with collecting information about flood extent from the public is in organizing the data received so that it can be used to best effect (Gao et al 2010, Goodchild and Glennon 2010). GIS and specifically, Geodatabases are a well-established technology for doing this. A GIS allows users to rapidly move between coarse overviews of a whole city to quickly identifying the information relevant to a particular area. This becomes particularly important as the number of data points increases. For example, the CCC call center received over 500 complaints relating to the stormwater issues during and immediately after the event (Owen Southen, pers com), viewing the geographic clustering of these reports provides an easy way to 'triage' and identify priorities for investigation. In addition, bringing the data into a GIS allows the reports from the public to be systematically overlaid with other information, such as model predictions or the layout of the stormwater network. Once zoomed in to an area of interest, the details of each record can be viewed (Figure 10). This is a vast improvement over spreadsheets sorted by address or folders full of photos.

3.1.1 Geocoding

We located all the photos we received spatially (geocoded) and brought them into a GIS. Locations were estimated based on comparing visible landmarks to reference imagery; therefore the location was recorded based on the location of landmarks in the photo rather than the location of the photographer. In a some cases the photo did not have sufficient detail to record the position precisely and in these cases the street address was used instead. In some instances, we received multiple photos from a single location. Each user and photos of different aspects (i.e. no common references) is recorded as a separate location.

Figure 11 – Example of interactive use of GeoDatabase to get fine details of an observation.

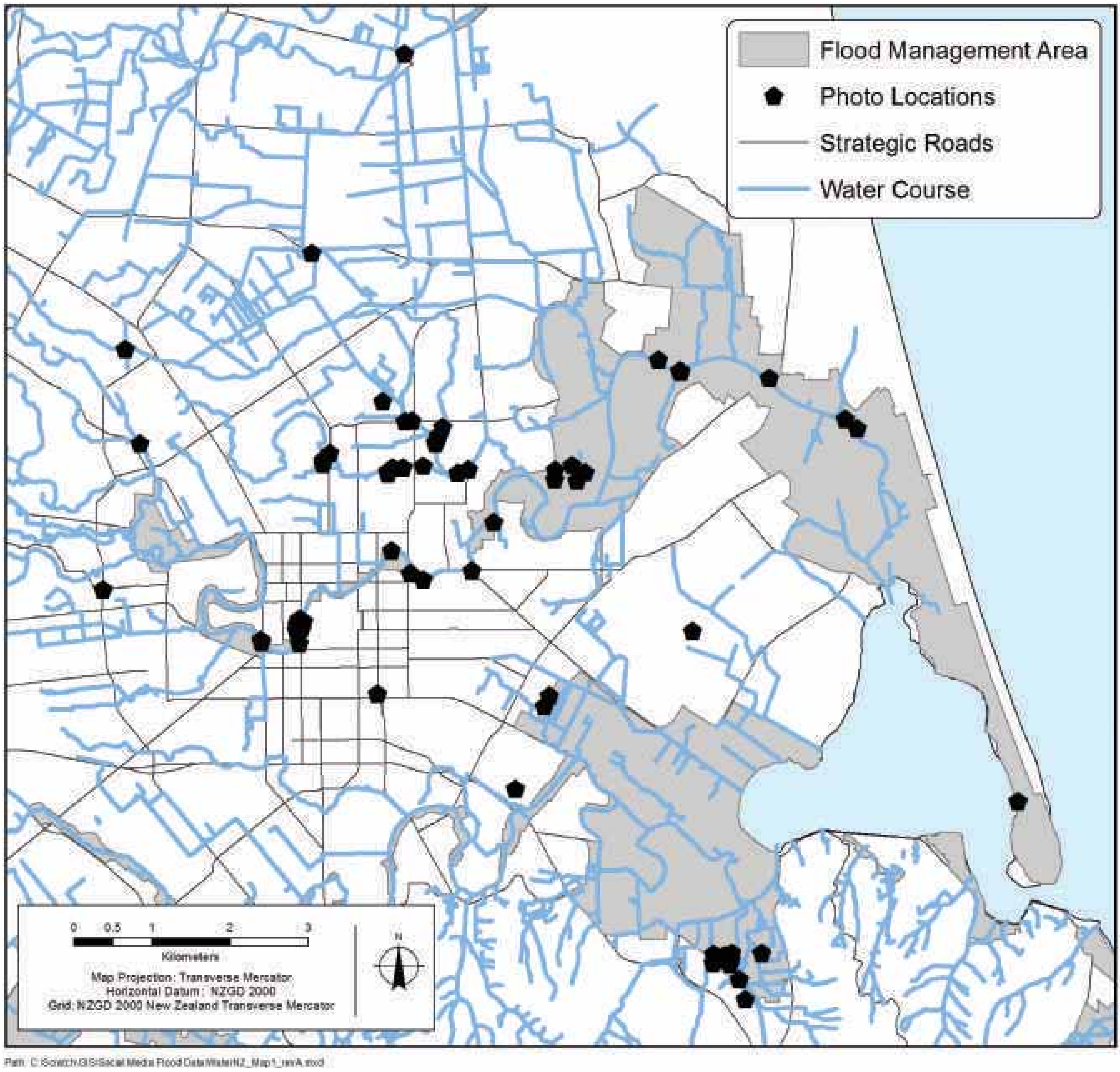
> "Although the Facebook page was set up three days after the event it reached 82,000 people and gained 850 page likes."

3.1.2 Comparison to Model Predictions

15 photos (20%) contained enough detail to estimate flood depth to coarse categories: 1, 2, 3, 4. These categories were selected with reference both to the types of landmarks visible in the photos (car tires, letter boxes, boundary fences) and to flood levels that affect residents. We found that where users self-reported flood depths, these often conflicted with our estimates from landmarks of known height visible in the photos. This could be because the photo didn't capture the worst flooding visible to the photographer, the landmark visible in the photo did not reflect the average depth over the whole photo, or an unconscious upward bias in depth estimates by the photographer reflecting the emotional impact of observing flooding on one's own section. This discrepancy will need to be considered for any future projects that wish to rely on self-reported flooding depth.

Although the proportion of photos where flood level could be estimated was low, the entire data set could be used to assess flood extent, which many modellers consider to be the first step in assessing a 2D prediction (DHI 2014) We compared our observations to the 50 year flood extent, as represented by the CCC flood management areas. Several photos fell outside of the FMA (Figure 12). There are multiple potential causes for this: (a) local failure of the stormwater system, (b) the storm exceeded the 50 year threshold in some areas, or (c) deficiencies in the model predictions. A detailed knowledge of the gaps between predictions and reality can guide response and recovery work.

Figure 12 – Comparison of received photo locations and flood management areas (proxy for predicted flood extent)



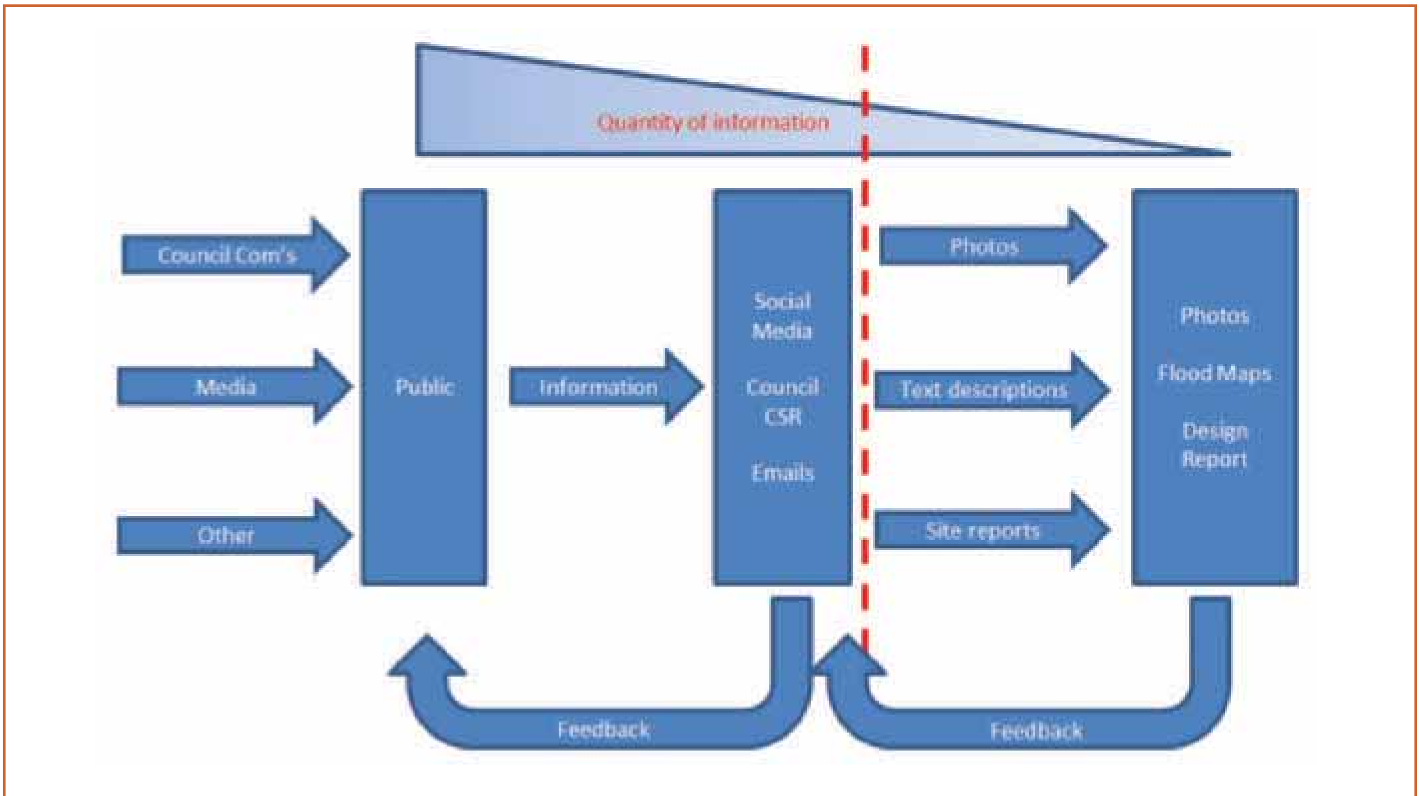
4. Future Directions

4.1 Social Media Platform Selection

We chose Facebook for our trial because it has a broad user base and a low cost of entry, both monetarily and in set-up time. Our choice of platform did have some drawbacks, however. Although we captured data in near-real time, we still needed to geocode the locations manually as Facebook removes the geocoding for privacy reasons, this meant the data was not ready in time to guide field crews sent out to assess flood damage in the immediate aftermath of the storm. Additionally, the level of effort required for geocoding scales directly with the success of the social media campaign – making it hard to budget for.

Crowd sourcing websites such as geoavalanche.org automatically geocode photos when submitted, setting up a website such as this for flooding would save a significant amount of time however these sites will never produce the number of responses that Facebook will due to the size of the audience. A middle ground would be to develop a Facebook integrated application with privacy permissions set such that uses could upload photos with the geocode still attached. It is our expectation that an approach such as this would be a tradeoff between the quantity and quality of data provided by each person and the number of people who participate. Each additional step in the process of submitting the data will drive away potential users.

Figure 13 – Diagram of future crowd sourcing approach



"An additional challenge for flood modeling in particular is that many streams, even those running through urban areas are ungauged."

A drawback of our single platform approach is that it could not reach people who do not have facebook accounts. A coordinated campaign across social and traditional media with an email address for those community members who do not use social networks (Figure 13) would broaden the reach considerably. Information solicited via traditional media would obviously be received well after the event, and thus could not be used to guide storm-clean up or flood-mark surveying efforts.

The need for broad market reach is underscored by recent developments in Christchurch. Subsequent to our project a Mayoral Taskforce was convened to examine flooding issues in Christchurch. Through the publicity surrounding this project, 68 households were identified who had severe flooding issues (including 11 with at least two episodes of over-floor flooding), but who had not previously contacted council about it (CCC 5 June 2014). This indicates that relying on call center reports alone for estimates of flood severity may be insufficient. It also indicates a need for alternative means of engagement with the public.

5. Conclusions and Recommendations

The results show that social media has clear promise in collecting data during extreme events. Moreover, although this data is lower quality than direct observations by trained engineers, it can be used in evaluating and calibrating flood models and other engineering analyses. Based on our experiences, we have identified a number of refinements in processing and analyzing the data and innovations in the use of social media platforms that should improve the effectiveness of this type of approach in future events:

1. Reaching out to the public through social media works. There are a lot of people who are keen to help their community, even if they don't have a specific complaint for council.
2. The scale of the event is important – the page received much less attention in the subsequent April flood events in both Auckland and Christchurch. Future projects will want to consider the merit of raising their profile versus participation fatigue in setting the trigger level for subsequent campaigns.

3. Leveraging the personal connections of the project team is an effective way to build support – particularly if an unbranded approach is chosen. This suggests that campaigns will be more effective if they gain internal buy-in before launching a public campaign.
4. No one social media platform reaches all community members. Future campaigns should consider a multi-platform approach, including traditional media (Figure 13).
5. If a crowd-sourcing application depends on members of the public to estimate flood depth, then it would be beneficial to develop and test a scale that references everyday objects well in advance of deployment.
6. Facebook was a low-cost way to gather information, but it strips location information from uploaded photos, requiring a manual post-hoc geocoding, based on self-reported photo location. Exploring alternative platforms that would not require this manual effort would increase the speed with the data could be made available and reduce the overall cost of the project.
7. With a slightly larger (several hundred observations) dataset, interpolation and prediction techniques developed in other disciplines for 'presence-only data' should be applicable to crowd-sourced flood data. This would allow a flood extent to be estimated directly from the supplied data.

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Glossary

General

CCC – Christchurch City Council

DHI – Danish Hydrological Institute

Geocode – To using other geographic data, usually street addresses, to assign geographic coordinates to a data point.

Facebook specific

Like – On Facebook, clicking Like is a way to give positive feedback and connect with a page or things you care about.

Messages – Messages are similar to emails but only with people on Facebook.

News Feed – News Feed is an ongoing list of updates on your facebook homepage that shows you what's new with the friends and Pages you follow

Page – Pages allow businesses, brands, groups and organizations to connect with people on Facebook

Timeline – A timeline is a collection of the photos, stories and experiences that tell your story on your page.

Organic Growth – Growth in Likes or page engagement achieved through unpaid means.

Paid Growth – Growth in Likes or page engagement achieved through paid advertising on Facebook.

Reach – the number of people who have seen your post / page.

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Amiad SAF Filters
The automatic self-cleaning filter – suitable for more applications than ever

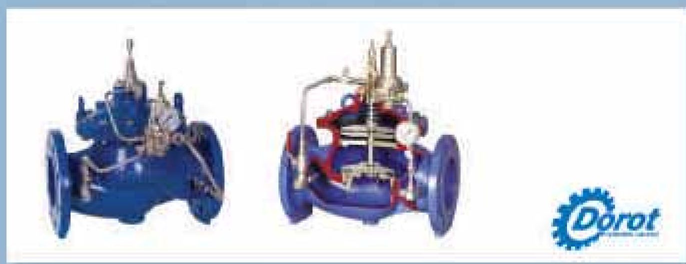
Filtomat AMF² Microfibre filters
Innovative self-cleaning microfibre water filter for treatment as fine as 2 micron

Apollo Backflow Prevention
Easy to maintain, Watermark approved and made in the USA

Arkal Spin-Klin filters
Reliable, effective self-cleaning SpinKlin® disc technology for clean water

Arkal Spin-Klin Galaxy filters
Unique SpinKlin® disc filtration technology upscaled for high volume handling

Dorot control valves
State-of-the-art automatic control valves designed for the most demanding water control requirements



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Cost Effective Calibration of Wastewater Hydraulic Models

Wioletta Straszak and Nihal Ginige – Opus International Consultants

With proactive and regular data management, SCADA (Supervisory Control and Data Acquisition) can be used for wastewater hydraulic model calibration, in conjunction with flow monitoring, to achieve significant cost saving for network utility operators.

Hydraulic modelling of wastewater collection systems is a common investigation tool used by network utility operators and local authorities for forward planning and management of sewerage systems. The conventional approach to development of a hydraulic model is via a complex process of calibration, verification and validation against 'real time' data and historical events. A calibrated hydraulic model is expected to represent the current levels of inflow and infiltration accurately. The model of the current situation is then used to extrapolate future scenarios based on projected growth and assumptions on future inflow and infiltration. Significant effort is often invested in calibrating hydraulic models to a high level of accuracy, and then broad assumptions adopted to define future scenarios. In some cases a pragmatic approach to investment in data for calibration, rather than seeking the 'n^{th} degree' of accuracy, may achieve the project objectives where there is uncertainty regarding future inflow and infiltration.

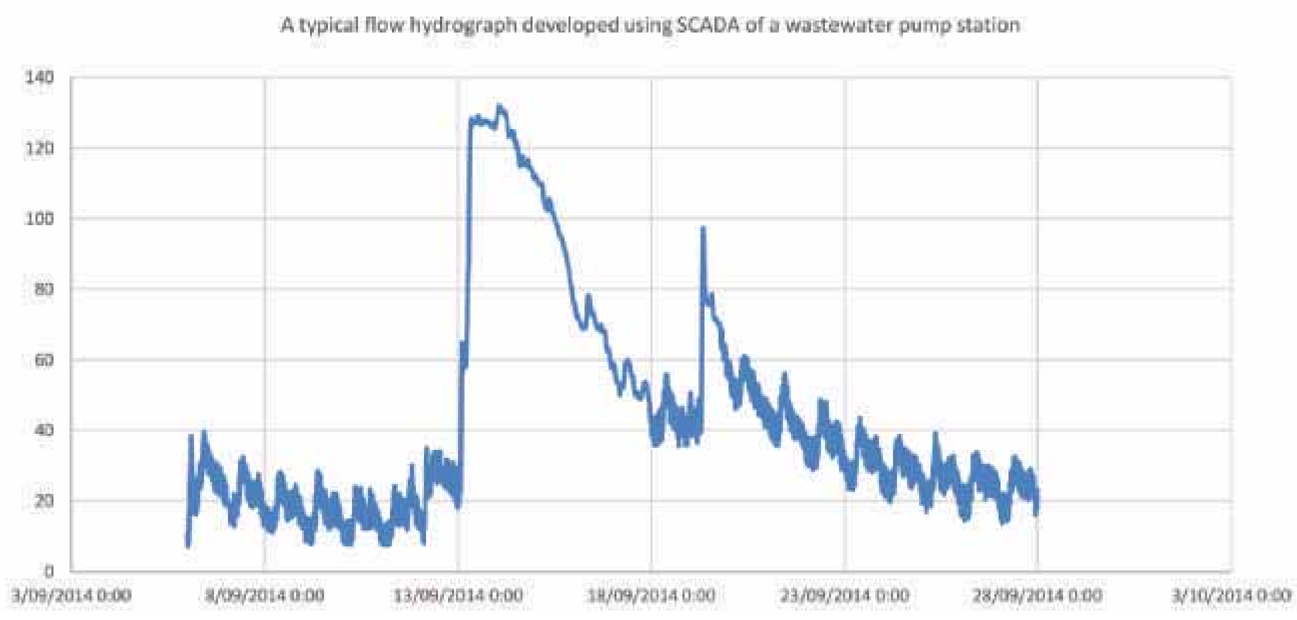
Recording actual flow rates and water levels in the network through flow monitoring is the most common method of collecting actual, 'real time' information for calibration purposes, however a comprehensive flow monitoring programme often has a high cost. SCADA data can be used to help make informed decisions on how much to invest in data collection.

Supervisory Control and Data Acquisition (SCADA) is a computer based system, often used in conjunction with telemetry, for the control of remote processes over large distances. SCADA and telemetry are therefore a critical part of water and wastewater infrastructure, used to remotely and usually automatically monitor and control the operation of infrastructure such as pumps, valves, and vents. For the system to operate automatically with minimal manual intervention, 'real time' data is measured at key locations, and programming instructions require the system to take appropriate actions. For example, when sewage reaches a specified level in a pump station wet well, a pump is turned on. The SCADA system should therefore be continuously measuring data at locations within the wastewater network where remote, automated processes need to be performed – measuring pumped effluent at wastewater pump stations, measuring inflows and outflows at wastewater treatment plants, potentially counting the number and duration at overflow locations, and monitoring disjunctions, inconsistencies and faults allowing operators to view the entire process and perform control actions.

It is helpful to have a prior understanding of the performance of discrete parts of the wastewater collection system before building the hydraulic model to prioritise areas for modelling and ensure appropriate levels of details are included. An initial assessment of system performance can often be carried out using SCADA data records from wastewater pump stations. This could involve analyzing the SCADA-derived pump station inflow hydrographs to gain an understanding of how much inflow and infiltration is occurring, and therefore how extensive flow monitoring should be in the upstream catchment. If there is limited infiltration, it may be acceptable to just use the pump station SCADA for calibration, and not install new flow monitors. Using SCADA data for the initial assessment means that areas of low priority could be either excluded or modelled with a level of detail more appropriate to the lower consequences of broad future scenario assumptions.

The real cost saving for network utility operators is in the potential to calibrate parts of the hydraulic model with SCADA data only, enabling significant cost saving in data gathering (i.e. flow monitoring). SCADA data for the wastewater network is already available (i.e. potentially free), and can cover the period from installation of the pump station – potentially many years of data. This represents a significant benefit over flow monitoring, which often only covers a period of a few months.

Wastewater hydraulic models can be calibrated using SCADA data by processing the recorded pump start and stop times into a 'real time', actual inflow hydrograph for the upstream catchment.



A typical inflow hydrograph developed using SCADA

Similar to flow monitoring data, the SCADA derived hydrograph is then compared to the 'modelled' inflow hydrograph and adjustments made to hydraulic model parameters so the 'modelled' situation is a reasonable reflection of the 'actual' situation. The figure below is a typical inflow hydrograph developed using SCADA. This hydrograph provides a wealth of information on the contributing catchment and the performance of the network, including:

- The ground water infiltration during dry weather is about 8 l/s.
- Rain dependent inflow and infiltration in the catchment is very high. The inflow and infiltration volume is well over 10 times the dry weather flow volume.
- The infiltration following a rain event prevails over a long period in excess of 7 days.
- The system has had overflows during the peak wet weather flow and the overflows occur when the peak flow reaches 130 l/s.

> "Correctly set up and well maintained SCADA system will allow hydraulic modellers to obtain and manipulate historical data for scoping the scale of flow monitoring, as well as actual hydraulic model calibration and evaluation of inflow and infiltration programmes."

Prior to detailed hydraulic modelling studies, SCADA data can also be used to evaluate the effectiveness of inflow and infiltration programmes – comparing SCADA-derived inflow hydrographs before and after implementation of the programme.

So what is stopping engineers and hydraulic modellers from using this widely available data for calibration of hydraulic modelling or inflow and infiltration analysis?

Data from SCADA is obviously only available at the specific locations of monitored infrastructure (e.g. pump stations). There will therefore potentially be large areas of gravity pipework with no data for model calibration. Large catchments, particularly those with various land use types (e.g. residential, commercial, industrial, schools etc) or with few pump stations, are likely to require more spatially representative actual flow information sourced from flow monitoring, which could still be supplemented by SCADA data.

SCADA data systems are usually installed with a customized reporting system. Unfortunately once up and running the recording and reporting is often left unsupported. Staff involved with the installation leave, or responsibility shifts, along with knowledge on how and what SCADA data is available. This often leads to SCADA systems becoming neglected and data has limited reliability and accuracy. The lack of data maintenance means when data is requested for hydraulic model calibration understanding of how to access the information can be limited, time consuming, and often doesn't meet the quality and accuracy needs for calibration.

Correctly set up and well maintained SCADA system will allow hydraulic modellers to obtain and manipulate historical data for scoping the scale of flow monitoring, as well as actual hydraulic model calibration and evaluation of inflow and infiltration programmes. Although it is unlikely to completely remove the need for flow monitoring, use of SCADA data has the potential to reduce the volume of new data needed. SCADA can provide a wealth of information if properly managed, however maintaining and troubleshooting SCADA systems is essential for network providers to protect and maximize their capital investment return. This will ensure their continuous operation, conducting core functions and optimize performance, along with collecting reliable and useful information for wastewater network modelling – in the long-run saving the network utility operator significant cost. ■

Flood Planning for New Zealand's Small Towns

James Reddish – Opus International Consultants

Introducing robust stormwater flood risk information in land use planning decisions and policy making is particularly challenging for local authorities with small and disparate populations. Flood risk information will often be based on river flooding information provided by Regional Councils.

> "The focus on river flooding information often leaves the local authority with the responsibility of addressing the stormwater or surface water flood risk knowledge gap."

These river flooding datasets usually do not take into account the risk from smaller watercourses, under-performance of the drainage network, topographical or man-made irregularities (such as railway embankments or water races) creating overland flow paths or ponding in areas away from rivers. This stormwater or surface water flooding can lead to equally hazardous conditions for people and property that needs appropriate identification, assessment, and mitigation – the risk from this source of flooding, and the associated importance as part of forward planning, cannot be under-estimated.

The focus on river flooding information often leaves the local authority with the responsibility of addressing the stormwater or surface water flood risk knowledge gap. This gap has been filled with information such as historic flooding records from the community or the knowledge of local operations engineers. In some circumstances local authorities will commission detailed hydraulic modelling of the stormwater network. Increasingly, this is utilising integrated 1D (pipe network) and 2D (digital terrain model of the ground surface) approaches to understand both the performance of stormwater infrastructure and the associated flooding risk when this is exceeded. The costs associated with this type of modelling can run into the hundreds of thousands of dollars – potentially the whole stormwater planning and design budget for some local authorities!

Over the last ten years the emergence of '2D only', also called 'rain-on-grid', hydraulic modelling gives local authorities the opportunity to produce flood maps, understand flooding mechanisms and identify flooding 'hotspots' in a fraction of the time, and critically at a fraction of the cost, of previous stormwater river and pipe network modelling approaches. The acceleration in adoption of the 'rain-on-grid' approach is a result of rapidly improving computer processor speeds meaning much larger areas are now able to be assessed in greater detail.

In simple terms 'rain-on-grid' modelling involves applying rainfall directly to the ground surface (a digital terrain model (DTM) 'grid' or 'mesh' usually based on flown LiDAR data). The modelling software calculates the direction, depth and velocity of flow over the surface in each 'cell' of the grid or mesh, providing outputs for each cell including flood extents, direction of flow, flood depth, velocity and hazard that can be manipulated and assessed using most GIS platforms. The size of the cells dictates how accurately the DTM is represented in the 'rain-on-grid' model, commonly cell sizes from 2m^2 to 10m^2 are used in urban areas. As each cell has a single ground level, increasingly modelling software offers a 'flexible' mesh approach, where the model automatically provides smaller cells where there are increased topographical changes, and larger cells where the terrain is flat, or has few features.

There are of course limitations to the 'rain on grid' approach, such as the need for access to appropriate modelling software and hardware, availability of LiDAR data to create a digital terrain model, the accuracy of the LiDAR data (in particular in incised channels or heavily vegetated areas), and assumptions made regarding the capacity of the stormwater network amongst others. Often the assumptions lead to an over prediction of flooding meaning 'rain-on-grid' is rarely suitable in isolation for informing capital investment decisions.

However in the absence of detailed data, most engineers or planners would advocate adopting the Rio Declaration's Precautionary Principle in decision making. The Principle states *where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation,* and the same applies to the assessment of flooding.

The assumptions and limitations associated with 'rain-on-grid' can be applied in such a manner to provide precautionary results, although sensitivity testing to understand the potential variability in flooding extent is important. Sensitivity testing could include varying the assumed capacity of the network, increasing or decreasing infiltration allowances, applying climate change increases to rainfall intensities, or adding in key stormwater structures that are considered unlikely to block, such as large culverts or bridges.

The 'rain on grid' approach is being applied in New Zealand and internationally. Much of the flooding that occurred in England during the Summer Floods of 2007 was attributed to surface water runoff that was unable to enter a stormwater drainage system. In

> "The costs associated with this type of modelling can run into the hundreds of thousands of dollars – potentially the whole stormwater planning and design budget for some local authorities!"

http://upload.wikimedia.org/wikipedia/commons/a/ac/Waimate.jpg

"A number of Councils in New Zealand, including Wellington Water, Gisborne District Council, and Christchurch City Council are already adopting a 'rain-on-grid' approach…"

2007 there was no clear responsibility in England and Wales for this source of flooding, with drainage network operators claiming they were only responsible for water that got into their network, and the national Environment Agency claiming their flood risk management responsibilities were for rivers and the sea. No authority in England and Wales was responsible for preparing information on, or managing, surface water flooding.

Changes to legislation as a result of the Summer Floods of 2007 led to the production of national surface water flood mapping. This adopted a course 'rain-on-grid' approach with flood mapping recognised as precautionary based on the data sets used and assumptions made. The national surface water flood maps have been adopted by local authorities across England and integrated with existing flood mapping for rivers and the sea for use in spatial planning, development control, as well as to identify areas whether further investigation into surface water flood risk issues are warranted. This new mapping led to a further 3 million properties across England and Wales being identified at flood risk.

A number of Councils in New Zealand, including Wellington Water, Gisborne District Council, and Christchurch City Council are already adopting a 'rain-on-grid' approach to provide flood maps in the absence of detailed modelling or as a screening exercise for identifying where more detailed analysis (modelling) is required. Gisborne District Council Stormwater Team Leader Joss Ruifrok noted:

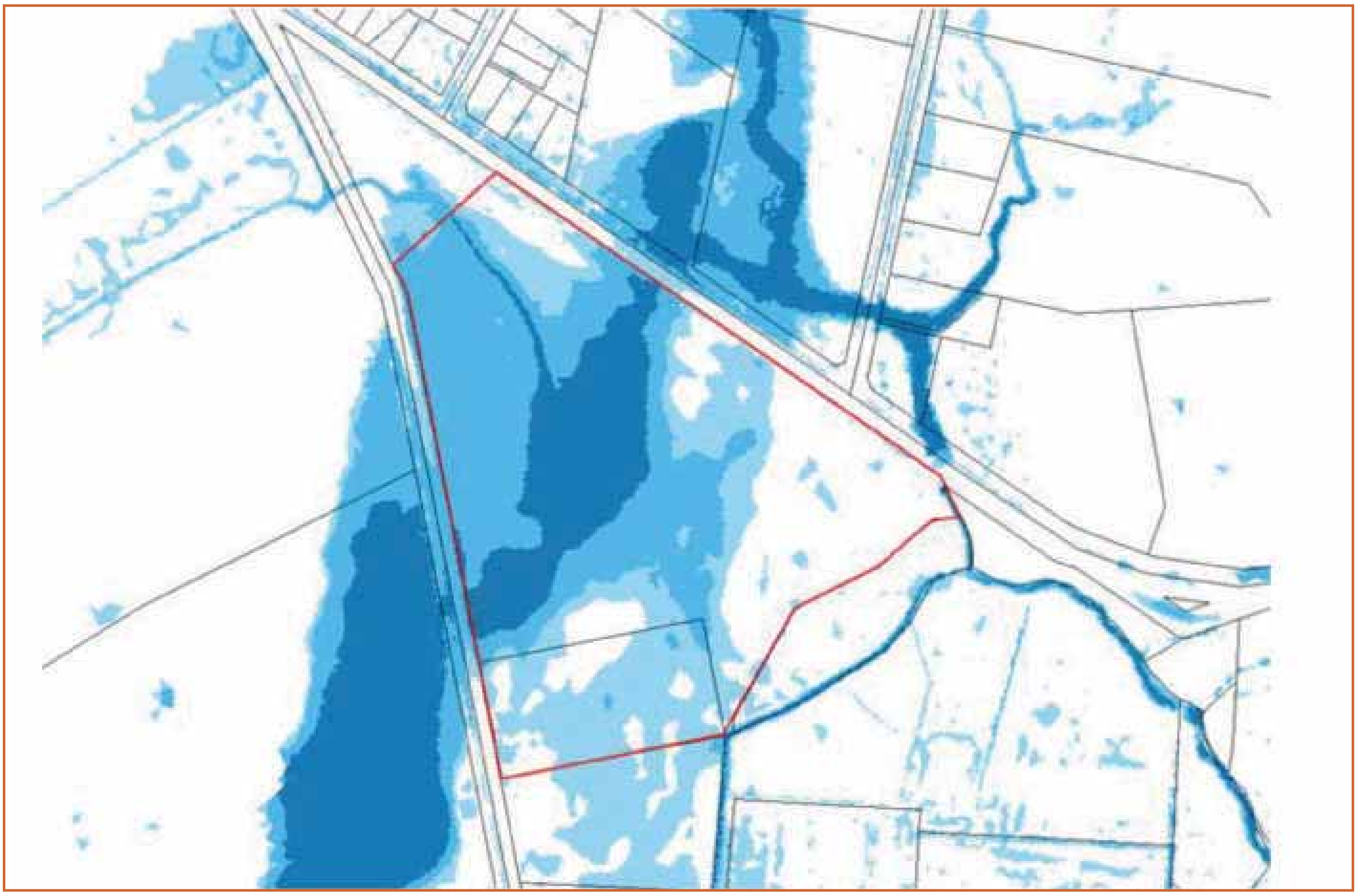
"The [rain on grid] outputs so far have been impressive, and a lot better than what we were expecting. This tool has highlighted a lot of secondary flowpath issues that we have in the city.

"The [rain on grid] data will be very useful in how we approach and manage infill housing from now on. It is also serving as a good validation tool for when our customers call up about stormwater issues in their backyards."

Where a community is lacking any reliable information on stormwater or surface water flood risk, the 'rain on grid' approach can provide a step change in understanding for the community and its Council officers – informing land use planning to help avoid areas at risk, identifying existing and potential future problem areas, enabling targeted maintenance where drainage network failure could have the highest consequence, and in some cases providing information suitable for informing catchment management plan or stormwater discharge consents.

Like all hydraulic modelling, 'rain-on-grid' has its limitations that need to be understood and communicated to the end user and the public. However the benefits of increasing the awareness and preparedness for the most common of New Zealand's natural hazards, mean that it is a particularly fitting tool for local authorities with insufficient funds or population to justify investment in detailed hydraulic modelling.

Example of 'rain on grid' modelling across a site that was developed prior to flood mapping being produced for the area



Allan Taylor in his low-water use garden

Sustainable Water Supply for Kapiti

Claire Harman – Senior Communications Advisor, Kapiti Coast District Council

We all need water many times a day for a range of purposes. So access to a reliable water supply is essential and is something all councils strive to provide their residents.

For the Kapiti Coast, finding a sustainable and affordable way to supply quality water for its increasing population has long been a major issue.

A new water charging system introduced in July last year, several water supply projects underway and public education about the importance of using water wisely (and how to do this) are all working to meet the challenge.

What We Are Doing

The Kapiti Coast District Council is doing a number of things to ensure a sustainable and affordable water supply is available for its households and businesses.

Water Supply

- We are building a system which will allow Waikanae River to be topped up with bore water below the treatment plant during dry times (meaning bore water doesn't enter our supply).
- We have purchased land to build a dam further down the track to meet the needs of a larger population when we need it.

Managing Demand

- Since August 2012, we have installed around 23,000 water meters which show people how much water they are using so they can manage their water use. Meters also detect leaks which once fixed, avoid wasting thousands of litres of water each day.
- We are now charging people for the amount of water they use (i.e. a volumetric charge) so they are more likely to use water carefully.
- We encourage people to use water responsibly by:
  - providing services that give free advice on how to conserve water and help with leaks
  - making water conservation tips easily available on our website and through media channels e.g. newspaper updates and Facebook
  - requiring water-saving systems e.g. rainwater tanks and greywater systems to be installed in new houses
  - offering interest-free loans of up to $5000 for rainwater tanks/greywater systems that reduce demand on the water supply.

Water Supply Network

- We are ensuring our network continues to operate efficiently by:
  - upgrading and replacing pipes as they age
  - proactively reducing leakage in our pipes.

New Water Charges

Water itself is free. However, capturing, treating, storing and piping water to homes and businesses is costly. Water charges are the way the Council distributes these costs.

Kapiti residents used to pay one fixed charge which was the same for everyone regardless of water use.

The new system has two charges – a fixed charge ($188.50 a year) and a volumetric charge on the amount of water used ($0.95 per cubic metre). What Kapiti residents pay now better reflects what they use and low water users no longer subsidise those who use more.

Decrease in Water Use

It's still early days, but water demand in Kapiti has already decreased significantly.

For example, if we look at water consumption over a six week period last summer and compare it to the same period this summer, there is a 20% decrease.

	Average water consumption (per day)	Peak water consumption (day most water was used)
This summer (1 Dec 2014 to 19 Jan 2015)	16,587,000 litres	19,170,000 litres
Last summer (1 Dec 2013 to 19 Jan 2014)	20,105,000 litres	25,550,000 litres

"This downward trend in water use is really encouraging and we have been applauding people's efforts to use water wisely," says Council's Water & Wastewater Asset Manager Martyn Cole.

"However, we're still learning about how we use water and what its value is. I expect it will be some time before water use patterns settle down and we have a clear picture of how we use water across the district. Our understanding will increase as we take more meter readings."

Datacol's National Operations Manager Dave Kitchen. Council has contracted Datacol to read about 23,000 water meters across the district every quarter.

Saving $$$ on Water

Paraparaumu Beach residents Beverley and Allan Taylor are one of the estimated two thirds of Kapiti households who are better off under the new meter-based water charging scheme.

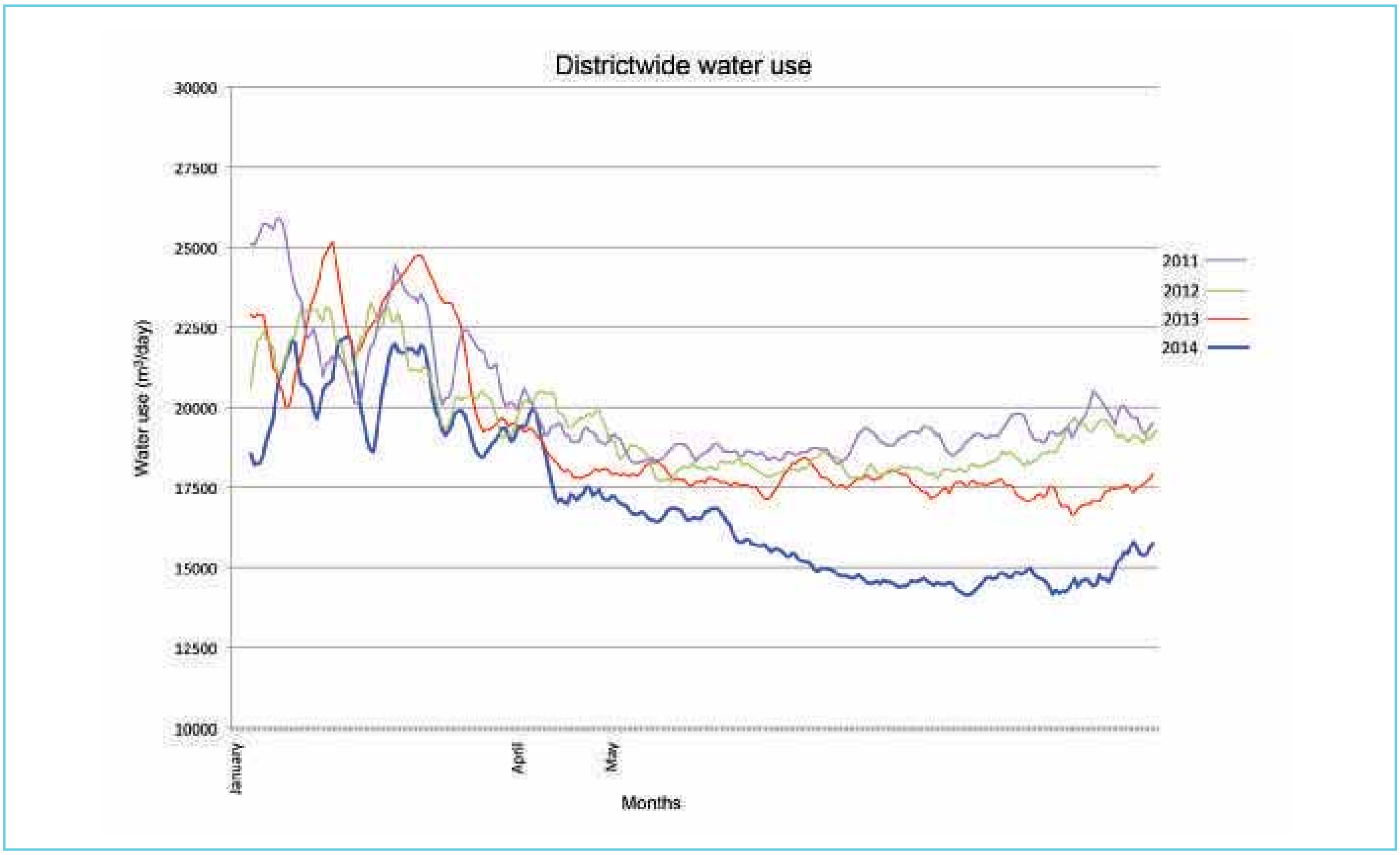
The couple are paying over $100 less for water per year compared to what they paid under the old system.

"The user pays system is fairer," Allan says. "It also encourages people to fix leaks and to avoid watering their gardens indiscriminately.

"We have to shift our thinking. We've been in a position where water was abundant and we didn't have to think about how much we used. But things are changing – the climate is getting warmer and the population is growing. We can't keep using water as we have been or we'll end up paying the price."

Allan has used his water meter to check for leaks a number of times.

"Water meters have saved the district millions of litres of water. I've heard countless stories of people having horrendous water leaks on their property which would've stayed hidden if meters hadn't helped to detect them. If you don't measure something, how can you tell if you're losing it?"



Graph showing water usage between 2011 and 2014

The couple have water saving measures in place including an in-ground rainwater tank which supplies water to flush the toilets. They also recycle their greywater from the shower, basins and bath to water parts of the garden when needed. However, the grounds around their house are covered with crushed lime, rather than grass lawn, which doesn't require watering and drought-tolerant plants grow in the garden beds.

"Having to be careful about using water is completely normal in so many countries," Allan's wife Beverley says. "In California you get fined $500 if you use water anywhere outside!"

Saving Water at Home

A family of five in Raumati are doing great things to reduce their water use.

Kate Foley, mother to Joshua (7), James (3) and Jack (16 months) says as soon as water meters went in, "we started trying to use less water as we wanted to make changes before water bills came in".

"The biggest thing we've done is to put in a huge rainwater tank. We use it literally every day mainly for watering the garden and when the kids want to have water play. They've drained the tank a couple of times!"

The family were also visited by an eco-design advisor from Council.

"The service is invaluable," Kate says. "We had the pressure of our shower checked and a gizmo lead weight put in our toilet cistern to control how much water each flush uses, among other things."

"I'm also using the eco cycle on my washing machine and dishwasher, which I didn't do before, have shorter showers and my boys share a bath."

"I think water meters are fair and will help save water. They've also discovered heaps of leaks. Most of us try not to use too much electricity and water shouldn't be any different – we need to conserve our natural resources."

Putting Energy Meters to Good Use: Benchmarking Energy Use in Water and Sewerage Systems

Lesley Smith – Technical Coordinator, Water New Zealand

Water and energy systems are interdependent. The nexus between these two life sustaining systems presents both challenges and opportunities. One aspect of this connection occurs on the supply side; energy systems use water and water systems use energy. It is estimated that about 8% of global energy generation is used for treating and transporting water to various consumers (WWAP , 2014). Energy benchmarking provides an opportunity to understand and manage this aspect of the water energy interface.

Energy benchmarking is the process of evaluating system components against best practice standards. It is a proven method to assess energy efficiency and identify opportunities for improvement. Established energy benchmarks exist for most major components of water and sewerage systems; sewage treatment, water supply pumping, sewer pumping, and company offices. However only limited information is available for water treatment. Energy benchmarking these system components can:

- Provide guidance on targeting energy efficiency initiatives to reduce operational costs
- Provide information to develop the business cases for process improvement initiatives.
- Identify opportunities to reduce environmental impacts associated with energy use

International energy benchmarks established to address water and sewerage system components are equally applicable to systems run in New Zealand. This article summarises available learnings with a focus on sewage treatment and water pump stations, areas which have received the most attention in international studies.

European sewage treatment plants are leaders in energy efficiency. The Water Environment Research Foundation (WERF) has published a review "Best Practices for Sustainable Wastewater Treatment" that makes available in English benchmarks for energy conservation and production at sewage treatment plants from across Europe (Crawford, 2010). Sewage treatment plant energy consumption was reduced by 38% in Switzerland and 50% in southern Germany (Crawford, 2010) in the decade after these manuals where developed.

Measuring Usage for Energy Benchmarking

There is an old adage that you cannot manage what you don't measure. Having processes in place to measure energy use is the first step in energy benchmarking. Electricity measured in kilowatt hours (kWh) is generally readily available from electricity meters used for billing purposes. Utility bills can be used to track kWh (or gas measured in gigajoules). However accuracy of benchmarking improves significantly where data is available in smaller time stamps.

Where smart metering is installed, time stamped data can commonly be requested from electricity companies. To account for seasonal variations in load, a years' worth of data is a best practice minimum. The smaller the time intervals the more accurate the benchmarking will be. Smaller time intervals may be limited by the ability to process data, or access corresponding information on flow, pressure or load characteristics.

Established benchmarks referenced in this paper all use kWh as the unit of measurement, making electricity meters the most useful source of energy data. Alternatively if you are developing a benchmark of your own seeking to optimise system performance, environment footprint, or cost more appropriate metrics may be gigajoules, tonnes of carbon dioxide equivalent, or dollars respectively.

Sewage Treatment Plant Energy Efficiency Benchmarks

Different sewage treatment processes have inherently different energy profiles. For example trickling filters are likely to consume just over half the energy of an activated sludge plant using sludge stabilisation. Existing facilities are best compared against similar processes, such as those shown in Table 1. At the design stage it may be more relevant to consider generic indicators, such as those in Table 2.

The Water Services Association of Australia (WSAA) has been leading utility collaboration to develop energy benchmarks for the Australian water sector, commencing with pumps and sewage treatment plants.

Jennifer Bartle-Smith is the WSAA staff member responsible for coordinating the studies. Ms Bartle-Smith notes "Outcomes highlight opportunities for improving data integrity, reducing energy use and identified top performers so our members can learn from those doing well. The magnitude of the efficiency savings will vary across each class and type of WWTP and depend on population served. Investigations at SA Water have identified opportunities for savings of 30% of total electrical energy at one of its WWTP sites."

The work at WSAA is ongoing with two technical working groups following through on recommendations to deliver practical outcomes for utilities. Summary reports, and associated training through IWES are expected in 2015.

SA Water in South Australia operates a number of sewage treatment plants of varying types and sizes. To determine the energy efficiency of their facilities they use German benchmarks shown in Table 1 and Table 2. SA Water has published their experience providing an instructive guide for other utilities wishing to conduct a comprehensive energy efficiency review of treatment plants (Krampe, 2013). The report also provides helpful English translations of the findings of the German studies from which the benchmarks in Table 1 and 2 where derived.

To account for variations in inflows and sewage quality benchmarks in Tables 1 and 2, a metric of kWh/population equivalent/year is used. Population equivalence is commonly used as a normative factor to account for variations in sewage quality in a catchment as well as providing a proxy for flow. A simple metric for determining population equivalence used by SA Water to benchmark against numbers in Tables 1 and 2 uses 60 g BOD5/PE/d, or, 120 g COD/PE/d where BOD5 numbers were unavailable (Krampe, 2013).

"There is an old adage that you cannot manage what you don't measure. Having processes in place to measure energy use is the first step in energy benchmarking."

Table 1 – Guide and target numbers in kWh/PE/year for the specific energy consumption in treatment plants (Baumann, 2008)

	<1000 PE		1000-5000PE		5001-10,000PE		10,001-100,000 PE		>100,000 PE	
	Guide	Target	Guide	Target	Guide	Target	Guide	Target	Guide	Target
Aerated lagoons	50	32	50	30	35	25	-	-	-	-
Rotating biological contractor	34	23	23	18	18	15	-	-	-	-
Trickling filter	32	20	25	17	20	15	25	18	25	18
Extended Aeration	70	38	45	28	38	23	34	20	-	-
Activated sludge*	60	32	40	24	34	20	30	18	27	18
Combination of ASR and trickling filtre	-	-	-	-	-	-	30	18	26	18

with sludge stabilisation. Grey shaded are usually nitrification only

Table 2 – German target and guide numbers for specific energy consumption at Sewage treatment plants (Haberkern, 2008)

WWTP Component	Parameter	Unit	Target Number	Guide number	
			>5000 PE	5000-1000 PE	>1000 PE
Total WWTP	Energy consumption	kWh/PEBOD60/y	18	35	30
WWTP with digester	Self supply for electricity	%	100	-	60
WWTP with digester	External heat supply	kWh/PEBOD60/y	0	-	3
Digester	External heat supply	kWh/PEBOD60/y	30	-	20
Aeration	Quantity of biogas	L/PE/d	10	18	16
Pumps	Energy consumption	kWh/PEBOD60/y	4	-	6
Additional allowance for					
Effluent filtration (sand filtration)	Energy consumption	kWh/PEBPD60/y	2	-	4
Membrane filtration (tertiary)	Energy consumption	kWh/PEBOD60/y	9	14	14
MBR for biological treatment	Energy consumption	kWh/PEBOD60/y	82	130	120
Sludge drying	Energy consumption	kWh/PEBOD60/y	2	-	4
Foul air treatment	Energy consumption	kWh/1000m3	1	2.5	2

In addition to the type of processes and equivalent population served, other site specific factors also affect sewage treatment energy efficiency. Considering the following factors will help interpret energy benchmarking results:

- Increased treatment requirements for sensitive water bodies
- Large pumping requirements at the plant as a result of topography or site layout
- Overcapacity because of safety margins or prospective developments

Pump Station Energy Efficiency Benchmarks

Energy efficiency of pumping is measured by three factors; energy imparted to water (kWh), volume of flow (L), and differential head (m). Pump station head determines how much energy needs to be imparted to lift water. This is most often measured as meters of head (m) but can also be determined by measuring the differential pressure between a pump stations inlet and outlet. Flow accounts for growth or contraction of a service area, variations in infiltration and other season factors and is typically measured in Mega Litres (ML). Accordingly, the most commonly used benchmarking metric for water pumping energy efficiency is kWh/ML/m.

Flow and energy usage monitoring is a minimum requirement for pump station energy efficiency assessments. Ideally energy efficiency would be flow weighted against the variable pumping head, although this requires differential pressure readings across the pump, generally unavailable in all but the largest pump stations. Static head can be used as an approximation. This limits accuracy of the benchmark, but still provides a rough guide highlighting areas of relatively low and high performance and an individual pumps performance over time.

Pump station manufacturer HydraTech conducted a broad ranging review of pump efficiency throughout water utilities in Ontario. The study, Toward Municipal Sector Conservation: A Pump Efficiency Assessment and Awareness Pilot Study (HydraTech, 2013) is available on the Water New Zealand website and provides a comprehensive overview of pump station energy benchmarking methodologies and know how. The HydraTech study showed that pumps with greater than 4 kWh/ML/m can generally be termed as having poor or below average performance.

With the support of the Ontario Power Authority's Conservation Fund, HydraTek completed an ambitious cross sector program assessing energy efficiency of over 152 pumps. The study reports, "Water pumps currently in use have peak efficiencies 9.3% lower than their originally manufactured state. Moreover, this gap increases to 12.7% when accounting for the fact that many of these pumps operate at ranges outside of their peak efficiencies.

"While the average efficiency for the conversion of electrical power into useful work produced by the pump,

known as water power, was 81.4% in the original design of the pumps (and motors), the installed efficiency is only 69.4%. The resulting power wasted through this combined inefficiency is approximately 12 MW in total for the pumps tested, translating into 33,700 MWh (33.7 GWh) of energy wasted annually. While not all energy could be recovered the study found many opportunities for improvement." (HydraTech, 2013).

While the HydraTech study is one of a number that have been completed looking at water pump station energy efficiency, little work has been completed on sewage pump stations. Sewage pump stations are expected to have similar efficiency characteristics to water but will be slightly less efficient owing to the more viscous nature of sewage. WSAA has completed a study that includes sewage pump stations, with learnings expected to be published in 2015.

Water Treatment Plant Energy Efficiency Benchmarks

The energy of water treatment is highly dependent on feed water source, with particularly large variations between desalination and rainfall fed systems. The relative energy use of these systems has been researched extensively, however no benchmarks appear to have been developed to date.

A rough guide of embodied energy in water treatment in cities across Australia and Auckland was examined in 2006/07 (Kenway, 2008). It found energy intensity of water supply (the amount of energy needed to deliver water including pumping) ranged from 335 GJ/GL to 6901 GJ/GL. The wide disparity can be explained in part by extreme drought conditions in some areas which led to large water pumping requirements. This makes it difficult to draw conclusions about water treatment energy intensity from the study.

Office Energy Efficiency Benchmarks

While not unique to water or sewerage systems, company offices can nonetheless form a large proportion of overall energy use of water and sewage treatment providers operations.

Benchmarking the energy efficiency of offices is possible through use of NABERSNZ, administered by the New Zealand Green Building Council. An independent NABERSNZ Certified Rating shows exactly how well a building uses energy, compared to other commercial office properties. A free online self-assessment is also available, which provides a useful first step to understanding and improving an office buildings energy use: http://www.nabersnz.govt.nz/tools/self-assessment

More detailed information examining energy end use drivers in commercial buildings has been published by BRANZ, in the BEES Building Energy End Use study (Amitrano, 2014). The study estimated a baseline Electrical Performance Indicator for commercial office buildings of 186 kWh/m2 floor area/year and is publically available on the BRANZ website www.branz.co.nz.

NABERSNZ™ is a scheme to measure, rate and improve the energy performance of office buildings in New Zealand. NABERSNZ is based on the successful Australian NABERS rating scheme, which has been adapted for New Zealand office buildings. Data from the NSW Office of Environment and Heritage (OEH) shows that Australian office buildings using NABERS to regularly measure performance, have improved energy efficiency on average by 9% or 23kWh/m2, collectively saving 345,100 tonnes of greenhouse gas emissions a year.

The NABERSNZ website (EECA, 2012) notes that "Commercial buildings in New Zealand account for 9% of our total national energy use, and 21% of electricity use. This includes energy used for lighting, heating, air conditioning, IT and other services. The Energy Efficiency and Conservation Authority (EECA) estimates that around 25% of this energy can typically be saved cost-effectively, through greater efficiency."

Other Uses of Energy Benchmarking in Water and Sewerage Systems

Energy benchmarks can also be useful for understanding individual process elements performance which can aid the prioritisation of maintenance and renewal schedules.

Benchmarking different technologies or supplier products can help inform design and equipment selection decisions. Ian Gunn's Performance Ranking of On-site Domestic Wastewater Treatment Plants published in Issue 187 of the Water Journal (Gunn, November 2014) , provides a useful example of benchmarks across a range of metrics (including energy) for different suppliers treatment plants.

Limitations of Energy Benchmarking

Gunn's article provides benchmarks for treatment plants across a range of metrics, highlighting that energy is only one part of the story (Gunn, November 2014). Important parameters such as water and effluent quality require consideration when evaluating energy use to ensure gains in one area are not traded in another.

It is also recognized that energy savings from individual system component performance only represents a fraction of possible energy savings. Other system based measures include demand management, leakage reduction and optimised system design. It has been estimated in pump stations approximately 20-25% of total potential energy savings are attributable to individual pump performance, with the remaining 75-80% attributable to system-based measures (HydraTech, 2013).

Nevertheless individual component benchmarking provides a valuable starting point to address energy efficiency, with a number of proven successes from across the world.

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LIT "UV" Technology

During the past twenty years, UV disinfection has rapidly gained popularity for water and air treatment. UV has many advantages over other disinfection methods – no chemicals are added – the reaction time is very short – UV does not alter smell or taste. Ultraviolet radiation is very effective in inactivating air or water-borne pathogens, viruses, and also parasites like Cryptosporidium.

History

The history of UV disinfection in Western Europe and North America is well known, however, it is less known that Eastern European countries, particularly Russia, also have a history of experience in UV disinfection. Downes and Blunt were the first to report on the germicidal effect of sunlight in 1887, then the Russian scientist A.A. Maklakov found in 1889 that the optimum wavelength for micro-organism inactivation was around 260nm. In 1910, a UV system for water disinfection was tested in St Petersburg and in 1950 the first standards and requirements for UV were introduced in Russia. In 1952, the first UV drinking water disinfection station based on these standards was opened in Ufa, a city located in the South-Western part of the Russian Ural Mountains.

"The development of UV as a solution for water disinfection was closely connected to the development of artificial UV radiation technology."

The development of UV as a solution for water disinfection was closely connected to the development of artificial UV radiation technology. The first examples of mercury discharge lamps were made in 1879 and in 1904 a huge improvement was made when quartz glass with a high transmittance for UV was introduced. A real break-through was achieved when gas discharge lamps (low and medium pressure mercury) went into industrial production in the 1940 and are continued to be used today.

LIT Technology

In 1991, a group of scientists from the Moscow Institute of Physics and Technology (MIPT), who had gained a wealth of knowledge and experience with UV radiation technology and UV disinfection applications, founded LIT TECHNOLOGY. LIT is now one of the top three leading developers and manufacturers of UV systems for water, air and surface disinfection in the world.

LIT has production centres in Erfurt, Germany and Moscow and Russia with subsidiary offices in the Netherlands, China, Hungary, Bulgaria, Spain and the Czech Republic. With trained distributors throughout the world, local sales and service support is assured.

The company has a strong focus on research and their Research & Development department is scientifically led by two professors and 10 Doctors of Science.

LIT offers a wide range of UV disinfection systems for various industries – natural, industrial, wastewater and other water applications with capacities depending on the project's specific water quality, the required disinfection level and the operational conditions. LIT is particularly interested in the development of innovative UV applications.

LIT offers four groups of UV disinfection systems for a wide range of capacities, different water qualities and applications.

- DUV (Closed vessel (pressurized) systems with longitudinal lamp orientation.)

- DUV Pro (Closed vessel (pressurized) systems with cross-flow lamp orientation.)
- MLP (Open channel systems with longitudinal lamp orientation.)
- MLV (Open channel systems with cross-flow lamp orientation.)

UV transmittance determines the size of the required UV system and thus the energy costs for UV disinfection. The lower UV transmittance, the more UV equipment and the more energy is required to achieve the same germicidal effect.

"UV transmittance determines the size of the required UV system and thus the energy costs for UV disinfection. The lower UV transmittance, the more UV equipment and the more energy is required to achieve the same germicidal effect."

LIT UV equipment's automation and controls are based on state-of-the-art microprocessor systems of renowned brands like VIPA, SIEMENS and Schneider Electric. LIT UV systems are equipped with UV intensity sensors which are either manufactured by LIT or a validated UV renowned global manufacturer.

All LIT UV equipment (except for ultra-small systems) has the option of a dose pacing system to optimize power consumption. LIT provides effective chemical cleaning and/or automatic mechanical cleaning systems for the various groups. Cleaning requirements depend on operational conditions and a client's requirements.

Distribution of the UV intensity field in the UV reactor, hydraulic optimization and flow equalization determine the disinfection efficiency and operational stability of UV disinfection systems. The equipment design of LIT UV units integrates all the above design parameters and operational conditions for different water volumes and water types.

LIT since commencing production of UV disinfection systems, has installed some of the world's largest water and wastewater disinfection systems. ■

26,000 m^3/day LIT DUV drinking water system in France

"LIT since commencing production of UV disinfection systems, has installed some of the world's largest water and wastewater disinfection systems."

New Senior Appointment to Fuel Growth at HTC

Specialised tooling leader, HTC Ltd has made a key senior appointment as it continues to strengthen its position as New Zealand's premier specialised tools and equipment solutions provider.

Mark Powell is the new Chief Executive at HTC Ltd Specialised Tools and Equipment. Previously he spent more than 20 years in the equipment hire industry, the last 10 with Hirepool, the country's largest rental equipment solutions provider, starting out as Business Relationship Manager in Taranaki, moving on to CEO of the business with more than 50 branches nationwide.

"There are some exciting times ahead for the business and I look forward to helping Robb and the team achieve their goals."

Established more than 30 years ago HTC Ltd – Specialised Tools and Equipment is the market leader in sales, service, hire and calibration of high-force hydraulic tools. The company services clients across the country from its head office at East Tamaki with a sales centre and workshop in Christchurch.

Powell says he is looking forward to joining a business "with a culture based on delivering service excellence and a clearly articulated vision of providing real value to their customers. HTC has a great reputation as a provider of a range of specialist tool solutions to the engineering, road and rail industries along with local infrastructure projects."

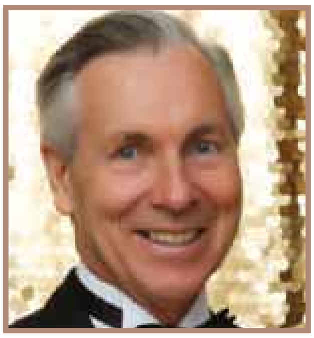
"There are some exciting times ahead for the business and I look forward to helping Robb and the team achieve their goals."

HTC Managing Director, Robb Huskinson says Powell brings "years of retail and commercial hire equipment experience and success. He also has first-hand knowledge of the industries we serve and has the knowledge and ability to identify and develop new business partnerships."

"We have recently acquired a new business and will continue to be on the lookout for further growth. With his vast knowledge of the rental equipment business I am confident Mark will play a key leadership role in the growth of our organisation." ■

Mark Powell

Engineering Growth


Doug Troon


James Carmichael

Planned strategic growth for ProjectMax in 2015 sees the welcome appointment of two new directors.

ProjectMax Limited, a specialist consulting company, is 100% NZ owned, focused on optimising when and how pipelines are renewed. ProjectMax are leaders in the fields of data confidence, condition assessment, renewal planning and the implementation of trenchless methodologies, all of which allows them to deliver innovative, cost effective and practical advice and solutions to water utilities.

Director and founding partner Steve Apeldoorn sees the appointments as a major coup. "Doug Troon and James Carmichael are both talented engineers with extensive experience across commercial and government sectors," says Steve. "Doug's experience has been around delivering infrastructure projects to local government. James has held regional executive and director roles in South East Asia where he oversaw vast infrastructure projects.

"Director and founding partner Steve Apeldoorn sees the appointments as a major coup. "Doug Troon and James Carmichael are both talented engineers with extensive experience across commercial and government sectors..."

We're thrilled to have them on board," remarks Steve.

Doug's other current directorships include Counties Power and Brightwater Group Ltd. James is a director of Vector and the Auckland Energy Consumer Trust.

"Their knowledge and experience as professional engineers, plus their proven abilities in directorship governance, will lend well to that already of the existing board to help us grow strategically and sustainably in 2015."

ProjectMax plans to strengthen its focus on assisting utilities improve their information, systems and processes to get the optimal performance from their assets and the right decision for their long term planning, both of which are becoming a major national issue. A recent LGNZ report highlighted that nationally approximately one quarter of potable, storm and waste water assets are more than 50 years old (their design life) and that 10–20 percent of the graded assets required renewal or were unserviceable. This raises utility's need for a better understanding of their asset performance and condition which is critical to a utility for optimal strategic planning.

Water New Zealand Conferences & Events

NZ Trade and Industrial Waste Forum

21 – 24 April 2015
Rotorua, New Zealand

For more information visit http://confer.co.nz/tiwf2015

Water New Zealand Backflow Conference

23 – 24 April 2015
Mercure Hotel, Queenstown, New Zealand

For more information visit www.waternz.org.nz or contact Amy Aldrich amy.aldrich@waternz.org.nz

Water New Zealand Asia Pacific Stormwater Conference 2015

20 – 22 May 2015
Pulman Hotel, Auckland, New Zealand

For more information visit www.waternz.org.nz or contact Amy Aldrich amy.aldrich@waternz.org.nz

Water New Zealand Annual Conference & Expo 2015 – *'Optimising Our Water Value'*

16 – 18 September 2015
Claudelands Events Centre, Hamilton, New Zealand

For more information visit www.waternz.org.nz or contact Hannah Smith hannah.smith@waternz.org.nz

Other Conferences

NZLTC Annual Conference 2015

25 – 27 March 2015
Wanaka, New Zealand

Australian Water Association Conference 'Ozwater 2015'

12 – 14 May 2015
Adelaide, Australia

For more information visit www.awa.asn.au

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