WATER

Issue 180, July 2013

Climate Change – the Challenge for New Zealand

Overland Flow Path Depression Mapping for the Auckland Region

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

ON TOP DOWN UNDER
Deeco
DEECO SERVICES Ltd
Provider of Water Process Solutions
for New Zealand since 1938
METERING
Domestic and Bulk
SENSUS
Electromagnetic Flow Meters
EUROMAG INTERNATIONAL
Automatic Meter Reading Sys-
maddalena
GSM/GPRS Data Loggers
CommCell 4
FILTRATION
Innovative Filtration Solutions
ARKAL
FILTOMAT
AMIAD
amiad WATER SYSTEMS
Vee Wire Screening Solutions
Johnson screens
VALVES
Water Control Solutions
Irrigation
Waterworks
Fire Protection
BERMAD
Backflow Preventers
WILKINS
a ZURN company
High Performance Air Valves
VENT-O-MAT
Deeco Services Ltd | Water Process Solutions
National Service & Distribution | 21 Regent Street PO, Box 33-226, Petone
Tel: 04 568 5293 | Fax: 04 568 5273 | service@deeco.co.nz | www.deeco.co.nz
Wellington | Auckland | Tauranga | Christchurch

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

Postal: PO Box 1316, Wellington 6140
Level 12, Greenock House,
39 The Terrace, Wellington, 6011
P +64 4 472 8925, F +64 4 472 8926
enquiries@waternz.org.nz
www.waternz.org.nz

WATER JOURNAL
Editorial/Writer: Robert Brewer, robert@avenues.co.nz
Advertising Sales: Noeline Strange, P +64 9 528 8009, M +64 27 207 6511, n.strange@xtra.co.nz
Articles: To contribute to future issues please contact Robert Brewer at Avenues, robert@avenues.co.nz, P +64 4 473 8054
Design: Leyla Davidson, Avenues, Level 1, 56 Victoria Street, PO Box 10–612, Wellington, P +64 4 473 8044
www.avenues.co.nz
Distribution: Hannah Smith, P +64 4 495 0897,
ISSN 1177–1313

The next issue of *WATER* will be published in September 2013.

WATER

On the Cover

Water New Zealand News

Features and Articles

Cover photo: istock.com

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.

Steve Couper

Don't Mention the "S" Word

Water is vital to our survival but we still pollute our lakes and coastline, and we are still filling landfills with resource laden solids. Some improvements have been made, but in a country where water is plentiful and re-use is the exception rather than the rule are the drivers there to recover resources? Do we still have some way to go to get closer to the "S" word in terms of minimising energy requirements and providing for recovery or re-use?

From the earliest recorded wastewater systems until about the 1960s wastewater engineering was more about keeping faecal material away from the people rather than protecting the environment. It was around the 1840s that the concept of a defined sewerage system was developed – but these systems were still about "transportation" of wastewater to a "safe" place for disposal – as opposed to "transformation" or treatment which could actually go some way to protecting the environment.

It is little wonder therefore that significant advances in treatment technologies have occurred over the past 100 years as populations have grown – initially focussed on public health and then on environmental protection and resource recovery. Many of the advances have been energy intensive. We use energy to convey and purify water, but also have the opportunity to recover it from wastewater streams.

So are we doing all we can to protect our environment via the most sustainable route?

Given the rapidly expanding global population, and the associated implementation of energy intensive treatment plants, many in our industry are calling for a paradigm shift in the role of wastewater treatment, from being solely waste removal to resource recovery systems. This recovery can include nutrients, water and energy.

There are excellent examples of energy and resource recovery here in New Zealand. Recently there has been substantial investment made by both central and local government to further explore or enhance resource recovery. Current working examples include:

- Anaerobic digestion and subsequent methane recovery and power generation at many of our larger WWTP's
- Nutrient recovery from the solids or sludge stream through bio solids re-use from composting or sludge drying
- Numerous treated effluent re-use schemes for irrigation water and cut and carry cropping creating on-going revenue streams

Is there more that we can do? Given that 95% of the waste that comes down the pipe is or was at some time one of the three key food groups – protein, carbohydrate or fat. Nature, through a large number of mixed microbial populations, has over the course of the past six billion years evolved to deal with these so-called waste products. Surely we more complex multi cellular organisms can provide some leadership to our single cell friends and further enhance the recovery of this food.

The following are a few initiatives focussed on enhancing the recovery of these resources.

- **Thermal Hydrolysis** – new technologies and process initiatives are emerging such as the proprietary Cambi process where particularly waste activated sludge is conditioned through heating under pressure to make this "food" more available for bacterial digestion. This further reduces the volume of solids and improves biogas yield.
- **Microbial Fuel Cell Technology** – while the process is not yet commercial, the technology presents the ultimate opportunity to directly convert a waste stream into electrical energy, with opportunities for hydrogen production.
- **Innovations with Nutrient Recovery** – natural deposits of phosphorus are due to be depleted over the next 150 years or so. Struvite (magnesium ammonium phosphate) recovery is currently being commercialised. It can remove nutrients from wastewater thus protecting the environment and allow for re-use. Urine separation in the Netherlands for nitrogen recovery is another example.
- **Thermal Deconstruction** – here in New Zealand both central and local government have been investing in the enhancement of wet air oxidation technology for biosolids destruction to minimise land filling volumes and potentially capture and exploit carbon and nutrient rich side streams.

Given that humans continue to breed and multiply at a rate that our finite resources on the planet are struggling to keep up with I can see three possible alternatives for the planet.

- **Population Control by Fiat** – this has been tried by a number of regimes around the globe with limited success. Even the staunchest environmental groups do not seem to promote this as a possibility.
- **Find Aanother Planet to Exploit** – most of us now have environmental foot prints based on 2–3 planet equivalents, however the costs and logistics of mining on Mars are problematic!
- **Look to Recover and Re-use our Resources** – close the loop where we can so that we minimise what we need to extract from the planet. Sustainable energy is the key here, as it frees us to exploit technologies that will allow resource recovery.

Surely a shift in thinking from energy hungry wastewater plants to one of opportunity for resource recovery needs to be the future focus of our sector, along with looking at the whole environment, where decisions are made regarding the level of treatment and associated energy inputs required to achieve the desired outcomes. ■

Steve Couper
President, Water New Zealand

new members

Water New Zealand welcomes the following new members:

NEAL PERROT	TROY BROCKBANK	ROB HILL	GRAEME DOHERTY	JOHN RADINOFF	CHARMAINE PETEREIT
CARL GOODHUE	RAYMOND CHAN	ANDY WELLS	CHRIS CARTER	SHANE ALLEN	PETER BAHRS
KARL SENTCH	PETER SCHIERHOUT	JUSTIN JORDAN	AIDAN COOPER	RICHARD KEIGHTLEY	AARON BUCKLEY
RICHARD MASTERS	TOMASZ KRAWCYZK	SHER FOLEY	ROSS COHEN	SIMONNE ELLIOT	JON FOOTE
IAN BLACKWELL	DARREN MICHALSKI	BILL FARMER	KENNETH WILLIAMS	ANDY IRWIN	ANAK LUMB
MICHAEL REED	ANDY OLIVIER	JAMES WHITEMAN	ALLAN DAVIDSON	SHANE JACKSON	GRAEME DOHNT

Murray Gibb

Improving Water Services

Over the past five years *Water New Zealand* has fostered debate on improving water services. It has done so because opportunities for improvement, in aspects of the policy settings, regulation and delivery of water services in this country, while fairly evident to close observers, haven't been so obvious to others. As a result it hasn't received the policy attention it deserved. This is now changing with the Government's Fresh Start for Fresh Water and Better Local Government Reform programmes – the latter superseded the Smarter Government: Stronger Communities initiative.

This piece provides a synopsis of the journey we've travelled over the past five years, and where we have arrived. To put it in context, debate in this area is not new. It has bubbled away periodically over the last 15 years. In the late 1990s the then Ministry of Commerce initiated a review (not completed), the NZWWA convened its Crossroads Conferences, and a former Parliamentary Commissioner for the Environment investigated and reported on water services in 2000.

Recent *Water New Zealand* initiatives started with the formation of the Turnbull Group in early 2008. *Water New Zealand* approached individuals with substantial expertise and experience to take a leadership role in the development of principles and structures through which water could be better governed.

The Group's views were published in July 2009 in a document entitled Governance of Water. It proposed:

- Rationalisation of water services into special purpose entities based broadly in current regional council boundaries
- Independent economic regulation by a Water Commission (with direction from Ministers as appropriate, for example on equitable charging policies)
- Placement of environmental regulation into an Environmental Protection Agency which would also regulate drinking water quality
- Direct volumetric charging to improve transparency and provide security of funding
- The new entities having responsibility for stormwater and flood management along with the provision of new infrastructure, including for irrigation

It is history now that the Government convened the Land and Water Forum in 2009 to take a collaborative approach to building better water policy. At the same time officials were asked to develop a parallel work programme and the Government commenced discussions with the Iwi leader's group on their rights and interests in regard to water.

The Land and Water Forum's first report in September 2010 (road tested and reiterated in April 2011) suggested desirable features of water services would include:

- Rationalising the existing water utilities (both urban and rural) into a small number of large, publicly-owned utilities to provide water supply, wastewater and associated management services
- Governance reform with a focus on performance and not oriented to other priorities
- A national economic regulator
- Funding via metering and volumetric charging

It acknowledged that these proposals needed wider discussion and recommended that – *"the way water services infrastructure is managed and organized should be investigated to consider the potential benefits of rationalisation. This includes the possibility of a national regulator with oversight of pricing and performance issues. Subsequently, the issue of volumetric metering and direct billing should be worked though collaboratively with stakeholders."*

It made a point of reiterating these recommendations in its third report released in December 2012.

Meanwhile the Board considered how *Water New Zealand* could further contribute to decisions and influence the shape of reform. It took the view that offering a 'straw man' for discussion would be a useful contribution and did so via a paper on water and wastewater (but not stormwater) services entitled "The Future Face of Urban Water Services in New Zealand?"

This paper does not represent *Water New Zealand* policy. Rather, it was developed in order to initiate wider debate on a subject of close interest to members. The Board did, however, endorse the principles contained within this paper.

> "The current policy environment for water generally is dynamic."

The paper was made public in November 2011. We subsequently had a forum on the subject at the annual conference that year and discussed it at regional meetings with our Senior Executives' Forum and the Water Services Managers' Group. The general feedback was supportive.

Now, when providing policy advice on water services, we point to the common features of well performing models:

1. One lead government agency being assigned overall responsibility for all water services policy
2. The default policy option of funding being secured directly from customers via fees for service
3. Rationalisation of water businesses to capture economies of scale
4. Independent economic, environmental and water regulation
5. Governance based on merit
6. Network pricing to help fund deferred investment and lift levels of service in smaller communities

The current policy environment for water generally is dynamic. Details on aspects of these features are of interest across the spectrum of policy makers including Ministers.

The recent report from the Local Government Infrastructure Efficiency Expert Advisory Group recommends going part way down this route, picking up on aspects of the first three of these points highlighted above. These and other recommendations from the Group are now part of the mix of policy advice that will help shape the second Local Government Act Reform Bill which will be introduced later this year. The journey continues.

Murray Gibb
Chief Executive, Water New Zealand

WATER SEPTEMBER 2013

The next issue of *WATER* will be published in September. The lead theme is Modelling, with sub-topics: Urban Metering, Governance and Public Policy.

Please contact the editor, Robert Brewer, robert@avenues.co.nz if you have any story ideas, contributions or photos. The deadline for the September issue is Monday 19 August.

CHANGING CURRENTS

2013 WATER NEW ZEALAND'S ANNUAL CONFERENCE & EXPO

Claudelands Event Centre, Hamilton 16–18 October

Conference Registration

Registration is now open for the *Water New Zealand* Annual Conference & Expo 2013 at www.waternz.org.nz

The preliminary conference programme is now on the website. For a preview of all presentations on offer in 2013 go to www.waternz.org.nz and click on the conference link in the banner at the top of the home page.

Register now to guarantee your attendance at the only New Zealand conference & expo that covers every aspect of the water environment and its management.

Early Bird Registration

Be sure to register before 23 August to take advantage of the Earlybird discount available on your registration fees and accommodation.

Corporate Package Registration

Make the most of the substantial discount available for groups of five or more attendees from the same organisation. Register your group early to ensure your organisation receives the great discounts. This offer closes on 23 August.

Conference Theme and Programme

The core theme of the Conference is ***'Changing Currents'***.

There will be on offer over 80 presentations covering every aspect of the water environment and its management.

The programme will include general streams as well as specialist streams of Modelling, Operations and IWA.

This year's conference will follow the same format as 2012 with two full days of presentations on Wednesday and Thursday. The *Water New Zealand* AGM and panel discussion will be held on Friday morning along with the exhibitor visitors' morning, a great opportunity for exhibitor/client meetings.

Expo Demonstrations

The Conference Exhibition continues to be the largest trade exhibition for the sector with over 170 sites. This year will see the reintroduction of live demonstrations. Demonstrations will be held each day during the lunch break on both the Wednesday and Thursday.

Networking Opportunities

Social functions throughout the Conference continue to provide a prime networking opportunity with attendance of people working in the many and varied aspects of the water environment and management sector.

Visit www.waternz.org.nz and click on the Conference link to view the programme and read more about the social functions at the Conference.

- **Welcome Reception**
  Wednesday 16 October
- **Modelling Dinner**
  Wednesday 16 October
- **Operations Dinner**
  Wednesday 16 October
- **Conference Dinner & Awards Presentation**
  Thursday 17 October

Water New Zealand Awards 2013

The following awards will be presented at the 2013 conference:

- Hynds Paper of the Year Award
- ProjectMax Young Author of the Year (New Award)
- CH2M Beca Young Water Professional of the Year
- AWT Poster of the Year
- Ronald Hicks Memorial Award (nomination required)
- Opus Trainee of the Year (nomination required)
- Orica Chemnet Operations Prize

Call for Nominations for 2013 Awards

Water New Zealand is now calling for nominations for the Awards to be presented at the Annual Conference this year. Members are encouraged to nominate suitable candidates for relevant Awards. Non-members of *Water New Zealand* are eligible for some of these awards.

Closing dates for nomination are:

19 August: AWT Poster of the Year
30 August: Ronald Hicks Memorial Award
30 August: CH2M Beca Young Water Professional of the Year
30 August: Opus Trainee of the Year

CH2M Beca Young Water Professional Award

The award will acknowledge and reward one young water professional who has made a significant contribution to the water industry and the general community, and has demonstrated exceptional achievement in the early stages of their career.

To download the CH2M Beca Young Water Professional of the Year nomination form visit www.waternz.org.nz visit the Annual Conference page and click on the Awards link.

Opus Trainee of the Year

The Award is open to any trainee currently involved in an NZQA approved course applicable to the water and wastes industry.

Send nominations and a short summary of why you think the trainee in question should receive the prize to Peter Whitehouse at *Water New Zealand*. Email peter.whitehouse@waternz.org.nz or phone Peter on +64 4 495 0895.

Orica Chemnet Operations Prize

We are seeking examples of best practice in the industry and nominations are welcome for individuals, an operations team, or a particular project that had a strong operations flavour.

Send nominations and a short explanation of why you think your nominee should be the recipient of the prize to Peter Whitehouse at *Water New Zealand*. Email peter.whitehouse@waternz.org.nz or phone Peter on +64 4 495 0895

Criteria and Scope for Awards

The definition and scope of each award, the criteria for selection, along with the nomination processes and timelines for submission can be found under the Annual Conference section 'Awards' on our website at www.waternz.org.nz

Water New Zealand Annual General Meeting

The *Water New Zealand* 2013 Annual General Meeting will take place at 9.00am on Friday, 18 October 2013 at the conference venue, Claudelands Event Centre, Hamilton.

To meet constitutional deadlines any notices of motion for this meeting must be supplied to the Chief Executive by 5.00pm, Friday 13 September 2013.

Notice of AGM and Call for Notices will be sent to financial members on Friday 9 August 2013.

Water New Zealand Board Election – Call for Nominations

Nominations for election to the Board of *Water New Zealand* will be called on Friday 9 August 2013. The closing date for nominations is Thursday 29 August at 5.00pm. The Board comprises six elected members and may include two co-opted members. Members are elected for three-year terms. This year two positions are available. Sitting members Robert Blakemore and Hugh Blake-Manson retire by rotation.

Members contemplating standing for the Board may wish to discuss the role and responsibilities of directors with sitting members of the Board. The candidate, nominator and seconder must all be financial members of the Association.

Please contact Hannah Smith, Association Secretary, *Water New Zealand*, if you have any queries. on +64 4 495 0897, or email: hannah.smith@waternz.org.nz

Key Dates for Your Diary

Earlybird & Corporate Package	
Registrations Close	**Friday 23 August**

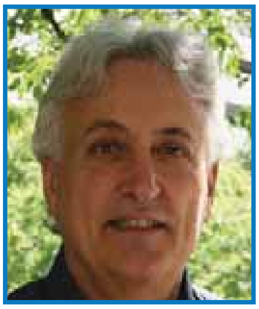
Key Dates for Presenters

Poster Summaries Due	**Monday 19 August**
Final Papers Due	**Thursday 22 August**
Powerpoint Presentations Due	**Friday 4 October**

Conference Speakers

Below are biographies on some of our confirmed speakers for the 2013 Annual Conference to be held at the Claudelands Event Centre, Hamilton, from 16–18 October. As more details on speakers become available we'll let you know through the conference website and through Pipeline.

Keynote Speaker Profiles



Dr Robert Costanza

Dr Costanza is currently Professor and Chair in Public Policy at the Crawford School of Public Policy, Australian National University.

Prior to this, he was Distinguished University Professor of Sustainability, in the Institute for Sustainable Solutions at Portland State University (2010–2012), Gund Professor of Ecological Economics and founding director of the Gund Institute for Ecological Economics at the University of Vermont (2002–2010), Professor at the University of Maryland (1988–2002) and at Louisiana State University (1980–1988).

His trans-disciplinary research integrates the study of humans and the rest of nature to address research, policy and management issues at multiple time and space scales, from small watersheds to the global system. He is co-founder of the International Society for Ecological Economics and founding editor in chief of Solutions (www.thesolutionsjournal.org).

He is author or co-author of over 500 articles and 23 books and has been named one of ISI's Highly Cited Researchers since 2004. More than 200 interviews and reports on his work have appeared in various popular media.

Graham Dooley

Graham Dooley is one of the most experienced Chairman level people in the Australian water industry having spent 40 years delivering capital and operating water solutions across Australia.

He has been a Chairman, MD and Director of over 40 companies in the past 25 years. Graham has spent approximately 50% of his career in each of the public and private sectors, so knows the challenges and issues from both sides. Graham spent 15 years up to 2007 as Managing Director of United Utilities Australia Pty Ltd (UUA), a UK owned company which was successful in winning many water infrastructure contracts for public authorities, local Government and industry throughout Australia in which over A$300M of debt and equity finance was invested in every combination of contract possible.

He is intimately familiar with the risks and rewards of investing in water infrastructure. Before 1991, Graham also worked for Sydney Water for nearly 20 years where he filled several senior management roles including managing all aspects of Sydney Water's 31 sewage treatment plants.

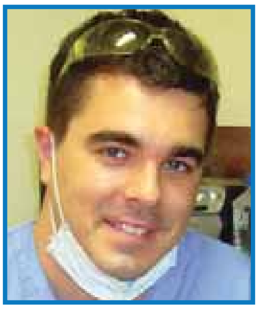
Invited Speaker Profiles

Rob Blakemore

Rob Blakemore is a Partner and Sector Manager for water asset management services and for Opus International Consultants Ltd. In this role he leads and coordinates the water asset management consultancy and water training services for the company – principally for local government utilities in New Zealand but also in Malaysia and Australia.

Rob has had significant experience in design and operations of water supply systems. His activity in the water industry spans his working life of 35 years. He has been a member of the Expert Working Committee for Drinking Water Standards and is currently a member of the MOH SAWTAC committee that reviews subsidy applications. He has had three previous terms on the Board of Water New Zealand and is a former President.

His operational experience and his passion for finding ways to lift the capability and profile of operations people provided useful insight into reviewing the incident that occurred in Darfield.



Jonathan Broadbent

Jonathan Broadbent is an oral health researcher who investigates the epidemiology dental diseases and their prevention, with particular focus on social disparities in oral health.

Jonathan is employed as a senior lecturer in preventive and restorative dentistry at the University of Otago's Department of Oral Rehabilitation and is a member of the Dental Epidemiology and Public Health Research Group of the University of Otago's Sir John Walsh Research Institute.

Duncan Gibb

From 9 May 2011 Duncan Gibb has been General Manager for SCIRT (the Stronger Christchurch – Infrastructure Rebuild Team) charged with rebuilding Christchurch's publicly-owned horizontal infrastructure (water, wastewater, drainage and roading) after the earthquakes.

The SCIRT organisation has since grown into a 2,000 strong team visible across the city of Christchurch on over 120 project sites. The team is working hard to keep the community directly affected by the works – and the travelling public, informed of progress.

Prior to this Duncan held a number of General Management and project based roles in Australia and New Zealand – delivering major infrastructure projects, many of which were delivered under Alliance contractual delivery agreements.

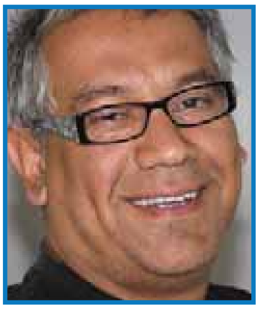
Duncan feels privileged to be part of the SCIRT Rebuild Team and is enjoying the challenges and opportunities associated with living in the Canterbury region.

John Harding

John Harding is a consultant adviser employed by the Ministry of Health to carry out technical peer review and administration of applications for subsidy under the $155M Sanitary Works Subsidy Scheme (SWSS) and the Drinking Water Assistance Programme.

He has worked in this role for more than 10 years in which time he has reviewed and advised on more than 100 wastewater treatment/disposal subsidy applications from the Awanui in the Far North to Oban on Stewart Island and more recently some 40 water supply subsidy applications.

He is a public health engineer who has spent much of his career working for large consulting firms. John has played key roles on a number of large wastewater schemes in New Zealand including wastewater treatment plants for Wellington, Hutt Valley, Palmerston North, Hastings and Masterton.



Donavan Marney

Dr Marney has a doctorate in chemical engineering, a masters in reactive organic chemistry and a bachelors of science. He is currently a team leader of an urban water systems engineering team and former stream leader in the Urban Water theme of water of CSIRO's Water for a Healthy Country Flagship.

He has lead international research projects seeking to understand the corrosion processes leading to the failure of polywrapped ductile iron pipes as well as steel pipes in buried environments within the water service provision sector.

His current research tends toward the development and utilisation of technologies to drive greater efficiencies in the provision of water services, which can delay augmentation or convert repairs from reactive to planned and budgeted or proactive, with a focus on data driven information for decision making – with the data coming from sensor technologies which have seen significant price reductions over the last decade or so. In addition the research has a strong mathematical and ICT bent in that the group is utilising existing data streams for new information by identifying patterns or trends of seemingly disparate data sets.

Mike Pohio

Mike Pohio is CEO of Tainui Group Holdings Limited and is of Te Arawa and Ngai Tahu descent and now heads the commercial interests of the Waikato-Tainui tribe.

Mike's responsibilities as CEO of Tainui Group Holdings Limited (TGH) include the management of a small, highly motivated team and a $660M portfolio of property and investments.

The key objective of TGH is to maximise wealth for Tainui. The current focus is on the predominantly Waikato-based property portfolio which comprises farms, hotels, industrial land, office blocks and retail. Key income streams are from ground rentals to Crown tenants including Genesis (Huntly Power Station and Meremere), Police stations, Courts, the University of Waikato and Wintec.

TGH's flagship asset is The Base which is now New Zealand's largest retail centre, following the completion of Te AWA in August 2011. Mike's career has included senior management positions at Port of Tauranga, Fonterra, NZ Dairy Group, Glencoal Energy, Elders Pastoral and Allied Farmers. Roles included Container Terminal management, general management, operations management and finance. Mike is a Director of Transpower. He is also Chairman of Tainui Auckland Airport Hotel and BNZ Partners Waikato.

Brian Sharman

Brian Sharman is a Chartered Professional Engineer with over 40 years' experience in the water industry including a total of 15 years at executive and senior management level in water-based organisations in the UK and New Zealand.

Brian has worked in a range of organisations from Consulting Engineers, Metropolitan Council, Water Authority and privatised Water Company in the UK and Council Controlled Organisations in New Zealand and is now an Associate Director of AECOM. Brian was Chairman of the UK Wastewater Planning User Group (WaPUG) for six years, is a Member of the Institute of Directors in NZ and has long experience of working with a range of industry regulators, governing bodies and Boards.

Murray Washington

Murray Washington joined the Selwyn District Council in late June 2012 to take up the position of Asset Manager with overall responsibility for Water Services, Transportation, Solid Waste, Property, Facilities and Reserves.

This follows ten years as Manager Infrastructure Services at Central Otago District Council, where he managed similar disciplines. Murray was a Board Member of Ingenium (now IPWEA New Zealand) for five years (2007–12) and is well versed in rural water supply issues.

He is somewhat passionate about water demand management as the primary tool for water conservation and making water quality upgrades more affordable.

Reflecting the wide range of his portfolio, Murray is an Infratrain assessor for Procurement Procedures, and on the National Advisory committee for NZIHT (Industry training needs).

Water Environment Federation (WEF) Report – June 2013

Garry Macdonald – WEF Delegate and member of WEF Board of Trustees

The "Value of Water" Campaign and the Ad Council

Since its launch in 2012, WEF's "Water's Worth It" campaign has been steadily gathering momentum within the WEF community, as well as attracting the attention of many other organisations, companies and suppliers to the water/wastewater market. Now, for the first time, it appears that the water industry in North America is prepared and willing to "speak with one voice".

The Value of Water (VOW) Coalition is a ground-breaking water industry collaboration among national associations of public utilities, both wastewater and clean water; engineering and construction firms; and private water companies. These groups have come together to develop and implement a professionally-designed, effective messaging and communications campaign to influence public awareness about the value and importance of water to public health, quality of life, the environment – and a growing economy.

VOW engaged a communications firm, The Glover Park Group, to begin work on the campaign. GPG will compile relevant facts and statistics to substantiate core messages and provide strategic guidance; design and implement campaign; identify tactics and audiences for delivery of message. GPG will also determine clear metrics for measuring effectiveness of campaign.

As the VOW group was formed and GPG began developing a campaign, the Ad Council, renowned for their innovative public service campaigns, independently invited WEF to submit a proposal for a water awareness campaign for their consideration. The Ad Council began producing public service announcements in 1942 with an aim to inspire social change to improve the lives of Americans.

Using seeding funds from the sponsoring organisation, combined with the donated talents and time of USA's leading advertising agencies and the media, the Ad Council produces, distributes and promotes public service campaigns on behalf of non-profit organisations and government agencies. The reach and longevity of such campaigns is well beyond most such organisations and they have demonstrated the "power of the media" with the right messaging and delivery methods. To see more visit: www.adcouncil.org/Our-Work

WEF and the VOW Coalition are now working towards a merging of these two initiatives. The focus right now is on the finding the single 'water issue and call to action' that meets the water sector needs and also meets the Ad Council's criteria – which is to determine a major public issue and identify actions an individual citizen can take to correct or improve the situation. There are many water issues that lend themselves to citizen actions – such as not using the toilet as a trash can for wipes, pharmaceuticals, etc., not over-fertilizing, picking up pet wastes, etc. But feedback from the Ad Council is that the water sector should choose one issue and begin building the campaign around it – others can be added over the three years.

WEF will need everyone's help to meet the Ad Council's partner-funding requirements of $3M ($1M per year for three years). This investment will leverage the Ad Council's average $90M in pro-bono professional services and media buys over the three years. WEF is accepting pledges towards the goal now within a campaign schedule which includes making the final proposal to the Ad Council for their endorsement in early September. See the website http://adfunding.watersworthit.org for more information and materials.

WEFTEC 2013, Chicago: 5–9 October

WEFTEC 2013 is looming large and close! As in previous Chicago years, it will be located at the McCormick Place Convention Center. The exhibits will be contained in one continuous exhibition hall and the technical programming and related meetings will span the center's South Building, as well as the Hyatt McCormick Place Hotel that is connected to the Convention Center.

The core WEFTEC format has been preserved, with two days of workshops followed by three days of Technical Papers, running in parallel with the enormous Trade Exhibition. However, to refresh the event and make it even more appealing to attendees and exhibitors, other initiatives have been added for 2013.

The WEFTEC Program Committee continues the long-standing tradition of providing the highest quality program available in the water quality field. This year is no exception with 27 workshops and over 140 sessions. The popular mobile sessions have been expanded to include 12 different topics and more may be added. These sessions include visits to exhibitors with a guide that helps attendees learn about the latest technical details and innovations, while also comparing products and services from related exhibitors.

WEFTEC 2013 exhibit sales are strong – as of June 7, over 300,000 square feet (or three hectares) of exhibit space – a new record – and one that is guaranteed to keep you walking through the three days of the show!

WEF's Stormwater Congress will be co-located with WEFTEC this year following on the very successful 2012 Stormwater Symposium in Baltimore. This "conference-within-a-conference" includes 17 sessions, over 70 world-class speakers, a mobile session, a luncheon with a speaker, the Stormwater Pavilion on the exhibit floor, and a theatre in the Pavilion for additional brief and educational sessions.

WEFTEC 2013 will offer a brand new mobile app. You can download the mobile app by scanning the QR code located on WEFTEC Mobile page on weftec.org or by going to the Apple iTunes store or the Android Market and downloading the WEFTEC 2013 app. You can browse through the exhibitor list, technical program (& abstracts – new for this year), and other events at WEFTEC and create your own personal schedule, as well as take a tour of the interactive exhibit floor plan.

WEF will debut the WEF Plaza at WEFTEC this year. The Plaza will provide the opportunity to attendees to become informed and interact with WEF's educational initiatives, merchandise, services and staff. The Plaza will consist of the Bookstore, Membership, Global Center, Learning Lounge, Honors & Awards Display, and the Mobile App Center all in one place.

Lastly, WEF has introduced a new registration pricing model for WEFTEC 2013 which simplifies pricing and reduces the registration fee for many categories. Those registering online for exhibit-only access are complimentary. This registration includes all activities located on the exhibit floor, which will include Operations Challenge, popular technical sessions, mobile sessions, and access to the vast technical knowledge and expertise provided by the exhibiting companies.

Registrations and hotel bookings are open now – so get in now for the best hotel deals! www.weftec.org

For more information contact me on garry.macdonald@beca.com or phone 09 300 9281, and do let me know if you have registered for WEFTEC 2013 so we can have a Kiwi get-together in Chicago as in previous years. ■

Government Invests $2.4M to Clean up Kopeopeo Canal

Environment Minister Amy Adams has announced the Government has committed an extra $880,000 to clean up that the Kopeopeo Canal in the Bay of Plenty. This funding is in addition to the $1.5 million invested by the Government in 2011.

"Kopeopeo Canal is a priority site under the Government's contaminated sites programme. We are committed to cleaning-up this waterway as quickly and as safely as possible," Ms Adams says.

The additional funding will be used to remove about 40,000 cubic metres of contaminated sediment from the canal. The sediment will be stored and treated in secure containment cells.

"Kopeopeo Canal is a priority site under the Government's contaminated sites programme. We are committed to cleaning-up this waterway as quickly and as safely as possible," Ms Adams says."

The Kopeopeo Canal was originally built to allow drainage and floodwaters from low lying farmland into the Whakatane Estuary. However, between 1950 and 1989 the canal was contaminated by dioxins from a local sawmill.

The project is being managed by the Bay of Plenty Regional Council, which has provided $2.4 million towards the clean-up. ■

Board of Inquiry to Consider Tukituki Catchment Proposal

Environment Minister Amy Adams and Conservation Minister Dr Nick Smith have announced that the Tukituki Catchment Proposal will be directed to an independent Board of Inquiry.

The proposal by Hawke's Bay Regional Council and Hawke's Bay Regional Investment Company is made up of two components.

Hawke's Bay Regional Council requested that both components should be referred to a Board of Inquiry for a decision.

"The Board of Inquiry process gives people an opportunity to have their views taken into account, and delivers a decision within nine months."

The first component relates to the creation and operation of a dam structure, storage reservoir and canal system. The second component relates to the regional council's Plan Change 6, which proposes new policies and rules intended to implement a nutrient management framework and water allocation regime in the area.

The proposal involves the Minister of Conservation because impacts of the scheme include the coastal marine areas for which he has responsibility.

In accepting the recommendation of the Environmental Protection Authority to call in the plan change and refer the whole proposal to a Board of Inquiry, the Ministers say the Tukituki Catchment Proposal meets the criteria for being considered nationally significant.

"There is likely to be wide public interest in the proposal, considerable use of natural and physical resources, significant changes to the environment and it affects more than one region or district," the Ministers say.

"The Board of Inquiry process gives people an opportunity to have their views taken into account, and delivers a decision within nine months."

A Board of Inquiry will be appointed in due course to consider the proposal. ■

New Staff Member

Nick Walmsley joined the *Water New Zealand* team in June. Nick is a chemical engineer with 40 years international experience across all aspects of water infrastructure. He is well known to members having worked on many of their water and wastewater systems during the last 30 years.

Nick has been a long standing member of *Water New Zealand*, past chair of the Technical Committee and a contributing author to several NZ guideline documents including the NZ Biosolids Guidelines.

Nick replaces David Edmonds as Technical Co-ordinator. We wish David well in his retirement and welcome Nick to the team.

Annual Membership Subscriptions

Your annual membership subscription is now due. Invoices will be emailed to you during July. Please note that hard copies of invoices will not be sent.

We take this opportunity to remind you that paragraph 6.2 of the Constitution reads:

"All subscriptions shall be payable to the Association on demand. Any member for whom an annual subscription has not been paid within ninety days of demand will automatically be removed from the membership list of the Association, with the loss of rights arising from affiliation with other organisations".

Please ensure your invoice is paid promptly to ensure continuation of your membership benefits. If you have any queries regarding your membership subscription, please notify Linda Whatmough, Finance Manager, *Water New Zealand* at accounts@waternz.org.nz

Website Upgrade – Register Now!

Water New Zealand has implemented new member management software, and updated our website.

As a member of *Water New Zealand* you will be able to log on to the new system. You will have access to a membership directory, as well as see the company profiles of our corporate members.

The first step is to register. You can do this by visiting our website and clicking on the REGISTER NOW button on the top left hand corner.

Once you have registered, you can go to your Dashboard, where you can change your password and update your details.

Please note: The email address you should use to register is the same email address that you receive the Pipeline newsletter through.

Privacy Settings

There are three levels of privacy settings: "Nobody", "Members Only" and "The Public".

The default setting is "Members Only". This enables other members of *Water New Zealand* to see your details in the member directory. If you select "Nobody", your details will be completely private. If you select "The Public", anyone using the *Water New Zealand* website will be able to see your details.

If you do NOT wish others to see your details, please contact Linda Whatmough at *Water New Zealand* immediately and your privacy settings will be changed to "Nobody". Alternatively, after you register on the site, you can go to the Privacy tab on your Dashboard and update the settings yourself.

Thank you in anticipation of your co-operation – Hannah Smith, Manager, Governance & Marketing.

Social Media

Follow *Water New Zealand* on Facebook and LinkedIn. From our recent social media survey, our members have indicated that they prefer these two media.

Connect Like Us

Local Government Reform Update

Helen Atkins – Partner and Vicki Morrison-Shaw – Senior Associate, Atkins Holm Majurey

Introduction

As promised, in this article we take at look at the local government reforms and the progress the Government is making on its Better Local Government reform programme. We start by providing an overview of the Local Government Amendment Act and the key changes it has introduced. We then move on to provide an overview of the reports from the two Local Government taskforces – the Local Government Efficiency and the Local Government Infrastructure Taskforces. We then take a look back at the Better Local Government Reform programme and consider what has been achieved and what is still to come.

Local Government Reform

In our March article we provided a brief update on the local government reform programme and noted the passing of the Local Government Amendment Act ("LGAA")[1] and the release of the Local Government Efficiency Taskforce's Report. We now provide further details of these reforms, reactions to these reforms and next steps in the local government reform programme.

Local Government Amendment Act 2012

The LGAA was passed in December 2012 and (with the exception of s 21[2]) came into force on 5 December 2013. The key changes of the LGAA are to amend the Local Government Act 2002 ("LGA") to remove reference to the four well-beings, to streamline provisions relating to reorganisation proposals and to provide the Minister with greater powers of oversight and rights to intervene in local government. In particular the LGAA:

- Removes reference to the four well-beings (social, economic, environmental and cultural) from the Act
- Refocuses local government on providing good-quality local infrastructure, local public services, and regulatory functions to the local community in a cost effective way[3]
- Inserts a definition of "good quality" as meaning infrastructure, services and performance that are efficient, effective and appropriate to present and anticipated future circumstances.
- Amends the provisions relating to reorganisation proposals to:
  - » Insert a new purpose provision which recognises that the purpose of reorganisation proposals is to improve the effectiveness and efficiency of local government[4]
  - » Provide an ability to postpone completion of certain statutory requirements (such as annual plans and policies) and postpone council elections for up to 12 months once public notice of a final reorganisation proposal has been given[5]
  - » Require local government to co-operate with, assist and provide information to the Local Government Commission in relation to reorganisations. Local Government is also barred from making a decision which would significantly prejudice or impact on a reorganisation proposal[6]
  - » Allow unitary authorities to apply to drop "city" or "district" from their name e.g. Auckland Council[7]
  - » Require all orders in council relating to reorganisation proposals to be published in the NZ Gazette[8]
  - » Clearly set out the Minister's expectations of the Local Government Commission in relation to reorganisations[9]
- Confirms the leadership role of the Mayor and to provide the Mayor with the power to appoint the deputy mayor, committees, and the chairperson of each committee[10]
- Requires a report from the Auditor General in the long term plan and annual reports[11]
- Replaces definitions of community facilities, community infrastructure, development contribution, development contribution policy, network infrastructure, and service connection
- Replaces and expands the powers of the Minister to take action in relation to local authorities that have a problem[12] In particular the Minister is empowered to do any of the following in certain circumstances[13] (and is not required to do in order or start with the least intrusive):
  - » Require local authorities to provide information in relation to the nature and extent of the problem and how the local authority is, or it planning to, address the problem
  - » Appoint a Crown Review Team to the local authority to investigate, report and make recommendations to the Minister on the problem[14]
  - » Appoint a Crown observer to the local authority to investigate, report and make recommendations to the Minister on the problem
  - » Appoint a Crown Manager to a local authority to direct the local authority to address the problem and make recommendations to the Minister for further action that may be required
  - » Appoint a Commission to replace the local authority for a specified period. The local authority members remain in office during the Commission's term but are prohibited from acting. Under this option the Minister is also able to postpone the next triennial elections while the Commission is at the helm
  - » Call a general election to replace the local authority

The Minister may consult with any person in determining whether to exercise any of these powers, must publish a list of principles and matters that the Minister will consider before deciding to act, and must provide notice of any such decisions.

So all in all, a fairly strong direction to local government to focus on their core business (infrastructure, services and regulatory services to local community) and to ensure that they perform their services efficiently and effectively – or risk being replaced by others that will.

Local Government Efficiency Taskforce Report

The Local Government Efficiency Taskforce was appointed in June 2012 and was tasked with considering how local government consultation, planning and financial reporting requirements under the LGA could be streamlined. Perhaps unsurprisingly, the Taskforce found that there were a number of areas in which the functioning and processes of local government could be improved and in its Report[15] the Taskforce made a series of recommendations (32 in total) for how this could occur. These recommendations covered not only consultation, decision making, planning and financial reporting, but also what the Taskforce described as "broader opportunities to build efficient local government". Due to space limitations, we do not propose to outline all 32 recommendations, but instead will highlight a few, of what we consider to be, the more substantive recommendations.

In relation to consultation and decision making the Taskforce found that some mechanisms created a barrier to efficient and effective engagement and decision making. The Taskforce recommended a number of changes to provide more flexibility and discretion in the way that Councils choose to engage and make decisions. In particular, that:

- The prescriptive decision making rules set out in sections 77 to 79 be repealed and replaced with a clear set of relevant principles for councils to consider when making decisions
- Changes be made where necessary to ensure that a requirement to consider community views does not impose a legal duty to consult
- Councils be given flexibility and discretion as to when and how they choose to consult and accordingly remove the requirement to use the special consultative procedure for such consultation. The special consultative procedure would however be retained for adoption and amendment of council long-term plans
- Councils be required to include an engagement and significance policy in the long term plan to determine the significance of decisions; how the council will engage with the community on matters of significance; when the special consultative procedure will be used; and how the Council will avoid duplication of engagement/ consultation

In relation to planning and financial reporting the key recommendations relate to the long term plan and annual plan requirements. In particular:

- Long term plans should be amended so that they:
  - » Set out the long term vision, strategies and priorities and the actions required to support these matters
  - » Contain a high level statement of financial strategy
  - » Include the engagement and significance policy
  - » Make the preparation of asset management plans mandatory;
  - » Provide a clear basis for accountability of a council to the community
  - » Be required to be adopted by 30 June after the election of a new council
- Annual plans should be scrapped and replaced with a requirement to prepare an annual budget

The report also outlines a number of broader opportunities to build efficient local government in four key areas:

"The report also outlines a number of broader opportunities to build efficient local government in four key areas."

- Integration of planning functions
- Sharing innovation and collaboration
- Sharing good practice
- Reducing the costs of procurement

Local Government Infrastructure Report

The Local Government Infrastructure Efficiency Expert Advisory Group ("Infrastructure Group") was established in late 2012 to provide advice as to how good quality local government infrastructure could be delivered in the most cost-effective manner to support a growing economy.

The Infrastructure Group released its report in April 2013. The Report includes a series of recommendations (63 in total) which relate to and are grouped as follows:

- Amendments to simplify and integrate the policy and legislative framework

> "The Government has made significant progress in implementing its reform programme for local government."

- Training, good practice and sharing of expertise
- Improved conversation with communities
- Improving business practices
- Funding and pricing mechanisms
- Better information and greater transparency
- Increased co-ordination and removal of barriers to shared services.
- Greater use of regional provision to deliver regional solutions

The recommendations in the report are stated to be underpinned by a spectrum of change which shows the current state of affairs and the effect of some change versus significant change. As this spectrum effectively summarises key findings and recommended actions it is set out in full below.

Next Steps in Local Government Reform Programme

The Better Local Government Reform Programme was announced in March 2012 and included an eight point programme. These were to:

1. Refocus the purpose of local government
2. Introduce fiscal responsibility requirements
3. Strengthen council governance provisions
4. Streamline council reorganisation procedures
5. Establish local government efficiency taskforce
6. Develop a framework for central/local government regulatory roles
7. Investigate the efficiency of local government infrastructure provision
8. Review the use of development contributions

These eight points were to be actioned in two phases, with points 1 to 4 included in Phase one, and points 5 through 8 in Phase 2.

Phase 1 of the reforms has now been largely completed with the passing of the LGAA. The remaining area of work, which relates to further financial prudence requirements, is underway and these requirements are intended to be introduced by regulation.

Some progress has also been made in terms of Phase 2. Points 5 and 7 – relating to local government efficiency and infrastructure – have been advanced through the release of the reports of the Local Government Efficiency Taskforce in December 2012 and the Infrastructure Group in April 2013.

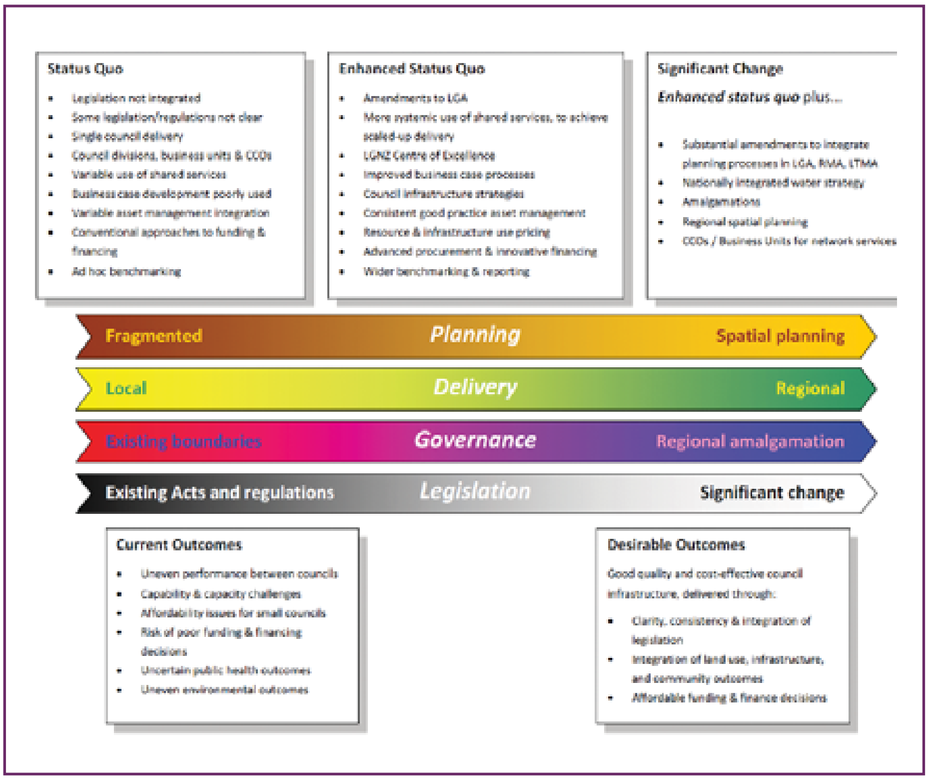


Figure 1 – The spectrum of change

The Government has also added two extra points to its reform programme for Phase 2. These are:

- Investigation of a dual or two-tiered governance model for local government
- Development of options for a performance framework for local government

All six points (ie points 5–8 and the two new ones recently announced) are intended to inform the development of a second LGA amendment Act which the Government proposes to introduce later this year.

Summary

The Government has made significant progress in implementing its reform programme for local government. It has refocused the purpose of local government, introduced new financial prudence requirements, changed the way Councils are governed and changed the process for reorganising local government. The Government's focus is now on making local government perform more efficiently and effectively and ensuring that governance models are optimal. Further changes are likely to be introduced later this year, but whether they will be in time for the next triennial elections in October remains to be seen. We will comment on any further changes in future articles.

Footnotes

[1]The full name of the Amendment Act is the "Local Government Act 2002 Amendment Act 2012".

[2]Section 21 relates to the role and power of Mayors and this has been timed to come into force at the same time as the local government elections have been concluded – 12 October 2013.

[3]For example refer to section 10 of the LGA which sets out the purpose of local government.

[4]Refer to section 24AA of the LGA.

[5]Refer to section 24A of the LGA.

[6]Refer to section 26A of the LGA.

[7]Refer to section 27A of the LGA.

[8]Refer to section 27B of the LGA.

[9]Refer to section 31A of the LGA.

[10]Refer to section 41A of the LGA. Note this change does not come into effect until the completion of the next triennial election i.e. 13 October 2013.

[11]Refer sections 84(4), 94(2) and 99 of the LGA.

[12]Refer to new part 10 of the LGA.

[13]Generally if the Minister believes on reasonable grounds that a problem (management/governance, significant/persistent failures to perform, civil defence emergency) exists, that such action is necessary, or if the local authority requests it.

[14]This option can be exercised if the local authority has not provided the information sought by the Minister and has no good reason for its non compliance; or if the Minister considers on reasonable grounds that a significant problem exists; or if the local authority requests it.

[15]Report of the Local Government Efficiency Taskforce – November 2012.

Climate Change – the Challenge for New Zealand

Hon Tim Groser, Minister of Trade and Minister for Climate Change Issues


Hon Tim Groser

New Zealand is richly blessed with a temperate, productive environment. New Zealand is luckier than most. We are ranked 4th out of 30 OECD countries on a per capita basis for the size of our renewable freshwater resource – although it doesn't always rain where and when we need it most. And, we are surrounded by ocean that moderates temperatures and provides a buffer against the impacts of climate change. Despite these advantages we are not immune from the environmental or economic consequences of failing to manage water wisely in the face of climate change.

As Minister of both Trade and Climate Change Issues, I am acutely conscious of the overlap between my responsibilities. Agriculture is a main driver of our export economy. Farmers and horticulturalists produced goods that earned 72 percent of New Zealand's merchandise export income last year, worth around $30 billion per year. More effective and efficient use of water will be a key contributor to helping New Zealand double its exports by 2025.

We face a tough challenge. How can we meet the critical need to mitigate climate change while still remaining a food basket to meet the ever growing food needs of the world? For New Zealand the challenge is particularly hard as agricultural greenhouse gas emissions account for almost half of our total emissions.

New Zealand initiated the Global Research Alliance on agricultural greenhouse gases to tackle this conundrum. This initiative brings interested countries together to drive greater international cooperation, collaboration and investment in climate change research. The aim is to produce more food, more efficiently, with fewer greenhouse gas emissions per unit of food produced. In other words we aim to increase agricultural productivity while minimising its impact on the planet.

The Government continues to invest in research to improve agricultural productivity. The Government has provided funding of $45 million over six years to June 2016 for the Global Research Alliance. We support the New Zealand Greenhouse Gas Research Centre, a consortium of nine research organisations led by AgResearch, with an annual $5 million grant. In addition the Sustainable Land Management and Climate Change research programme allocates nearly $9 million a year. All of these programmes aim to find practical technologies that will reduce methane and nitrous oxide emissions on farms, reduce nutrient run-off into waterways and increase productivity through better farm practices and more efficient use of fertilizers and water.

Supported by research and science, New Zealand farmers are already planning and adapting for a changing climate, and will have to continue to do so in the future. It is critical to New Zealand's prosperity over the long term.

Last year, the Ministry for Primary Industries released a report that reviews the impacts of climate change on the primary industries ['Impacts of Climate Change on Land-based Sectors and Adaptation Options', MPI website]. Climate change indications are that over and beyond the next 30 years New Zealand will experience a warmer, more intense and variable climate, and this will place added pressure on water resources.

In New Zealand, it is our eastern regions that are more likely to experience water stress as a result of climate change. The food baskets of the Bay of Plenty, Hawkes Bay, and the Canterbury Plains are drier now than in the past. In some seasons and years, yields will increase but in other years production downturns will be more pronounced.

It is clear that we can expect more frequent droughts and floods. The impacts for the agricultural sector – and by extension the national economy – from this past summer's drought are going to continue to be felt for several more production seasons. The cumulative impacts of back-to-back extreme climatic events such as recurring droughts are potentially our largest challenge. To keep our agricultural regions productive we need to pay attention to water – both its availability and its quality.

Adaptation options do exist, and leading farmers and growers are using them. For instance, existing day-to-day and season-by-season practices can help counter low to moderate climate change impacts. This might involve adjusting cropping schedules and improving irrigation efficiency.

> "A new Crown company will be established on 1 July to act as a bridging investor for irrigation projects. This will involve short-term, minority investments to help kick-start these regional projects."

Where climate change impacts are more extreme, we may need to develop or switch to other practices. This might mean diversifying production options in sheep and beef farming, finding new forestry plantation sites, or storing water when it is plentiful to use when it is dry. Our demands on water have increased with the growth of our population and the intensification of farming. How well we manage water quality and availability will be critically important to continuing to grow our agricultural production in an environmental friendly way.

As a first step in improving the way we manage water, the Government has introduced a National Policy Statement for Freshwater Management. This requires regional councils to end over-allocation of water and to maintain or improve the overall water quality in catchments.

A suite of proposals for reforming our water management system were released for discussion in March ['Freshwater reform 2013 and beyond', MfE website]. These proposals were the result of substantial discussions and engagement with stakeholders over the past four years.

In particular, the Land and Water Forum brought together a broad range of stakeholders in a collaborative process and succeeded in building a wide consensus on the direction for reform. The proposals focus on three key areas: planning as a community, a National Objectives Framework for setting objectives and limits for water quality under the NPS (with two national bottom lines), and managing within water quality and quantity limits. These reforms are intended to secure our future and protect what Maori call te mana o te wai – water's most important intrinsic qualities.

Hawkes Bay landscape during typical dry summer conditions

These reforms are about the Government supporting communities to make decisions, plan, set freshwater objectives and limits, and then meet the challenges over time of managing our land and water within these limits. It is only by working together – collaboratively and in partnership with all users and managers of water – that we can achieve a common understanding of the uses, values and challenges around water bodies, and agree on common aspirations and actions.

Officials are working on advice following public feedback and decisions are expected on the key foundational steps for reform later this year.

There is no shortage of water in New Zealand, but we lack the ability to store and use that water when it's needed most. Currently, only two per cent of rainfall is used for irrigation. We need to do a better job of using this resource.

Increasing irrigation could see a further 420,000 hectares of irrigated land becoming available, creating thousands of new jobs and boosting exports by $4 billion a year.

This is why Budget 2013 has confirmed $80 million in funding for regional irrigation projects.

In total, the Government has signalled plans to invest up to $400 million in regional irrigation schemes to encourage third-party capital investment.

A new Crown company will be established on 1 July to act as a bridging investor for irrigation projects. This will involve short-term, minority investments to help kick-start these regional projects.

The Government is also supporting rural communities and businesses to secure more reliable water supplies through the $35 million Irrigation Acceleration Fund (IAF). This fund was established in 2011 to support the development of regional-scale, rural water infrastructure proposals.

IAF grants are available to help backers get a proposal to the stage where it's ready to be presented to potential investors. To date, eight projects have been approved for IAF funding, to the value of $14.2 million. Several of these projects have an emphasis on water storage. Some examples are the Ruataniwha Plains Water Storage Project, the Wairarapa Water Use Project and the Central Plains Water Scheme, which has access to stored water from Lake Coleridge.

In promoting these water infrastructure proposals, the Government is encouraging backers to consider the full range of potential benefits – and also the impacts. Projects must aim for environmentally sustainability and plan for best-practice water use. Backers must show how their proposal will meet regional strategies for freshwater management, which include a range of needs and uses, and there must be community engagement in the planning stages.

Storage can do a lot for the environment, as it takes the stress off over-allocated groundwater aquifers and lowland rivers, and makes water available during periods of lower rainfall, which can help reduce ecosystem stress. Also, we expect to see the application of modern technologies that enable efficient use of water and less wastage, and efficient use of water that will reduce leaching of nutrients from land to neighbouring waterways.

Increasing the predictability and security of water supply is a good hedge against the increased variability we will face as a result of climate change. It will enable our agricultural sector to continue to contribute to the country's wealth through the products we grow and trade overseas. And the environmental benefits of water storage infrastructure will contribute to the environmental and recreational opportunities that make this country so attractive to overseas visitors and domestic tourists.

Kalkallo (Merrifield) Stormwater Harvesting and Re-use Project Overview

Matthew Bismark – Beca Pty Ltd, Melbourne VIC and Francis Pamminger – Yarra Valley Water, Melbourne, VIC

Introduction

The Kalkallo Stormwater Harvesting and Reuse Project will showcase leading edge water recycling, ultimately identifying what has to be done to achieve drinking water quality from stormwater harvested and treated in an urban catchment.

Project Context

The millennium drought stressed water supplies across Australia and created strong drivers to reconsider approaches to water security.

The Victorian State Government strategy included demand management, large scale centralised augmentations (including the Victorian desalination plant) and local scale re-use projects to cater for growth and provide water security within the context of a changing climate.

Demand management made significant and cost-effective contributions to water security, reducing Melbourne's household water demand from 244L per person per day in 1999/00 to 149L per person per day in 2010/11.

Augmentation is also required to provide water security for Melbourne's growing populations. Large scale augmentations have been completed. There remains a focus on the role of decentralised reuse systems in deferring subsequent large scale augmentation projects.

Recycling stormwater for non-potable use may compete with sewer mining or oterh wastewater reuse and may save up to approximately 50% of household water use. Recycling stormwater for potable use increases the demand reduction on the existing system up to 90%. The risks, costs and benefits of potable reuse needs to be further explored, better understood and widely discussed as a means of achieving long-term water security.

The Kalkallo Stormwater Project is a pilot plant project that will investigate real-world performance of decentralised stormwater harvesting and reuse. The project will inform on-going research and debate that will contribute to urban water cycle management in the future.

Figure 1 – Merrifield, a fully integrated multi use centre north of Melbourne at Kalkallo

Project Overview

Yarra Valley Water, one of the three retail water companies in Melbourne, has been developing a series of sustainable water servicing projects across its service area. A new growth area to the north of Melbourne has provided the impetus to explore the role that stormwater might play in the future.

Kalkallo is located approximately 28km north of the Melbourne CBD. A large greenfields site (currently farm land) covering almost 730 Ha is to be developed as a fully integrated multi use centre, and will be known as "Merrifield". This presents an opportunity for urban water services to be provided in a more sustainable way.

The Kalkallo Stormwater Harvesting and Reuse project will collect water from a 160 ha portion of the total development which forms a Business Park precinct on the eastern side of the site; Figure 1.

Stormwater will be harvested from the catchment area via a conventional stormwater drainage system consisting of drainage pits and pipes, treatment devices and a series of wetlands before final storage in a 65ML raw water pond.

Raw water will be pumped to a nearby 1ML/day water treatment plant where it will be treated to a potable standard and in the first instance be supplied into a recycled water network in the vicinity. However the ultimate aim is to achieve water quality that could be used to supplement supply.

The project is a pilot scheme and as such is focussed on assisting the wider industry to better understand the management of stormwater as part of the urban water cycle.

The project is being commissioned at the time of writing in June 2013.

Key Project Outcomes and Lessons

Contribution to Water Demands

The project has shown that decentralised stormwater harvesting for potable reuse can significantly offset the additional water demands of new developments. In this instance the project will be able to supply up to 90% of the potable water required to service the catchment, thus minimising the additional load that this urban development will place on the centralised water supply.

Project Economics

The project is costly. This is primarily due to the need to construct a large raw storage (necessary to maintain an agreed level of reliability) and a sophisticated treatment plant necessary to achieve and demonstrate potable water quality.

At the time the project was being considered, the Business Case was based on:

- Capital cost $19.7M
- Federal Government grant of 50% of capital cost
- Initial Operating expenditure of approximately $450K per annum

Traditional accounting cost and revenue analyses show the project will not pay for itself using traditional financial analyses,

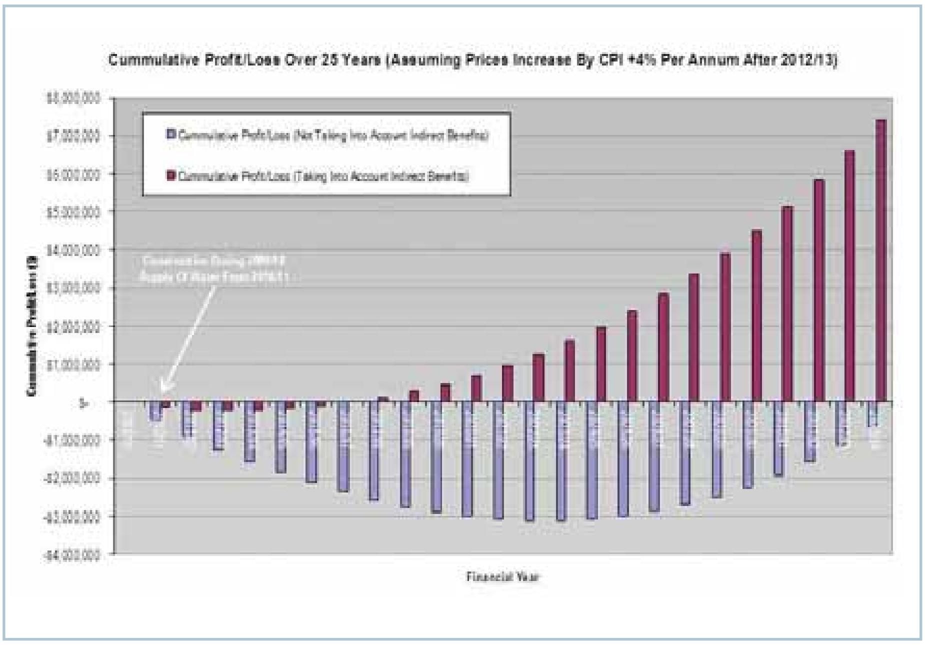


Figure 2 – Summary of Project Case for different cost scenarios

however integrating external and indirect costs and benefits from nitrogen reduction and deferment of capital works upgrades showed that project economics were positive.

Figure 2 demonstrates the different outcomes of traditional and more holistic project evaluations. Figure 3 forecasts the relative cost per KL of water from the Kalkallo plant compared to Melbourne generally, and confirms that the plant will be cost effective over time.

Other project analyses also show that stormwater projects for Class A equivalent (non-potable) or better quality will generally be more expensive than equivalent recycled water produced from sewage.

A more holistic and industry agreed methodology for costing indirect costs and benefits from stormwater harvesting must accordingly be established. Degradation to downstream receiving waters and greenhouse gas offsets could be additional factors to integrate. An industry agreed approach would provide a more transparent and reliable project evaluation methodology that aligns with the overall objectives for the management of Melbourne's, or any other cities, urban water cycle.

Design

Stormwater can contain a wide a variety of chemicals, some of which could potentially be of concern for human health. The list of substances potentially present is extensive and continually changing with more than 71 million substances registered, and new substances registered with the CAS Registry (Chemical Abstracts Service) at a rate of approximately 15,000 substances per day.

Stormwater concentrations are highly variable and there are too many chemicals in existence to consider them individually.

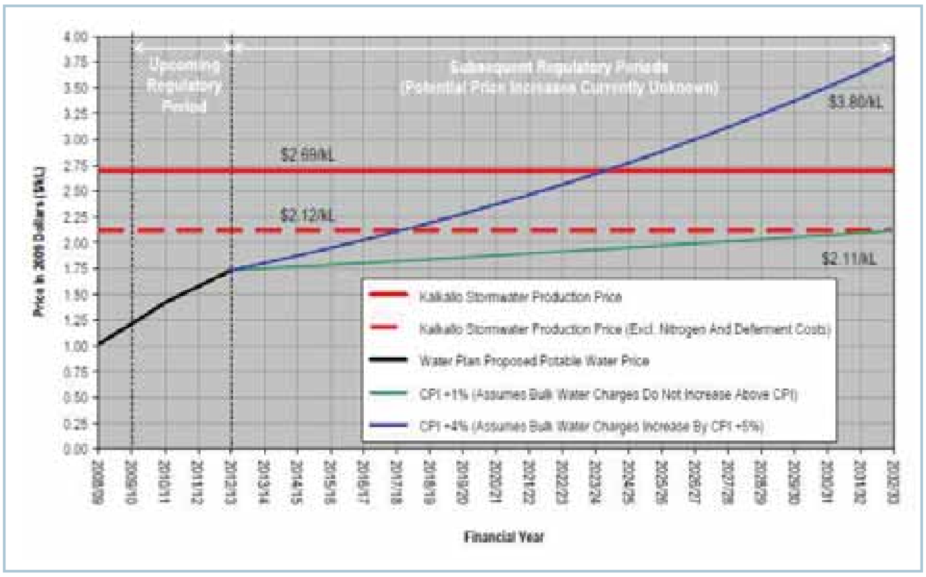


Figure 3 – Kalkallo Stormwater production costs versus current Melbourne

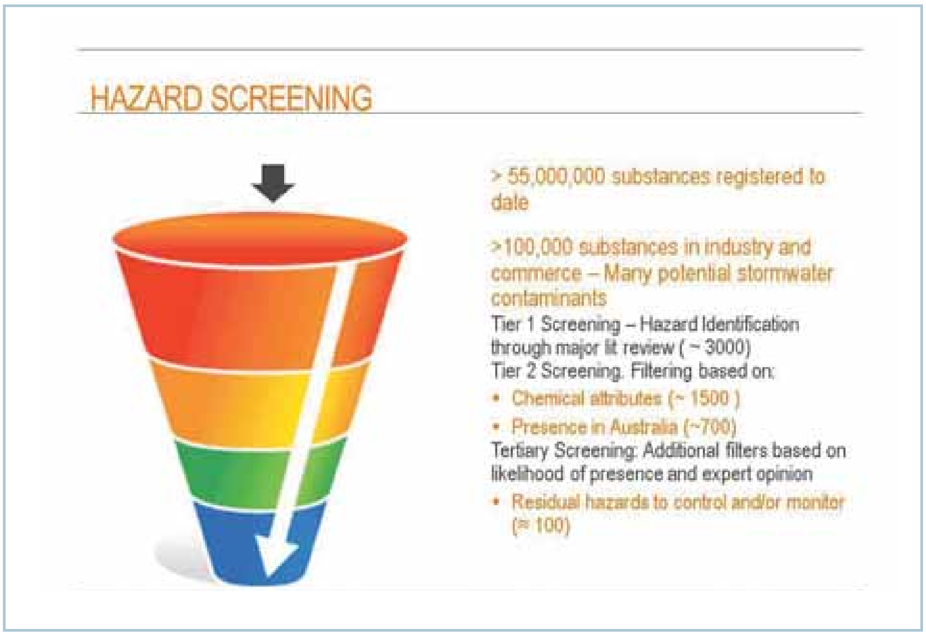


Figure 4 – Kalkallo Stormwater chemical contaminant screening process

> "The millennium drought stressed water supplies across Australia and created strong drivers to reconsider approaches to water security."

Simplification into functional and compositional groups is needed to assess performance, (refer to Figure 4).

Guidelines for the reuse of stormwater were not specifically written for potable reuse and there is a general paucity of water quality data available when considering potable reuse of stormwater. Catchment specific data is only of limited use in the greenfields situation as water quality will change dramatically between that which can be observed today and that which needs to be designed for.

Achieving the required levels of pathogen removal for potable reuse of stormwater is conceptually simple, utilising proven sewage and drinking water treatment technologies, and the risk based methodology of the Victorian Class A validation requirements extrapolated to drinking water application.

Removal performance of process units across the array of chemicals present is less well researched. Studies of process unit chemical removal performance logically focused on the persistent substances for reasons of research efficiency.

A precautionary, multi-barrier approach to the removal of all groups of substances of concern to human health was adopted, to develop several treatment train options so that the costs, benefits, performance and risks of various treatment trains could be compared.

The site from which stormwater will be harvested is not yet developed, and the type and size of the industries that will be operating out of the final development is also unknown. With direct monitoring of the existing catchment of limited use, and little published data on micro-constituents elsewhere, a cautious risk management based approach has been adopted as follows:

- A detailed international literature review has been used to produce a three teir chemical screening process to identify potential chemicals that could occur in the catchment; O'Connor & Pamminger (2011) This has been complied considering the potential chemical contaminant concentrations, observed concentrations, treatment plant process removal performance, field data available on contaminant concentrations and treatment process performance to guide the design.
- Multi barrier treatment philosophy – the scheme uses a series of barriers to ensure that pathogen and chemical removals are reliable and effective.
- Risk Management Workshops – A series of comprehensive risk assessment workshops have been run with industry specialists and key stakeholders. These have focused on identifying and managing risks in the catchment and local area to develop a comprehensive risk register. Workshops have also assessed the suitability of treatment system controls.
- Extensive industry consultation – the project team has built strong relationships with other stormwater management projects across Australia in order to tap into and maximise learnings. Specialist water industry experts have also been engaged to provide strategic advice and assistance on chemical analysis, treatment train adequacy and risk assessment.
- Pilot plant operation – the treatment plant performance will be verified during initial operations while supplying a third pipe water supply system. This enables testing to demonstrate that the plant meets the desired water quality standards. Once in operation, online monitoring for key parameters and

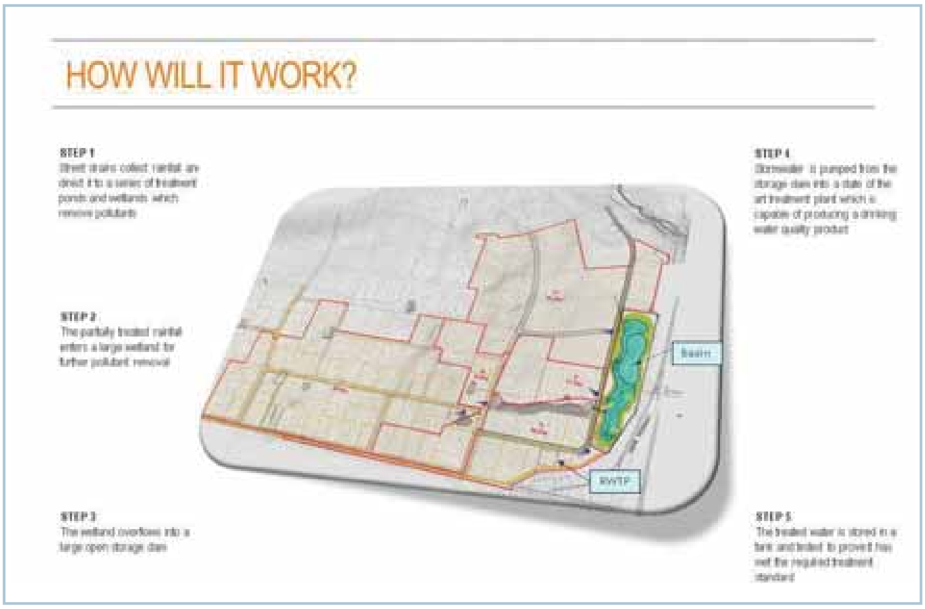


Figure 5 – System Overview within the catchment

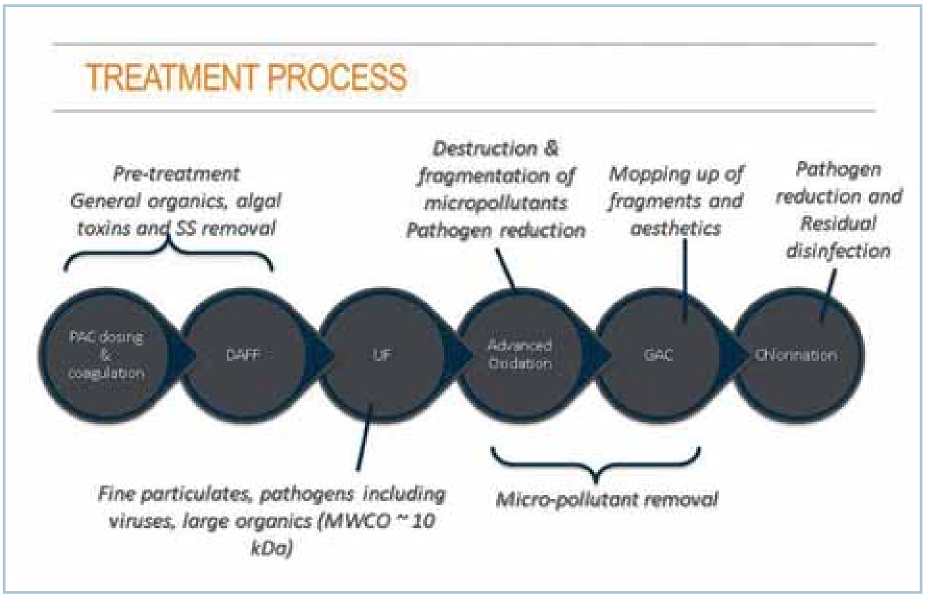


Figure 6 – Process schematic

regular testing will assist in developing a suite of data to gain confidence in the operating regime over time.

More research is required to characterise the temporal and spatial variability of stormwater quality from developed catchments, to enable lean process design for potable stormwater reuse projects in the future. The project will be a leading contributor to this body of research and on-going monitoring associated with the project will establish suitable means of raw and treated water monitoring.

The final treatment train selected combines natural treatment systems with an advanced water treatment plant. The treatment train includes:

- Catchment controls
- Wetland treatment
- Aerated storage basin
- Pre-treatment incorporating spill detection, PAC dosing, coagulation and DAFF
- Ultra-filtration
- Advanced oxidation
- GAC filtration
- pH correction and chlorination
- Use of bio-monitors on treated water.

As a major spill cannot be ruled out in any semi-developed or developed catchment, online monitoring infrastructure detects shifts in raw and treated water quality and monitors chemical removal performance across the treatment train. Bio-monitoring provides a holistic monitor of treated water quality.

The plant has been engineered to enable relatively easy retrofitting or piloting of other processes if performance verification or research needs indicate this.

Regulation

There are currently no guidelines or regulations associated with potable stormwater reuse. This has created challenges for both for the project team and the Regulators.

Firstly, even recycling stormwater for non-potable use, which the project will start with, has challenges. In Victoria, the EPA manages the Class A requirements, which formulates the process. However these requirements were written for recycling treated wastewater, and were not written with recycling stormwater in-mind.

Figure 7 – Kalkallo Stormwater Treatment Plant – nearing completion

> "The project is new, innovative and proposes a major step forward in stormwater management and recycling."

The next complexity arises when considering stormwater for drinking water. Australia has separate guidelines for drinking water, and for recycling, and both are silent on recycling stormwater. Each also uses different methodologies, reflecting the knowledge of when they were written. The most recent is the recycling guidelines, which uses health based targets.

This manifests itself in many challenges some of which are fundamental. For example, what number of protozoan log-credits should an urban stormwater harvesting project be designed to meet and what are the key chemical constituents that should be routinely monitored? YVW has managed this uncertainty by adopting a philosophy that whatever it does must be of a quality and content that could contribute to bridging this existing gap. A key element has been keeping the regulators informed and involved at key decision points of the project:

- Treatment train selection
- Risk management matrix
- Guideline interpretation and comments
- Seeking to inform all on approaches and methodologies being adopted.

Community and Stakeholder Communication and Consultation

The project is new, innovative and proposes a major step forward in stormwater management and recycling. As a result the early engagement and on-going consultation with key stakeholders, including Melbourne Water (as the stormwater manager), the Local Council, Department of Health (DoH), Environment Protection Authority (EPA), plus key industry opinion leaders and industry groups has been a key requirement for the project.

Being a greenfield site no community consultation could be undertaken. However we will be using our on-going learning's from brownfield redevelopment water projects, to inform and guide our approach with the tenants and property owners once the development proceeds. This will include early engagement, provision of detailed information on issues and risks, and on site education as required.

If recycled water will ever be accepted for drinking it will require a detailed community engagement program, including education on what is possible

In order to maximise the effectiveness of the implementation, we believe that a well-planned change management and education program involving the industry and community is required.

Conclusions

The project shows that decentralised stormwater harvesting and reuse can significantly mitigate impacts of additional water demands from new developments and doing so can be cost-effective in systems where the cost of existing water sources have already been covered.

There are many challenges in developing such projects, and early engagement with developers and regulators is important.

Performance monitoring data from this project will significantly contribute to the body of knowledge surrounding the potential for potable reuse of stormwater as part of the urban water cycle.

References

O'Connor N., Pamminger F. (2011) Characteristics of Stormwater Quality to Inform The Design Of The Merrifield Stormwater Harvesting Scheme. Ozwater11 Conference, Adelaide, 9–11 May 2011.

Unpublished data – Yarra Valley Water

Managing Fish Passage in the Hikurangi Swamp Land Drainage and Flood Protection Scheme

Conal Summers – Whangarei District Council

Abstract

Hikurangi Swamp Scheme is a land drainage and flood protection scheme managed by Whangarei District Council, providing protection to 5,600ha of low-lying pastoral farmland within a catchment of 55,000ha. The scheme was progressively implemented over the last century with major stopbanks and pump stations being installed in the 1970's, and has extensively modified what was one of the largest wetlands in the southern hemisphere. This has resulted in major impacts on the eel fishery which is of significant cultural and historic importance for local landlocked iwi as well as a commercial source.

Significant barriers exist to both upstream elver passage and downstream migrant passage, with evidence of eel mortality through deoxygenation of impounded waters and pump stations. Whangarei District Council is examining mitigative measures for improving fish passage and habitat by implementing or trialling a range of options. These include electric barriers, modified gravity discharges and screen sizing, and (in conjunction with NIWA) a tag and release programme to determine mortality rates through pump stations.

This paper gives an overview of the scheme operation and proposed fishery enhancement measures, its role within the wider catchment and the often conflicting issues arising between environmental and economic drivers.

Keywords

Fish passage, eels, flood protection, land drainage, cultural impact

1. Introduction

The Hikurangi Swamp Scheme (the Scheme) is a flood protection and land drainage scheme lying to the north west of Whangarei which receives water from a catchment of 55,000ha, draining to 5,600ha of lowland farms. The scheme consists of drainage networks, 64km of stopbanks and seven pump stations.

The scheme protects pastoral land from flooding and removes floodwaters from pastoral lands to reduce pasture loss. The Scheme is owned and managed by Whangarei District Council (WDC) and funded through a targeted rate system.

Through a recent resource consent process, the impacts of the scheme on fisheries (particularly the eel fishery) were highlighted and as a result mitigative measures are underway within the scheme and the wider catchment. This paper details the issues and options for mitigation.

2. Scheme Description

2.1 Catchment Description

The Hikurangi Swamp is located within Whangarei District, approximately 20km north of Whangarei CBD. The three main tributaries entering the head of the scheme are the Waiotu River, Waiariki Stream and Whakapara River, draining an area of 321km^2. These tributaries join at the northern end of the swamp (below State Highway 1) to form the Wairua River. Other tributaries from catchments totalling 148km^2 join the Wairua River in the main swamp which has an area of 5,670ha, so that at the outlet of the swamp in the south west the total catchment is 528km^2 with a straight line length of the swamp of 8.8km and river length of 23.3km.

Below the swamp, the Wairua River flows for six kilometres through a narrow valley with limestone rock outcrops and further downstream over a basaltic lava flow before cascading down the Mangere Rapids (Moores et al, 1968). The river runs for another 16km before reaching the Wairua (Omiru) Falls, at which point partial diversion through the "run of river" Wairua power station occurs, then to the confluence with the Mangakahia River to form the Northern Wairoa River at Tangiteroria. Relative locations of features are shown in Figure 1.

Prior to modification through drainage and construction of the scheme, the Hikurangi Swamp was one of the largest wetlands in the southern hemisphere.

2.2 Scheme History

Initial drainage of the Hikurangi Swamp was undertaken by the Lands & Survey Department and commenced in 1919, continuing until the 1930s. This resulted in an extensive drainage network being established which reduced flood frequency. Lack of maintenance of the drainage networks over the following two decades impacted on their performance, and in 1953 Whangarei County Council took over responsibility for their management. Drains were reinstated fully by 1962 at which time the newly formed Northland Catchment Commission took over management (Moores et al, 1968)

The Northland Catchment Commission examined options for improved protection of the low lying swamp farmlands and the current scheme was constructed between 1969 and 1977.

2.3 Scheme Design

The design intent of the scheme was twofold: To prevent the main river from inundating farmlands in events up to a five year ARI, and to prevent loss of pasture by removing internal catchment water within three days (through pumping) during the same design event. Recent modelling has shown that the performance is currently closer to a 3.5 year ARI. Physical works undertaken included the following:

1. Channel reconstruction of the Wairua, Whakapara and Waiotu rivers (straightening and removal of oxbows)
2. Construction of Control banks on the Wairua, Whakapara and Waiotu rivers to constrain event storm flows in the main channel
3. Division of the swamp into seven "pockets" through construction of stopbanks, each pocket having its own pumping station.

Figure 1 – Catchment Features

4. Construction of designated spillways at each pocket to control spills for events larger than design into the pockets. The apportionment of flows was established by examining known, significant floods (prior to scheme inception) and calculating the volume of water lying within the theoretical pocket boundaries, based on existing topography (Blackburn, 2010).

A map of the scheme showing the flooding and control bank extents is shown in Figure 2.

2.4 Scheme Management and Resource Consent

Following local government amalgamation in 1989 management of the scheme

"The Hikurangi Swamp Scheme (the Scheme) is a flood protection and land drainage scheme lying to the north west of Whangarei which receives water from a catchment of 55,000ha, draining to 5,600ha of lowland farms."

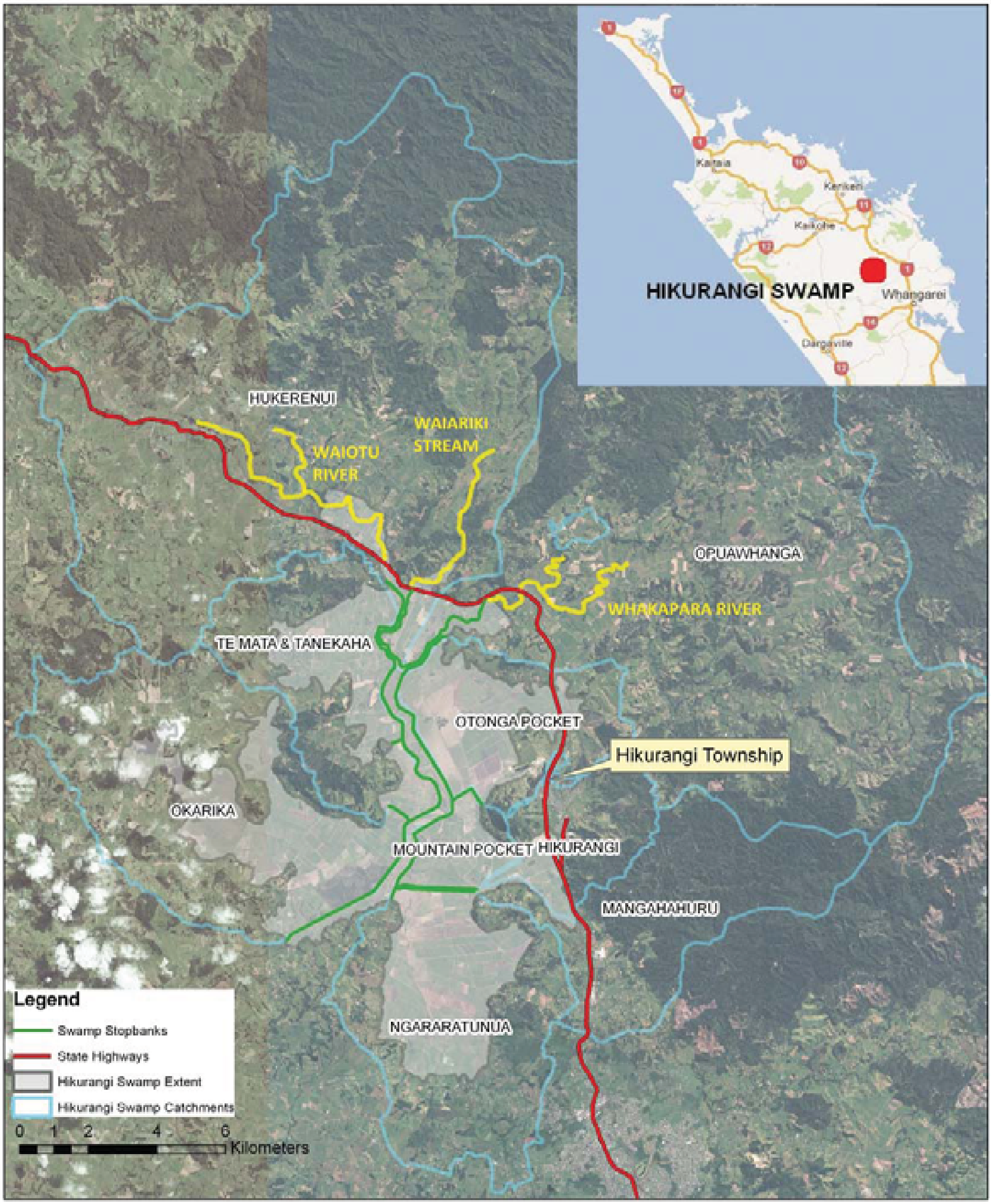


Figure 2 – Scheme Location, Catchments, Stopbanks and Flood Extents

> "The Hikurangi Swamp has long been a traditional source of eel (tuna) for local iwi."

moved from the Northland Catchment Commission to Whangarei District Council. The funding of the scheme is through two targeted rates, one for the drainage district (related to the network of drains pre-scheme) and the other related to the scheme as described in 2.3.

Whangarei District Council applied to Northland Regional Council for resource consent for the Scheme in 2004. As a result of submissions related to the scheme hydraulic model and the resulting proposed spillway amendments further refinement of the hydraulic model was undertaken over the following years. Consequently the consent was re-notified to original submitters, and consent was granted in May 2010.

Conditions of consent required a number of management plans related to Scheme management, Riparian and Oxbow restoration management, and fishery management. The primary focus of fishery management is on the eel fishery due to its cultural significance, although measures taken will improve fish passage for all species.

3. Eel Fishery Management

3.1 Cultural Fishery

The Hikurangi Swamp has long been a traditional source of eel (tuna) for local iwi. As part of the WDC resource consent process for the Scheme, a Cultural Effects Assessment Report was prepared in conjunction with Ngati Hau. This report clearly demonstrated the importance of the traditional tuna fishery to Ngati Hau. An excerpt from the report (Chetham & Shortland, 2010) is reproduced below:

"Effects on fish and fishing were of enormous importance to Nga Hapu o Te Reponui and this concern is multi-facetted. Of prime importance is the ability of the hau kainga and ahi kaa to be able to fish for the needs of their whanau and manuhiri. It is widely acknowledged that fish stocks, both in terms of numbers and diversity of species, have been heavily depleted over time and any additional impacts that may affect stock recovery will have significant effect on the wellbeing of tangata whenua."

The significance of tuna to local iwi is exemplified through historical photos (Photo 1) and their prominence at local marae (Photo 2).

Photo 1 – Eel drying rack

WDC was largely unaware of these issues until the report and has since developed an ongoing relationship with Ngati Hau to examine the fishery issues within the scheme. WDC, NIWA and Ngati Hau initially undertook a number of field trips and meetings/workshops to examine the issues and evaluate mitigative measures in place both nationally and internationally.

Photo 2 – Carvings at Akerama Marae

As a result of the catchment wide nature of this issue, the stakeholders involved have expanded well beyond the physical scheme boundaries and now include Northpower, multiple iwi groups, NIWA, local landowners and farmers, and school groups. The continued engagement and support of local iwi is critical to progressing fishery management both within the scheme and across the greater catchment.

3.2 Eel Lifecycle

In order to complete their lifecycle, freshwater eels must move between freshwater and the sea (known as a diadromy), spending extended periods in marine, estuarine, and freshwater habitats. The eel has a unique and complex life cycle (Figure 3). Breeding occurs in the marine environment, following an extended adult growth stage in freshwater (40–60 years), and a long migration from their freshwater habitat to spawn in the Pacific Ocean near Tonga (Williams & Boubée, 2012).

Upstream migration relates to movement of juvenile eels (elvers) from the sea to the inland waterways where they will remain until returning to sea to spawn as Tuna Heke (downstream migrants). Based on records obtained at the Wairua Power Station in summer 2011/12 the upstream migration appears to begin around September-October and runs until approximately March. Movement of elvers at the schemes control structure may, however, only begin around November.

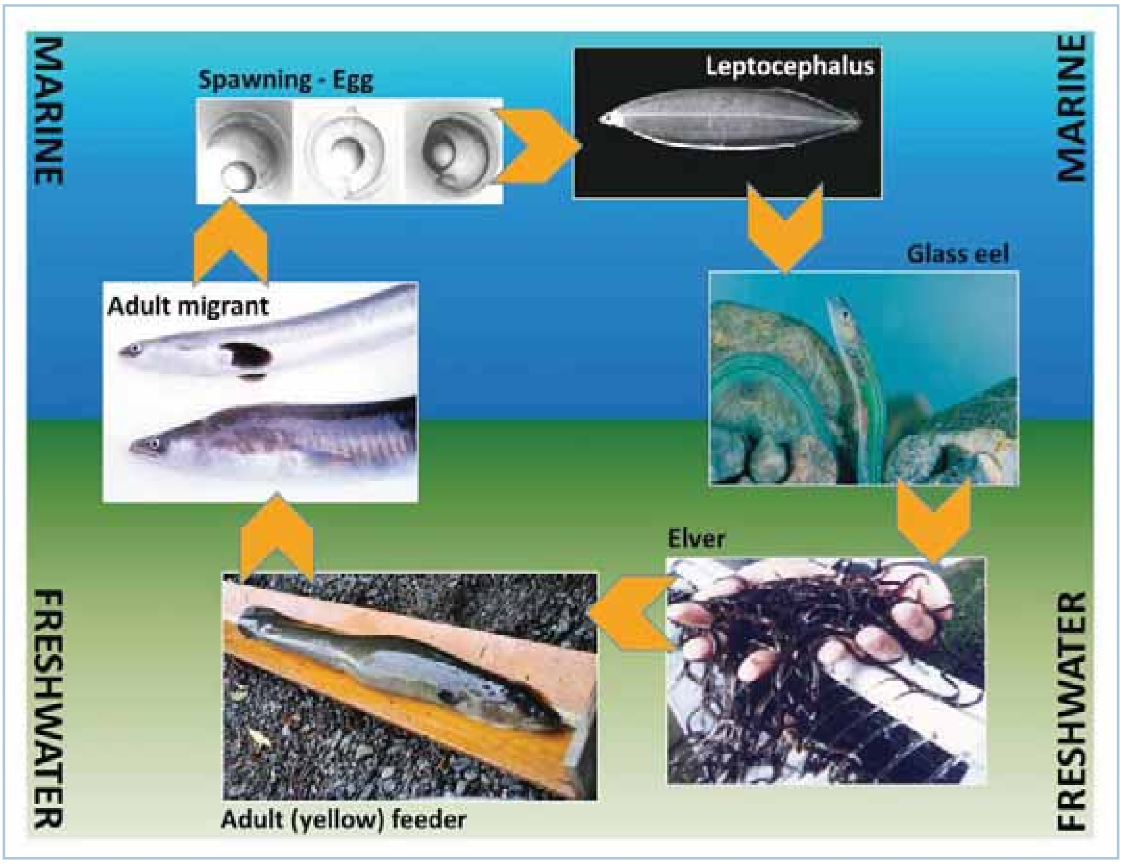
3.3 Scheme Impacts on the Natural Fishery

Within the Hikurangi Swamp Scheme, the pump stations and stopbanks present barriers to both upstream and downstream migration to tributaries within the swamp scheme "pockets" but do not impact on migration within the main channel or to tributaries above State Highway 1.

3.3.1 Upstream Barriers

Within the scheme, the primary barriers to movement from the main Wairua River channel to tributaries are at the pump stations. Each station has a gravity flapgate which is designed to prevent flows from the main river channel entering the pockets during elevated river levels. Elvers must pass through these gates to access the upstream tributaries. Elver movement is impeded due to two separate issues at the gate:

Figure 3 – Eel Lifecycle (reproduced Courtesy of NIWA)



"The continued engagement and support of local iwi is critical to progressing fishery management both within the scheme and across the greater catchment."

Velocity Barrier

Outside of flood events the gates are kept minimally open, allowing passage of pocket water into the main channel. The aperture size is such that water velocities are increased to a point where elver passage is difficult (Photo 3). Opening the gates is possible operationally but leads to the potential for human error; with major consequences in terms of internal catchments being inundated by river water should the gate not be closed.

> "The Hikurangi Swamp Scheme has introduced significant barriers to eel passage through construction of spillways, pump stations and habitat degradation, resulting in damage to a food resource of significant cultural value to local iwi."

Photo 3 – Looking down on to gravity flapgate

Photo 4 – Looking upstream to gravity flapgates and overhang

Physical Barrier
The invert of the gravity flapgate is above the invert of the outlet channel (Photo 4), and at low flows it is difficult for elvers to climb over the gate frame. The gate frame is constructed of angle iron and thus has a horizontal overhang which is difficult for elvers to transition.

3.3.2 Downstream Barriers

Downstream migration is impeded in two ways:

- Eel mortality through entrainment in scheme pumps
- Impediments to migrant movement into the main river channel during periods of oxygen depletion in the pocket areas following significant storm events (where the river has spilled into the pockets).

The extent of, and exact factors that lead to, mortality are unknown. In the case of extreme storm events where waters are impounded for several days and extensive oxygen depletion occurs, eels mortality may occur across large areas of the catchment but may not be evident until water is drawn down to the pump stations and eel carcases are destroyed through the pumping process. Video evidence exists showing significant numbers of chopped mature eels downstream of a pump station. It is difficult to ascertain whether eels passing through the pumps were dead or alive prior to entrainment.

> "WDC in conjunction with NIWA is installing a trial site at a single pump station to validate mitigative measures to reduce the incidence of eels being entrained in the pumps. If the trial is successful the measures will be implemented across the whole scheme."

Factors such as seasonality, size of storm, and time of migration by eels to the stations from within the pocket catchments all impact on mortality throughout the scheme. It is probable that some mortality due to oxygen depletion would have occurred in the natural (pre-developed) state of the swamp area following extreme storm events and it is difficult to quantify the effect of the scheme on the extent of mortality through this mechanism. However, the presence of the stopbanks effectively hinders passage of fish species into the main river channel where a more oxygenated environment exists.

3.3.3. Habitat Degradation

Swamp and wetland drainage, waterways re-alignment, decrease in extent and frequency of flooding (during which eels feed extensively on land invertebrates), loss of natural riparian cover and increased nutrient loadings have all contributed to a significant loss of fish habitat within the entire catchment.

3.4 Wider Catchment Impacts on the Fishery

There are two other areas that have impacted on the natural fishery within the wider catchment, commercial fishing and the Wairua power station.

Photo 5 – Tensioning strip to keep gate partially open

3.4.1 Commercial Fishing

The extent and impact of past and present commercial fishing within the scheme and wider catchment has not been documented. The Ministry of Fisheries manages the eel fishery under a Quota Management System. The Hikurangi Swamp is part of the Northland quota management area but this is geographically large and specific catch locations and numbers are not recorded. In the 1970s significant commercial harvesting was undertaken and a processing plant was operated in Hikurangi, exporting to Europe. Anecdotally, commercial presence and catches have decreased markedly over the last decade or so.

3.4.2 Wairua Power Station

The most significant natural barrier to upstream migration within the catchment (but outside the Scheme area) is the Wairua/Omiru falls. Since the construction of the Wairua power Station in 1917, significant flows have been diverted through the headrace (just above the falls) to the penstocks, at times reducing the base flows by up to 90%. Given the historical abundance of eels within the scheme area, it appears that in its natural state the falls did not severely impede elver recruitment.

3.5 Mitigative Measures

This section outlines the mitigative measures implemented or proposed to be undertaken by Whangarei District Council within the Hikurangi Swamp scheme in relation to the barriers and issues identified in Section 3.3. Many of these measures are being trialled currently with implementation planned over the following 6–12 months.

3.5.1 Upstream Barriers

Velocity Barriers

WDC is currently trialling a mechanism to hold the flapgates open in the larger pump stations. These gates already have a retaining bracket for keeping flapgates up safely to facilitate maintenance (Photo 5), and a loop of industrial grade rubber, or chain and spring, is attached to the bracket and to the counterweight frame on the flapgate (Photo 5). The tension is then adjusted to open the gate sufficiently to reduce velocities whilst still allowing the rising river head to effectively close the gate during a storm event.

Physical Barriers

In order to remove the physical barrier presented by the flapgate frame overhang, WDC is increasing the water level downstream of the gate through installation of a bund using half-pipes in the gravity channel several metres downstream of the gate (Photo 6). This will elevate the water levels 50–100m above the gate invert at all flows. As elvers are able to pass vertical and inclined surfaces (but not horizontal overhangs) the use of half pipes will not present any impediment to their passage.

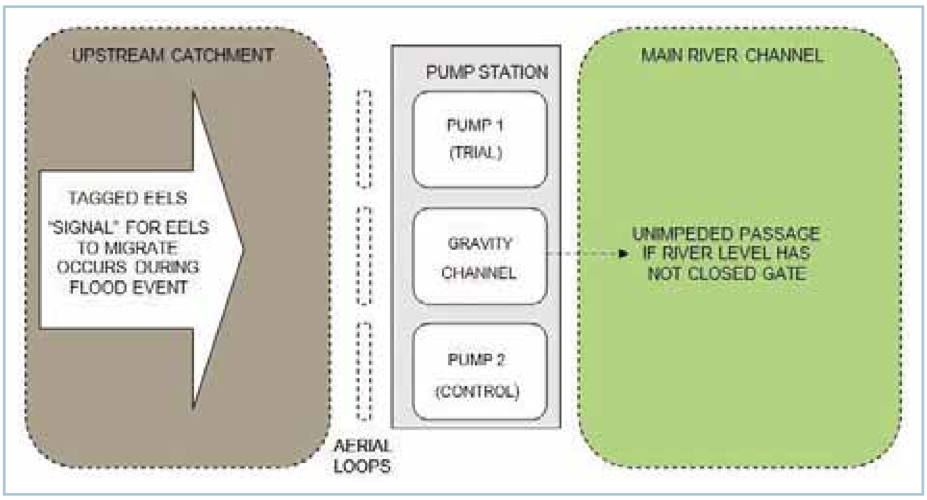
3.5.2 Downstream Barriers

WDC in conjunction with NIWA is installing a trial site at a single pump station to validate mitigative measures to reduce the incidence of eels being entrained in the pumps. If the trial is successful the measures will be implemented across the whole scheme. This will also provide valuable research information to assist in management of eel fisheries nationally and internationally.

Photo 6 – Proposed downstream bund

Figure 4 is a representation of what occurs at Mountain pump station when eels within the "pocket" (the upstream catchment bounded by stopbanks and pump station) look to migrate downstream. The eels are thought to be driven to migrate during a significant rain event, at which time the main river level will be rising and (depending on the event size) pump stations will be operating. Mountain pump station is being used for the trials due to having two identical pump bays and ease of access.

Figure 4 – Representation of Migrant Eel Movement through Pump Station



"The most significant natural barrier to upstream migration within the catchment (but outside the Scheme area) is the Wairua/Omiru falls."

"Restoration of the oxbow loops through riparian planting and installation of earth bunds to increase water levels will provide additional habitat for tuna and other fish species within the main channel catchment."

The approach involves catching mature eels (with the permission and assistance of local iwi) and attaching a RFID (Radio Frequency Identification) transmitter to them, followed by release upstream of the pump station. Each pump bay and the central gravity gate are fitted with an aerial loop which activates the RFID transmitter and logs the information when the eels pass through.

One pump bay will be used as a control with no alterations and the other will be used for the trial measures (detailed below). Monitoring the gravity gate will allow collection of data on the number of eels able to migrate through the gravity flapgates before the river level rises sufficiently to close the doors.

Trial 1

This involves setting up a pulsed DC electrical field across one intake screen. This is achieved by installation of three copper strips on the pump bays:

- Before the intake screen (upstream)
- At the intake screen
- Behind the intake screen

with application of the DC field on the strips in a negative-positive-negative arrangement, leaving the gravity gate and other intake screen unmodified. Voltage of 3–12 volts is applied with a pulse frequency of 1.5 hertz, as NIWA have shown this to be an effective deterrent in pilot scale trials and limited field trials. The installation is underway and will be operational for the 2013 migrant season (approximately May–August).

Trial 2

This involves reduction of one intake screen size to 20mm from the current spacing of 50mm. Due to the presence of aquatic weeds within the scheme some pockets have significant problems during a storm event with blinding of intake screens and a subsequent operational impact, the extent of any screen modifications on operational resources needs to be determined.

Fish Friendly Pumps

It is acknowledged that the current pumps will cause mortality if eels are entrained in them. WDC has previously investigated use of Archimedes Screw pumps which are more fish friendly, but for a number of reasons (including cost, inability to access during storm events, and operational aspects) these were not deemed feasible for implementation within the Scheme.

Photo 7 – Aerial of main channel showing old oxbow loops

"An estimated three million elvers were transferred in the first year. For the 2012/13 year, a more permanent installation was undertaken and a dedicated vehicle with aerated holding tanks was supplied by Northpower."

3.5.3 Habitat Degradation

WDC has prepared a riparian and oxbow management plan as required by the Scheme resource consent, which identifies areas where significant waterway modifications occurred. Restoration of the oxbow loops through riparian planting and installation of earth bunds to increase water levels will provide additional habitat for tuna and other fish species within the main channel catchment. Photo 7 shows the extent of channel straightening and the remnant oxbows.

3.5.4 Fishery Population Surveys

Electric fishing and trapping of waterways within the swamp area was undertaken during March 2013 in order to provide data for a baseline population estimate of species present and numbers. Results of this are currently unavailable.

3.5.5 Wider Catchment Measures

Northpower installed a prototype trap and transfer mechanism at Wairua power station in 2011/12 consisting of an elver ladder and holding tank (Photo 8). This was monitored daily by local iwi representatives and any elvers were transferred to upstream waterways within the catchment. An estimated three million elvers were transferred in the first year. For the 2012/13 year, a more permanent installation was undertaken and a dedicated vehicle with aerated holding tanks was supplied by Northpower. This site has also played a valuable role in engagement with the local community, with visits from schools, farmers, and community groups.

4. Conclusions

The Hikurangi Swamp Scheme has introduced significant barriers to eel passage through construction of spillways, pump stations and habitat degradation, resulting in damage to a food resource of significant cultural value to local iwi. Many improvements to enhance fish passage are relatively simple and low cost in installation, although measuring effects off these improvements may not be evident for many years due to both the size of the catchment and the lifecycle of the eel.

Dependent on the outcome of trials, measures will be implemented across the Hikurangi Swamp Scheme over the next 6–12 months.

Photo 8 – Elver capture at Wairua Power Station

Acknowledgements

I would like to acknowledge Dr Jacques Boubée of NIWA for his tireless enthusiasm and ability to engage all stakeholders in fishery management issues. I would also like to acknowledge Te Raa Nehua and Allan Halliday of Ngati hau for showing me the importance of the eel fishery to their cultural wellbeing.

References

Moores, A., Simpkin, J.A., Graafhuis, W.K.P. and Burridge, B.E. (1968) Hikurangi Swamp Major Scheme, Scheme Report, Volume I, Northland Catchment Commission, 1–4.

Blackburn, J.C. (2010) Statement of Evidence (Hikurangi Swamp Major Scheme Resource Consent Hearing), 2–4, 13–17.

Chetham, J. and Shortland, T. (2009) Cultural Effects Assessment Report: Hikurangi Swamp Scheme, 8, 14.

Williams, E.K. and Boubée, J.A.T. (2012) Freshwater fish in the Wairoa River Catchment, Training Workshop 24–26 February 2012, Akerama Marae, 58–60.

Overland Flow Path and Depression Mapping for the Auckland Region

Josh Irvine and Nick Brown, Auckland Council

Abstract

A significant proportion of flooding issues in an urban environment can be attributed to stormwater flowing overland at relatively low depths. Typically, in a catchment-wide study a hydraulic model is developed to identify potential flooding areas. However, these models are often limited in extent to main channels and lack the ability to predict the path of small magnitude overland flow.

This paper describes two different methodologies used in producing mapped overland flow paths undertaken for the Auckland region. The methodologies make use of a series of automated Geographic Information System (GIS) tools in ArcGIS 10.

The final output is more than 60,000km of mapped overland flow paths showing the probable routes of stormwater in a storm event and associated catchment area.

Over 40,000 topographical depression areas have also been mapped for the region. These are the potential extent of ponded water if the piped network was to fail. Valuable information can be attributed to each depression area including the spill level, number of buildings in the extent and potential storage volume.

These mapped datasets ultimately lead to better decision making in catchment planning, evaluating consents, development control, hydraulic modelling and operational activities.

Keywords

Flooding, overland flow paths, GIS, catchment planning, modelling, critical assets, dams, depressions, ponding

1. Introduction

The flooding potential represented by overland flow paths and topographical depressions is poorly understood. This paper details efficient GIS methodologies to map both topographical depressions and overland flow paths. Much effort and money is spent predicting floodplain levels and areal extents using fully hydrodynamic models. While prediction of floodplains is necessary, the tools used to produce them are not well suited for the prediction of flooding issues caused by overland flow or culvert blockage.

Two different methods are outlined in this paper, the mapping of overland flow and the mapping of topographical depressions. Mapped overland flow paths and depressions areas coupled with floodplain extents give a more complete picture of the flooding issues in a catchment compared with looking at any one aspect in isolation.

Overland flow path mapping adds value upstream of floodplains and depression mapping adds value by being able to identify residual flooding risk and flood prone areas. Mapped overland flow paths and depression areas lead to better decision making in catchment planning and assessments of potential developments.

2. Overland Flow Path Mapping

2.1 Background

Overland flow paths are the path taken by stormwater as it concentrates and flows downhill over the land. Identifying and mapping overland flow paths (OLFPs) provide an important stormwater management tool. Stormwater planning, modelling, operational and consenting staff of Auckland Council are regular users of mapped overland flow paths and it is a critical business need for these areas.

In 2012, Auckland Council created mapped overland flow paths for the Auckland region. The methodology used by the North Shore City Council to produce overland flow paths in 2004 and 2009 formed the basis of the process used by Auckland Council. The process, using automated GIS tools, is an efficient and accurate way of mapping overland flow paths for the region.

However, one identified shortcoming of the previous methodology was that in depression areas, e.g. immediately upstream of culverts, the overland flow paths would be shown incorrectly as straight lines and would not represent the real flow paths in these areas. A new method was sought to resolve this issue and provide an accurate representation of the overland flow paths in these depression areas. A second overland flow path layer was created using a corrected digital elevation model (DEM) to account for culverts.

The methodology is based on a digital terrain model and does not take above ground structures into account. The mapped overland flow paths provide a good indication of where stormwater might flow in a storm event but onsite verification needs to be undertaken in order to determine the impacts of structures such as buildings and walls which will alter the specific location of the flow paths.

2.2 Business Drivers

Overland flow paths were generated for the region primarily to:

- Ensure future development adequately caters for overland flow paths
- Identify existing properties at risk of flooding from overland flow

2.2.1 Development

Overland flow paths need to be identified and made available to the staff influencing building control to ensure developments are considering overland flow paths.

2.2.2 Flooding Risk

Mapping the overland flow paths allows for the possibility to identify houses likely to flood prior to a large storm event occurring.

2.3 The Difference to Floodplain Mapping

Overland flow paths are activated more frequently than floodplains due to their small catchments and time of concentrations. High intensity, short duration rainfall events activate overland flow paths but are unlikely to activate the floodplains which typically require larger storm durations (i.e. larger time of concentration) and more runoff volume. Small, high intensity rainfall is common in Auckland and in urbanised catchments, where there is a high proportion of impervious areas, the resulting overland flow paths can cause significant issues in these 'smaller' rain events. Climate change is also likely to increase the frequency of these type of events in the future.

Figure 1 – Overland flow path in Mairangi Bay

On the 3rd of July 2012 there was a 20–100yr ARI storm event in the Mairangi Bay and Albany area of North Shore, Auckland (for the 30min duration). Approximately 50% of the issues were attributed to overland flow and have a direct correlation with the mapped overland flow paths shown on the Council's GIS system. The rest of the issues were predominately private landscaping and drainage issues with only a few floodplain related.

When identifying properties at risk of flooding in a catchment, considering only properties in floodplains would identify under half of the total number of properties at risk in urbanised environments. These properties at risk from overland flow flooding are likely to flood more frequently than those in floodplains.

As an example in the area shown below 25 residential buildings were identified in the flood modelling study (i.e. in the extent of the floodplain), an extra 82 buildings have predicted overland flow paths through them and an extra 29 buildings are within 2m of an overland flow path (refer to Figure 2). However, not all of these properties will have issues in a 100yr ARI storm event (including those in the floodplains).

Flood models are generally designed to model the 100yr ARI event, typically modelling open channels and large overland flow paths. Due to factors such as subcatchment delineation and loading points they are not considered to be accurate for predicting low magnitude overland flow paths.

The amount of time required to map overland flow paths is less than 1% of the time required to produce floodplains for a catchment.

2.4 Methodology

Overland flow paths were mapped using the GIS package ARCGIS 10. The mapping process utilised ModelBuilder to build various GIS models.

The simplified mapping process for overland flow paths is as follows:

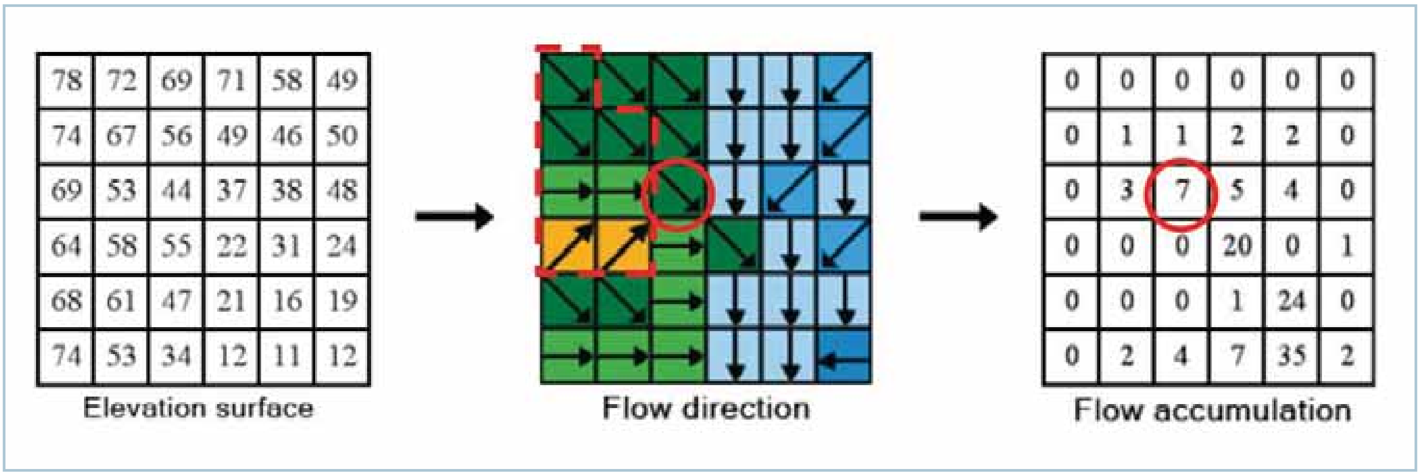
- Start with a DEM representing the land (above ground features removed)
- 'Fill' all depression areas in the topography (Fill tool)
- Compute the flow direction of each cell (Flow Direction tool)
- Compute the upstream catchment area of each cell (Flow Accumulation tool)

Figure 2 – Comparison of identified flooding issues in a catchment

- Map the overland flow paths, using the flow direction, if the upstream catchment area is greater than 2,000m² (Stream to Feature tool).

The process starts at the cell with the highest elevation and finds the lowest adjacent cell and continues to do this downstream (refer to Figure 3). The flow direction shows the adjacent lowest cell. The flow accumulation (proportional to the catchment area) is the number of cells that flow into the particular grid cell (refer to the red outlines in Figure 3). The process stops in the lowest point of a depression area (as all adjacent cells are higher than the current cell). Filling the grid removes all depression areas which allows a continuous flow path to be mapped from the top of the catchment to the outlet at the bottom.

Figure 3 – Overland flow path mapping steps from topography to upstream catchment area



"The overland flow path and depression layers provide very useful information in the catchment planning process to identify buildings at risk of flooding."

2.4.1 Terrain Adjustment

One identified issue with creating overland flow paths are that straight lines are created in the depression areas (refer to Figure 4). This comes about from using the filled grid to produce overland flow paths. The filled DEM in depression areas have the same elevation value giving a flat surface. In large depressions (especially in urban areas) there is a need to know where the water will flow inside the depression extent.

Figure 4 – 'Straight' overland flow paths in depression areas

To get accurate overland flow paths in depression areas the DEM needs to be adjusted to account for large culverts and natural ponding areas (refer to Figure 5 & Figure 6).

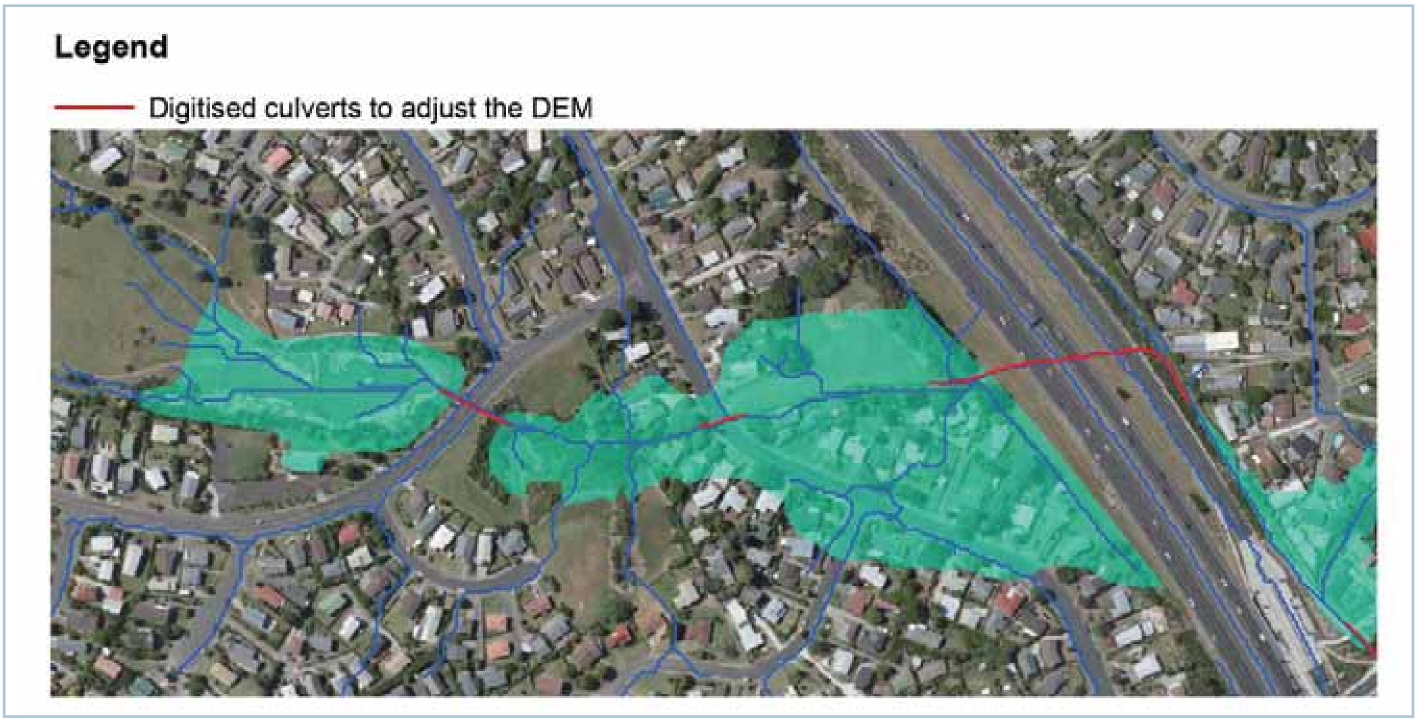


Figure 5 – Digitised culverts to adjust the DEM and corrected overland flow paths

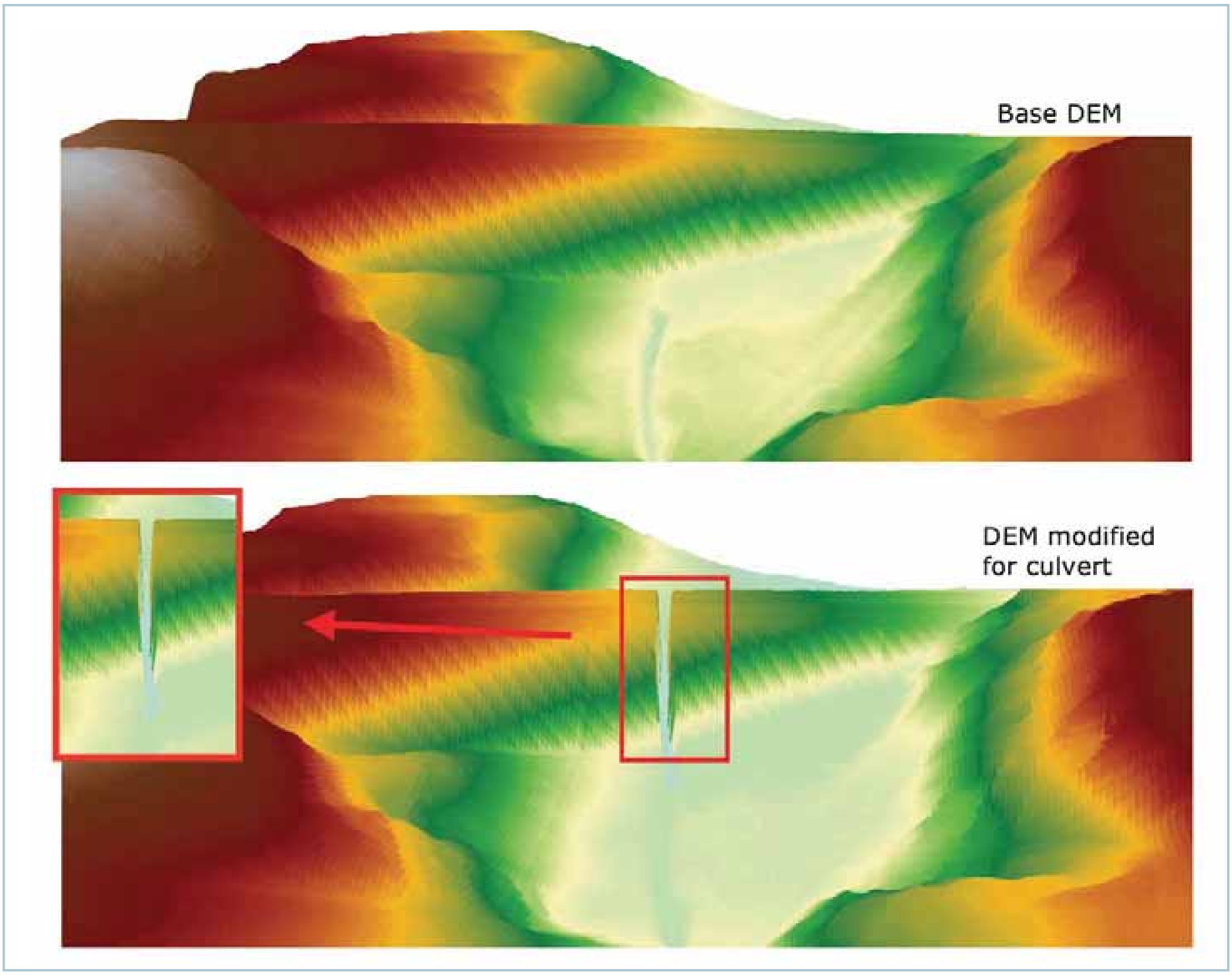


Figure 6 – Adjusted DEM to account for culverts

> "Overland flow path mapping adds value upstream of floodplains and depression mapping adds value by being able to identify residual flooding risk and flood prone areas."

Three months were spent manually digitising over 2,500 line features to alter the terrain across the region. An automated GIS process could not be used due to factors such as the incompleteness of the available GIS data.

Small depression areas, either constructed or natural ponding areas, were commonly found not to be 'drained' by a culvert and therefore a culvert could not be digitised to get accurate overland flow paths in these areas. These areas were generally at the sag points of roads or in private property. In these cases the spill path, from the overland flow path dataset with straight lines in the depression, was digitised. Over half of the 2,500 lines across the region were actually digitised overland flow paths.

The process to adjust the terrain is as follows:

- Identify the lowest point of the depression (using a difference grid)
- Digitise from the lowest point, along the alignment of the culvert/stream, until the DEM is lower than the lowest point of the depression
- Buffer the lines by at least the distance $\sqrt{\frac{grid\ size^2}{2}}$
- Burn the digitised line into the DEM by 20m (lower the elevation of the grid cells)
- Fill the grid to create the new elevation surface to use for overland flow path mapping.

2.5 Model Process

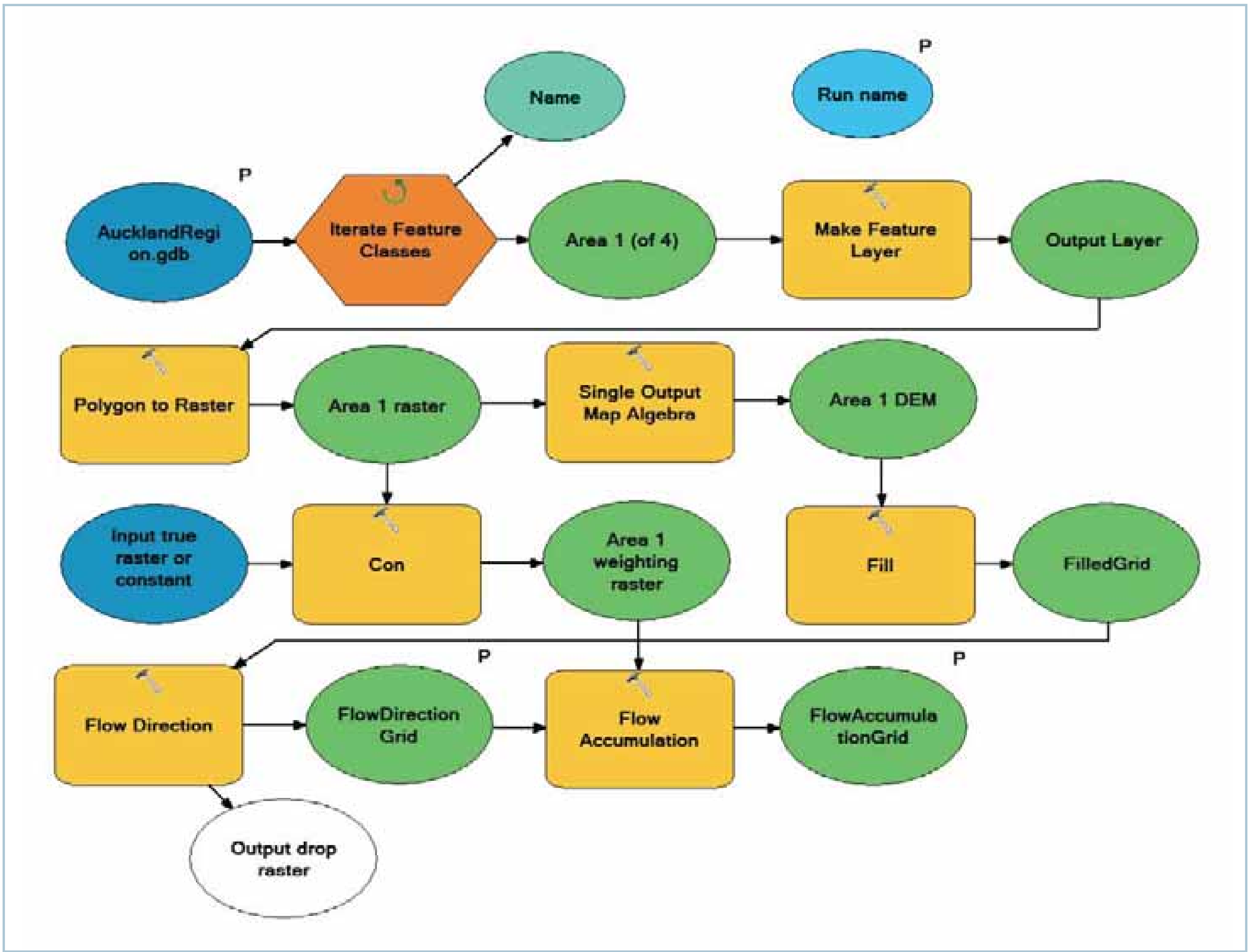
The GIS tools and models required to produce the overland flow paths were built in ModelBuilder, ARCGIS 10. A high specification HP Z800 workstation containing a 2.66GHz processor, six cores and 12GB of RAM was used for the processing. Each overland flow path layer took up to three days to run and a number of weeks developing the methodology and models.

The sheer size of the Auckland region coupled with the detail of the mapping was a huge challenge to overcome and pushed computational capabilities to the limit. A 2m digital elevation model (DEM) grid was used for the region which contained 62,000 columns and 69,000 rows and was 16GB in size covering an approximate 4,900km^2 area.

The region/datasets needed to be split into four different areas for computational purposes and then later be remerged before creation of the lines.

Figure 7 below shows the GIS model to produce the flow directions and accumulation rasters without adjustment of the terrain and is one of six models used in the overland flow path mapping process.

Figure 7 – Overland flow path model (partial)



2.6 Output

Two overland flow path layers were produced, one produced without terrain adjustment (causing straight lines in the depression areas – refer to Figure 7) and the other produced using the adjustments to the terrain.

The unadjusted terrain model captures the spill path from each depression. Overlaying the two overland flow path layers ensures a full picture of the possible paths of stormwater in a storm event, i.e. overland flow, flow through the culvert and flow from the crest of the depression (the spill path if the depression was to fill).

Thirty million overland flow path lines equating to over 60,000km of mapped overland flow paths were created with each line (every 2m along every flow path) containing a unique contributing catchment area. The shapefile is 5GB in size which is about 25 times larger than the regional floodplain dataset.

Figure 8 shows the mapped overland flow paths for Rothesay Bay (1 of 234 catchments) and Figure 9 shows the attribute information for the overland flow path layer (unique catchment area for every ≈2m along every flow path).

2.7 Uses

The common uses of mapped overland flow paths to date are:

- 'Flagging' developments that are occurring in overland flow paths to ensure adequate building provisions are considered
- Identifying the existing properties potentially at risk of flooding due to overland flow
- Quick catchment/subcatchment boundary checks
- Easy contributing catchment area check tool (unique catchment area available every 2m length along the flow path)
- Useful for flow calculations
- To identify stream/rivers, e.g. overland flow paths with a contributing catchment area greater than 2ha can normally be considered a stream unless piped (Kettle et al, 2013)

2.8 Assumptions and Limitations

The assumptions for the mapping process are that the:

- Lateral extent of the flow path is not considered (only the centreline is mapped)
- Velocity of flow is not considered

Figure 8 – Mapped overland flow paths for the Rothesay Bay catchment

Table

Overland flow path

	OBJECTID *	Shape *	arcid	from_node	to_node	Shape_Length	Catchment_Area
	1	Polyline	1	1	2	1.414214	48100
	2	Polyline	2	3	1	2.828427	47952
	3	Polyline	3	4	3	2.828427	47576
	4	Polyline	4	5	4	2.828427	47472
	5	Polyline	5	6	5	2.828427	47308
	6	Polyline	6	7	6	2.828427	47076
	7	Polyline	7	8	7	2	47068

0 (0 out of 29505547 Selected)

Overland flow path

Figure 9 – Attribute table for mapped overland flow paths

> "Depressions were mapped using the GIS package ARCGIS 10. The mapping process utilised ModelBuilder to build various GIS models."

- Depth of flow is not considered
- Solid fences and walls are not considered
- Buildings are not considered

Identified limitations to the process are the:

- Accuracy of the LiDAR data (e.g. the point density, equipment, process and the post-processing techniques). The accuracy of the mapped overland flow paths is highly dependent on the quality of the LiDAR data.
- Rural/Urban LiDAR (different LiDAR point densities for the rural and urban areas).
- Grid or raster size used. Computationally a 2m grid was chosen as the appropriate grid size for the region. A minor improvement would be realised if a smaller grid size was used, although far larger run times would result.

2.9 Future Work

Future work includes:

- Quantifying the 2yr, 10yr and 100yr ARI peak overland flow for existing and future land use and for existing and climate change adjusted rainfall (based on TP108).

Possible future work includes:

- Investigating the adjustment of the topography based on large commercial/industrial buildings as they are likely to divert the overland flow path around the building (say for buildings larger than 1,000m²).
- Investigating the adjustment of the topography based on a mapped stream shapefile to ensure there is accurate alignment along the stream especially in dense bush areas and farm drains (no regional accurate stream shapefile currently exists).

3. Topographical Depression Mapping

3.1 Background

Depressions are areas that have a potential to pond or 'fill' up if the piped system was blocked or under capacity (wherever there are closed contours). They are the potential areal extent of the water up to crest level where water would spill downstream (instead of continuing to pond up). Generally depressions are created due to the construction of a road perpendicular to a stream (refer to Figure 10). Large depressions are drained typically by a culvert/inlet although some natural depressions (e.g. lakes) do occur.

3.2 Business Drivers

Depressions were generated for the region primarily to:

- Identify flood prone areas – to influence development in these areas
- and to identify existing properties at risk of flooding
- Identify critical assets
- Identify large dams (as defined in the Building Act 2004)

Figure 10 – Example depression extent with closed contours

3.2.1 Flood Prone Areas

Depression areas can be considered as flood prone areas. There is usually a floodplain/flood hazard area mapped at large depressions but their extent is usually smaller than the depression extent. It is likely that the culvert will experience some form of blockage in a storm event and therefore reduce its capacity and capability to convey flows downstream causing a backing up of water upstream of the culvert and hence raising flooding levels and increasing the flood extent. Applying a typical 0.5m freeboard for building floor levels on top of the computed 100yr ARI flood level is not sufficient to account for factors like blockages in depression/ponding areas. These depression areas and associated spill levels have been identified around the region to influence intensification in these areas.

Figure 11 – Cartwright Road flooding

Figure 12 – Overtopping of Great North Road (Cartwright Road flooding)

An example of a flood prone area is the depression upstream of Cartwright Road, Glen Eden. In the 17 February 2012 storm event the Cartwright Road culvert collapsed causing the depression area upstream of Great North Road to fill up and spill over the top of the road (refer to Figure 11 and Figure 12). Eighteen habitable floors were flooded as a result.

3.2.2 Critical Assets

Auckland Council is currently in the process of identifying critical assets, predominately to ensure these assets are proactively maintained and perform to their potential at the start of a large storm event. These assets are often critical to the performance of the wider stormwater system in a storm event. Mapped depressions are one input into an ongoing process to identify these assets.

3.2.3 Large Dams

The definition of a dam, in part 1, subpart 7 of the Building Act 2004, is ambiguous and it's uncertain as to whether road culverts fit into this description of a dam.

The Building Act 2004 and the Building (Dam Safety) Regulations 2008 form the framework for the Dam Safety Scheme. Under the Dam Safety Scheme, the owner of a large dam is required to classify their dam and if considered medium or high in the Potential Impact Category (PIC) a Dam Safety Assurance Programme and an annual Dam Compliance Certificate needs to be submitted to the regional authority.

A large dam is defined as a "dam that retains 3 or more metres in depth and holds 20,000m^3 or more volume of water".

The number of depressions greater than 3m in height and greater than 20,000m^3 in volume in the Auckland region were identified by classifying the depression dataset. The Dam Safety Scheme estimated 1,150 dams would be affected nationwide. 1,022 dam/depression areas would be considered as large dams in the Auckland region alone.

An amendment to the Bill proposes to split these dams into 'classifiable' and 'referable' dams due to the large number of dams (1,150) that they foresee the Dam Safety Scheme would impact upon.

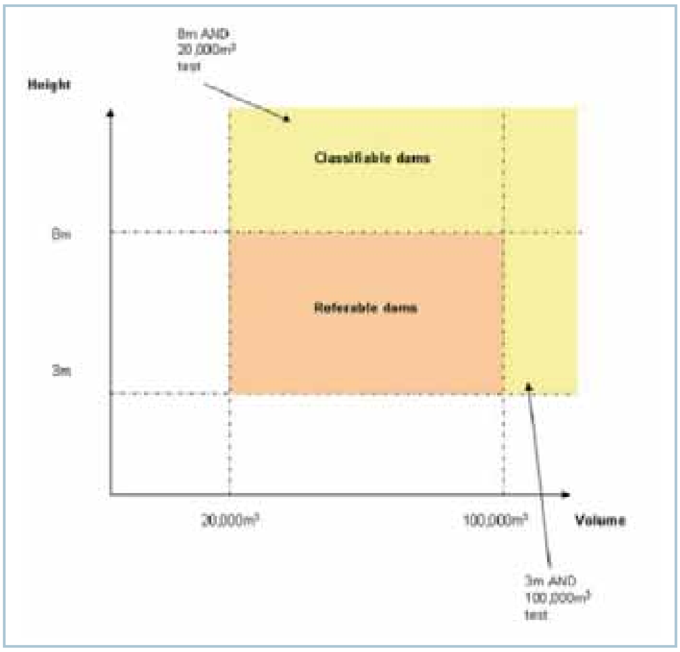
Classifiable dams would be those that:

- Are greater than 8m in height and greater than 20,000m^3 or
- Can hold greater than 100,000m^3 of water and greater than 3m in height

Referable dams are those that are greater than 3m in height and hold more than 20,000m^3 in volume (refer to Figure 13).

Classifiable dams would automatically require a Dam Safety Assurance Programme and an annual Dam Compliance Certificate to be submitted to the regional authority and referable dams would have to be assessed to determine whether they fall into the same medium or high PIC (refer to Building Act, 2004). The Dam Safety Scheme has been deferred until July 2014.

Figure 13 – Classifiable and referable dams



3.3 The Difference to Floodplain Mapping

Buildings constructed in depression areas, upstream of culverts, have an inherent residual risk of flooding. Often building levels are set based on the culvert acting at full capacity in a 100yr ARI event with the addition of freeboard (typically 0.5m in height). There is generally no consideration given to the potential of blockage or collapse of the culvert before or during a storm event. Figure 15 is an example of a near full blockage of a 1800mm diameter culvert which caused the depression in the 3rd of July 2012 storm event to fill to just below the spill crest (refer to Figure 15 for flood extent).

A more robust standard could relate to the spill level of the depression, e.g. the building floor level set at 0.5m above the depression spill level, or 0.5m above the 100yr ARI flood level (assuming 100% blockage).

Additionally, hydraulic models typically assume no blockage even when there is a grille close to or covering the inlet to the

culvert or pipe. The output from these models form the extent of the floodplain used for development control. However, in a storm event a certain amount of blockage will usually occur and therefore upstream of culverts will likely be underestimating the actual ponding extent (refer to Figure 15). The amount of blockage of an inlet depends on a number of local and catchment conditions and vary widely depending on the asset. Currently assumptions relating to blockage have generally not been included in hydraulic models in the Auckland region to date.

The amount of time required to map depression areas is less than 1% of the time required to produce floodplains for a catchment.

3.4 Methodology

Depressions were mapped using the GIS package ARCGIS 10. The mapping process utilised ModelBuilder to build various GIS models.

The simplified mapping process for depression areas is as follows:

- 'Fill' all depression areas in the topography (Fill tool)
- Subtract the filled grid off the original DEM to create a difference grid
- Convert the difference grid to a polygon shapefile
- 'Clean' shapefile
- Attribute shapefile with useful information

The steps to 'clean' the layer involved:

- Removing areas that are less than 500m^2 in area
- Removing areas that can store less than 50m^3 in volume

"The amount of blockage of an inlet depends on a number of local and catchment conditions and vary widely depending on the asset. Currently assumptions relating to blockage have generally not been included in hydraulic models in the Auckland region to date."

Figure 14 (top left and right) – Level of blockage before and after rain event, Figure 15 (left) – Inundation of Sunnynook Park on the 3 July 2012

- Removing areas that have a maximum depth of less than 300mm
- Removing 'islands' in depressions that are larger than 500m^2

This reduced the number of depression areas from 2,800,000 to 40,000.

3.5 Output

Over 40,000 depressions have been mapped across the Auckland region. These are areas that have a maximum depth of at least 300mm, are a minimum of 500m^2 in extent and contain a minimum of 50m^3 of storage.

The following attribute information has been calculated for each depression:

- Mapped extent
- Surface area (m^2)
- Potential storage volume (m^3) – e.g. up to the crest of the road
- Minimum and maximum elevation (m RL) – spill level
- Maximum depth (m)
- Number of houses in the depression extent
- Catchment area (m^2) – based on the overland flow path layer
- Amount of rainfall required to fill the depression (mm)

3.5.1 Rainfall Depth Calculation

The amount of rainfall required to fill the depression was back calculated using the TP108 method and is outlined below (ARC, 1999).

By rearranging the runoff depth formula (formula 1), the rainfall depth can be calculated using the quadratic formula (formula 2).

$$Q = \frac{(P - Ia)^2}{(P - Ia) + S} \qquad (1)$$

where:

Q = runoff depth (mm)
P = rainfall depth (mm)
S = potential maximum retention after runoff begins (mm)
Ia = initial abstraction (mm)

$$P = \frac{-b \pm \sqrt{b^2 - 4c}}{2} + \mathrm{Ia} \qquad (2)$$

where:

b = - Q
c = - QS
P = rainfall depth (mm)
Ia = initial abstraction (mm)

The runoff depth (Q in mm) was calculated using the formula below:

$$Q = \frac{1000 \times V_{pot}}{A} \qquad (3)$$

where:

Vpot = Potential storage volume (m^3)
A = Catchment area (m^2)

A unique, composite curve number (CN) was calculated for every 100m^2 area (10m grid) of the Auckland region, based on the relevant soil type (group A, B, C classes as per TP108) and the predicted future imperviousness (assumed 70% if in the urban area and 20% if in the rural area).

Using these CNs a unique, averaged CN for the upstream catchment draining to each point along the overland flow path was calculated. From this average CN value a unique initial abstraction (Ia) and soil storage (S) can be calculated (refer to formulas 4 & 5). Curve numbers of 39, 61 and 74 were used for pervious areas (soil type A, B and C respectively) and 98 was used for impervious areas.

The weighted curve number, CN, was calculated using the following formula.

$$CN = \frac{\sum CN_i A_i}{A_{tot}} \qquad (4)$$

The soil storage, S, was calculated using the following formula.

$$S = \left(\frac{1000}{CN} - 10\right) 25.4 \qquad (5)$$

The 100yr ARI rainfall contours were interpolated and the average rainfall in the upstream catchment was calculated (unique to every part of every flow path). The averaged rainfall (with climate change) was compared with the calculated rainfall required to fill the depression.

Calculations show 5% of the identified depressions can't fill completely in a 100yr ARI event.

"Depressions are areas that have a potential to pond or 'fill' up if the piped system was blocked or under capacity (wherever there are closed contours). They are the potential areal extent of the water up to crest level where water would spill downstream (instead of continuing to pond up). Generally depressions are created due to the construction of a road perpendicular to a stream."

3.6 Uses

The most common uses of mapped depressions to date are:

- Identifying flood prone areas
- Identifying critical assets
- Identifying large dams under the Building Act 2004
- Identifying areas where there might be issues with LiDAR data (i.e. depressions shown in streams where there are no structures – LiDAR not able to penetrate dense bush areas)

3.7 Assumptions and Limitations

The assumptions for the mapping process are that the:

- The runoff volume for a smaller or larger duration storm event is the same as the TP108 24hr storm event (calculation of the rainfall depth required to fill the depression).

The limitations for the mapping process are that the:

- Statistics calculated for each depression (e.g. minimum and spill elevation) are extracted from LiDAR. Therefore, the accuracy of the information is highly dependent on the quality of the LiDAR data (e.g. the point density, equipment, process and the post-processing techniques).
- Extent of the depressions aren't necessarily the maximum extent in a storm event (i.e. if there is any flow over the road crest then the depression will be higher and larger in extent then shown).
- Grid or raster size used. Computationally a 2m grid was chosen as the appropriate grid size for the region. A small improvement would be evident if a smaller grid size was used, although far larger run times would occur.

3.8 Future Work

Future work includes:

- Calculating stage/storage values for all the depressions to be used for 1D hydraulic modelling and calculating the potential 100yr level (assuming a certain percentage of blockage of the outlet)
- Mapping the 100yr ARI extent for depressions that are very large (i.e. depressions that would require >100yr ARI rainfall depth in the catchment)
- Including the depressions layer in an appropriate way, using flood prone rules, in the Unitary Plan
- Reproduce layer after LiDAR is re-flown

Figure 16 – Mapped depression and overland flow paths

4. Combined Datasets

The overland flow path and depression layers provide very useful information in the catchment planning process to identify buildings at risk of flooding.

Figure 16 below shows the final output of the mapped overland flow paths and depressions. Overland flow paths are represented inside and outside of the depression area. The mapped blue line leaving the depression area (via the digitised culvert) is the path of stormwater in low flows (i.e. through the pipe) and the mapped yellow line is the potential spill path if the depression was to 'fill' up (due to blockage, inadequate pipe/inlet capacity or high peak flows) and spill downstream.

Figure 16 shows the spill path potentially affecting one property. Generally the spill path takes a similar route to the culvert/stream. It's important to identify the spill path especially in areas where there is a divergence and properties are potentially at risk of flooding.

5. Conclusions

From the mapping work and recent experience in the use of these datasets the following conclusions can be made:

- Organisationally the overland flow path and depression layers provide a valuable resource to Council staff and developers in planning and consenting for new and existing developments
- Flood models only capture a portion of properties in a catchment at risk of flooding
- Mapped overland flow paths and depression areas can identify potential flooding issues in catchments outside of the mapped floodplain or flood hazard areas
- GIS can be a powerful and efficient tool in mapping overland flow paths and depression areas
- The amount of time required to map overland flow paths and depression areas is less than 2% of the time required to produce floodplains for the same catchment
- High resolution LiDAR data is vital to ensure reliable GIS data is produced
- Flooding rules need to better allow for depression areas that have the capability to flood given partial or full blockage of culverts or pipe inlets

6. Acknowledgements

The authors would like to acknowledge Dr Ming Peng who was an integral part in developing the overland flow path methodology in GIS.

References

ARC (1999). Guidelines for stormwater runoff modelling in the Auckland Region (TP108). Prepared for Auckland Regional Council by Beca Carter Hollings & Ferner Ltd.

Department of Building and Housing (2004). Building Act 2004. http://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html

Kettle, D; Irvine, J; Mayhew, I; Young, D (2013). The methodology for developing stormwater management areas for flow control for the Unitary Plan.

Smart Solutions for Understanding Simple Systems

Paul King and Andrew Ironmonger – Opus International Consultants Ltd

Abstract

Opus International Consultants Ltd. was engaged by the Christchurch City Council to investigate their stormwater network in the Port Hills. This investigation was driven by Council to both determine the network condition and prioritise the repair of damage anticipated from the series of earthquakes in Canterbury from September 2010 – June 2011.

This investigation was required to determine:

1. The condition of the network (including the identification of earthquake specific damage).
2. Emergency (urgent) works required to address immediate failures within the network.
3. Priorities for the CCC remedial works programme.

The Opus project team faced several challenges in completing these investigations. This included the determination of the:

- Condition of a wide variety of assets in standardised repeatable manner.
- Differentiate between earthquake damage vs. age deterioration for the asset.
- Prioritisation of remedial works between assets of the same condition.
- Locating & assessing stormwater infrastructure often in heavily vegetated areas.

The project team was able to embrace technology to help meet these challenges, to aid the field data collection, condition assessment and conversion back into the Council corporate systems.

Keywords

Stormwater, Condition Assessment, Earthquake, Criticality, Open Channel, Stormwater Network

1. Introduction

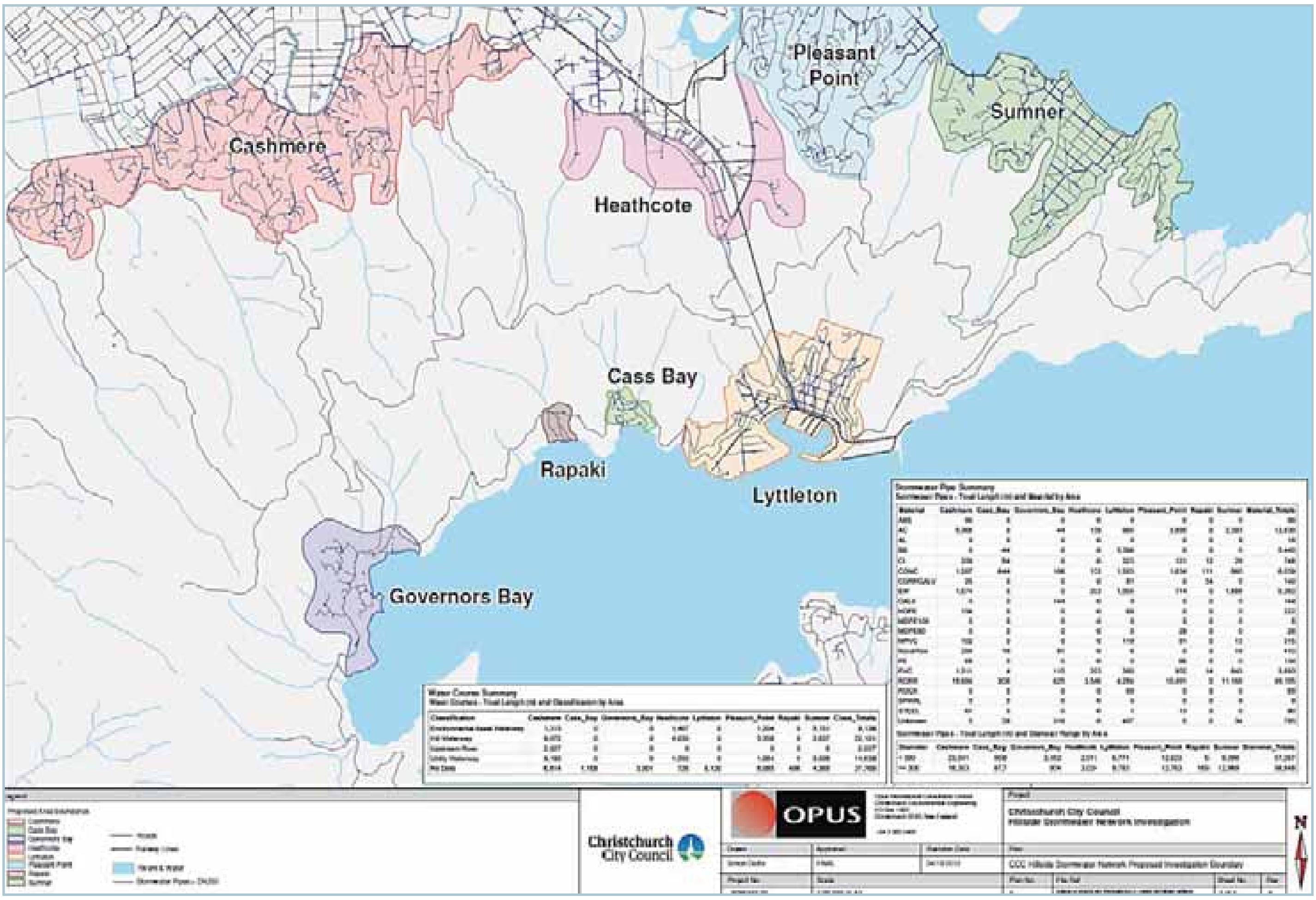
Christchurch City Council's (CCC) stormwater network within the Port Hills had not been fully assessed to determine the extent of damage resulting from the series of earthquakes from September 2010 – June 2011. CCC required an investigation, condition assessment and a programme of remedial works for the stormwater network in the Port Hills. The goal of this investigation and condition assessment was to identify which sections of stormwater network that require the following:

- Emergency works to immediately restore service to the network
- Maintenance works to restore the capacity of the network
- No maintenance works or repair works

Emergency works would be reported immediately for the CCC to action whilst the maintenance works would be combined with a criticality rating to determine its prioritisation for future repair works.

The criticality rating assigned to each watercourse will also be used for optimising maintenance works in the future. Criticality ratings will be subject to periodic review to account for the changing nature of the hillside catchment and to keep in line with the development of the hillside areas.

Figure 1 – Hillside Investigation project areas



The Port Hills were divided into eight 'Project Areas' for this investigation. These being: Cashmere, Cass Bay, Governors Bay, Heathcote, Lyttelton, Pleasant Point (Mt Pleasant), Rapaki, and Sumner. These areas are mostly hillside suburbs and the project areas (located entirely within the Port Hills) represents the majority (60%+) of the urban areas within these catchments.

2. Field Investigations

The field investigation was divided into two phases. These being:

- Pilot Study – to confirm the collection methodology and delivery formats
- Field Works – to complete the balance of the works

2.1 Pilot Study

The first two weeks of the field investigation was used for a pilot study to:

- Confirm the format for the Standardised Assessment Record Sheet (SARS)
- Confirm the methodology for the visual inspection
- Trial the use of a tablet device for data collection

The pilot study was conducted in the Rapaki project area as this was finite isolated stormwater network. A range of collection methodologies could be trialled and the outputs confirmed and agreed with the CCC.

2.2 Field Works

Once the pilot study was completed a meeting was held with the CCC to confirm the format for the SARS and confirm the method-ology used for the visual inspection. After successful completion of the trial of the tablet it was also decided to purchase tablets for each of the field teams.

The field works were carried out using two survey teams over a period of 4 months to complete the visual inspection of all the watercourses in the eight project areas.

2.3 Use of Tablets

The teams in the field collected data using electronic tablets (Apple iPads). As outlined below this helped speed up both the field work and data collation process. The tablet integrated a Global Positions System (GPS), Geographical Information Systems (GIS) and a high resolution camera into a single unit. This enable the field teams to locate watercourses in the field, input the data directly into the network database and ensured that the report and photos were assigned an exact location to allow remedial works areas to be easily located.

Manually typing data whilst standing in the bottom of the watercourses proved to be problematic using a touchscreen. The process was simplified to address this. Given the successful use of the tablet device the SARS was then developed for use on a database format utilising dropdown menus in the field to enable efficient accurate data entry.

2.4 Challenges

Several challenges faced the project team undertaking this work for the CCC. These challenges included:

1. The extent of the network in the Port Hills (totalling 75+ km)
2. Locating the open network in remote often heavily vegetated areas
3. Defining earthquake damage
4. Determining criticality normally confined to formal (piped) networks with defined end users determining the consequences of failure (i.e. sanitary sewer or potable water customers)

2.4.1 Extent of the Network

The total extent of the Port Hills open channel network totalled several hundred kilometres. It was determined through discussion with CCC that the survey should be confined to the urban areas in the northern half of the Port Hills (being those closest to the epicentre of the February event) and most likely to have sustained significant damage. The reduced study areas are shown in Figure 1; however the lengths of these watercourses in the eight project areas still totalled approximately 75km.

The timeframe for the completion of this work was short and it was quickly realised that this would require at least two teams in the field undertaking assessments in parallel. This brought two key challenges:

1. How do you achieve a consistent grade score based between the teams?
2. How can you coordinate the teams to ensure works don't overlap?

It was decided to use the New Zealand Infrastructure Asset Grading Guidelines (1999) as the basis for determining the average and peak condition and that each of the three teams would undertake a 10% audit of the other teams works to ensure consistency in approach.

The teams would also use tablets to collect data which would be updated daily with the progress of all teams to ensure that overlap only occurred when undertaking an audit of the other teams work.

2.4.2 Locating the Network

The challenge with the assessment of the stormwater network is that the majority of it consisted of heavily vegetated open drains, with the piped network confined to the lower reaches in the denser urban areas. In addition the majority of this network is located within Private Properties.

The use of tablets incorporating GPS and GIS of the network allowed for the real time interrogation of the network and often directed the project teams to the spot to allow the survey to be undertaken.

2.4.3 Damage Source (Earthquake vs. Aging)

Given the investigation was being undertaken in excess of 12 months after the initial event and in particular the February 2011 event the determination of earthquake damage could be difficult in older areas where significant age deterioration had occurred already.

To address this the team took high resolution photos of the watercourses and significant damage areas to record what was seen by the investigation teams to allow for review by the asset owner. These photos were also invaluable to the project team later as they allowed independent review of the condition grading in addition to aiding the assignment of the criticality ratings.

In addition to the photos, the local residents also possessed anecdotal knowledge of the network in their areas. This knowledge was invaluable as often they could describe the extent of damage observed directly after the earthquake events.

This was then incorporated into the data collection to indicate the spilt to CCC between regular maintenance requirements and additional damage from the earthquake for budgeting purposes.

2.4.34 Use of Criticality

Criticality was used (in addition to condition assessment) in order to prioritise the assets in the worst condition with highest consequence resultant from their failure. This then allowed for CCC to develop a forward works programme based on biggest needs within the Port Hills network.

Emergency work (i.e. assets that had already catastrophically failed) was reported immediately to the CCC to enable action to be undertaken whilst the assessment of the network was on-going.

How the criticality was determined for each watercourse is explained further in section 3 below.

"The challenge with the assessment of the stormwater network is that the majority of it consisted of heavily vegetated open drains, with the piped network confined to the lower reaches in the denser urban areas."

3. Criticality Assignment

In addition to the condition assessment of the watercourse network the criticality of the watercourse assets had to be determined in order to prioritise the CCC remedial works programme. This enables the critical assets in the worst condition to be addressed first to limit the risk/extent of collateral damage should the assets fail.

The criticality of an asset reflects the consequence of the asset failing (not the probability). In assessing the criticality there was a number of assumptions used by Opus for the Hillside Stormwater prioritisation process. The key assumptions were:

- Asset types included i.e. natural water course, lined water course and culverts
- Asset Types excluded i.e. headwalls and miscellaneous structures
- All assets have a minimum criticality of minor (1) i.e. unassigned assets will default to 1

Failure modes form an integral part of the criticality assessment and include:

- Scouring of water course and downstream areas
- Blockages of culverts and water courses: these can be partial to full
- Slumping of water course walls and channels
- Deposition
- Tomos or tunnel gullies

The Stormwater Criticality Methodology process used the criticality matrix previously developed by CCC to ensure that this methodology and systems of analysis was consistent with their approach to their potable water and sewer networks.

This criticality matrix was modified to allow easier understanding by:

- Deleting those items not directly applicable to the Hillside stormwater network
- Adding consequence examples associated with the Hillside stormwater network
- Adding additional items within the individual impact i.e. CCC Levels of Service areas for CCC utilities due to the effect on these service from stormwater failures

The prioritisation programme of Hillside stormwater assets repairs and renewals will uses the following calculation:

Asset priority = Average asset condition score (1 – 5) x Maximum Criticality score (1 – 5)

This simple equation allows all the watercourses in the eight projects areas to be ranked and allows the CCC to direct available resources to the infrastructure most likely to fail with the highest consequences of failure first.

Figure 2 – Example of the combined review data showing criticality score of each water course (coloured lines) and priority score colored dots. Refer to legend (below)

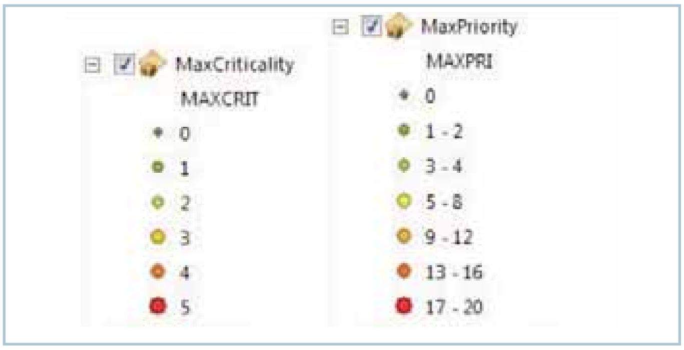


Figure 3 – Scoring legends showing Criticality vs. Asset Priorit

4. Outcomes

The condition assessment concluded in August 2012 and the data provided to CCC to enable them to update their GIS system. This data also provide the baseline not only for immediate maintenance works but for future repeat assessments.

The criticality assignment works are on-going currently (based on recent agreement of the methodology with CCC) but when complete will allow a programme of remedial works to be developed based on both the observed condition grade but also the importance of the watercourse to reduce the risk of failure for the CCC.

Future surveys will have the criticality will process will be pre-programmed into the tablet to allow for a field assessment of criticality to be conducted concurrently with the condition assessment of the watercourses. This will improve the process twofold:

1. Allow the field team to verify the criticality factors such as proximity of nearby floodable structures.
2. Further reduce time allowing a ranked list to be produced straight from the field work

5. Conclusions

The key elements of this study were:

1. The successful development of a data collection methodology to enable the collection of condition grading data for watercourses in the Port Hills.
2. The swift identification and reporting of emergency works to the CCC. This enabled remedial works to be identified and action undertaken immediately.
3. The successful use of tablets for field data collection to improve:
   a. The timeframe for data collection (based on the successful marriage of GPS & GIS) and the elimination of the need to process data in the office (double handling).
   b. the ability for independent review of the data collected by inclusion of geographically linked high resolution photographs.
   c. the ability of field teams to locate watercourses quickly in the field (often in heavily vegetated areas) where visual identification would be problematic.
4. The development of a criticality matrix for an open channel (watercourse) stormwater system to enable the prioritisation of remedial works to initiate immediate risk reduction for the asset owner.

Acknowledgements

I would like to thank the Christchurch City Council, in particular: Mike Gillooly, Graham Harrington, Owen Southen and Stephen Adam, for the opportunity to work on this project. I would like to acknowledge the support of the Opus Project team being: Adam Wheeldon, Daniel Koziol, Jayesh Danjee, and Andrew Iremonger and Citycare Ltd. for providing additional staff at moments notice to undertake field survey.

References

New Zealand Water and Wastes Association Inc (1999) Infrastructure Asset Grading Guidelines – Water Assets.

Waikato River outlet, Taupo – photo Phillip Capper

Assessing Uncertainty in Estimates of Urban River Flow using Theoretical Methods

Mark Groves – Opus International Consultants

Abstract

Methods for estimating flood flows in urban catchments are known to have reliability issues due to the potential attenuation effect create by the stormwater pipe network. This paper attempts to quantify the difference through comparison of an existing detailed calibrated model of an urban watercourse and its associated stormwater drainage network against a theoretical lumped run-off modelling approaches using two methods commonly used in the industry. The catchment selected is relatively flat in nature and a large storage component within the urban landscape is expected due to its relatively gentle topography. Results show that both the lumped and detailed methods can calibrate well using a high frequency observed event with the same hydrological parameters, yet diverge significantly when estimating peak flows for low frequency events that exceeds the pipe networks capacity. The implication is that, at least where catchments are relatively flat in nature, predicted flood flows from lumped hydrological models considered to be calibrated can significantly over estimate key flood events. The implications being planning and capital works decisions are poorly informed leaded to erroneous decisions. This study also shows that the impact of climate on peak flows can be overestimated for the same reasons, demonstrating the value of a complete and detailed model of the catchment when attempting to understand flood risk and make critical or costly decisions based on the results. The results also highlight the value of having and using observed flow data when assessing flood risk in urban catchments over theoretical approaches that fail to represent all the physical processes occurring upstream.

Keywords

Flood Risk, Modelling, Hydrology, Climate Change, Stormwater

1. Introduction

When assessing flood risk for a river with a predominantly urban catchment and no gauged flow data is available, theoretical estimation is required as a substitute. This is often undertaken using lumped hydrological methods often using software such as InfoWorks™ CS or ICM, EPA's SWMM, DHI's MIKE Urban or MOUSE or HEC-HMS, all of which incorporate methods to predict flow for a given catchment area based on hydrological parameters. Utilisation of software negates the manual derivation of hydrographs using a spread sheet or hand calculations and is common practice within the industy.

The lumped methods used to estimate flow typically consist of a run-off volume model combined with a run-off routing model to estimate percentage run-off, timing and storage effects within the catchment. The flow hydrograph generated is than either imported into another software package such as DHI's MIKE 11 or HEC-RAS to look at open channel flow hydraulics or used within the same package to generate a point flow into an open channel model (such as MIKE Urban, SWMM or InfoWorks CS). The AEP of the flow hydrograph is assumed to equal that of the rainfall event used.

> "Where theoretical run-off models are used to estimate flow for urban river catchments, those involved need to be aware of this potential divergence and convey that uncertainty to the user of the results."

Flows are typically estimated from a single catchment area defined by topography and / or the drainage network upstream. However, another increasing common approach is that of creating a sub-catchment for land parcels and then connecting ('lumping') them all to a point, though this is more commonly done when modelling stormwater drainage systems to reduce the amount of time required manually defining sub-catchments.

However, lumped theoretical run-off methods are not designed to include the physical effects of stormwater drainage systems as they are originally intended for estimation of overland flow from un-developed river catchments, particularly when flood events exceeding 10% AEP are considered (the maximum standard most stormwater pipe systems are designed to). Exclusion of the pipe network may lead to overestimation of the flood flows and resulting flood depths / extents. To gauge the likely uncertainty when using a lump approach for a predominantly urban catchment, this paper compares a typical theoretical method with a full model of the river and piped network upstream; the latter being able to represent the effect of including the pipe network, using the same run-off volume and routing models and hydrological parameters. The only difference between the two methods being: the hydraulic restriction of the piped network, and surface storage utilised by the stormwater network when its capacity is exceeded.

This paper also looks at how climate change effects on peak flow differ between a full detailed model and a lumped approach in order to gauge uncertainty and what effect 'lumping' parcels to a point has in terms of peak flow estimation.

The results of this paper should be considered only to relate to urban catchments of a generally flat nature and are not valid for comparison with steeper catchments with well defined topography and overland flow paths or catchments that are generally rural in nature.

2. Modelling Approach

InfoWorks™ ICM was adopted for the analysis; this is because it allows analysis of the piped network and the river system within a single environment and an existing calibrated model was available for use. The existing model was developed by Opus International Consultants Ltd.

The model includes the entire system from river channel right back to catch-pits in the road corridor, with nearly all data being based on accurate survey (pipes, bridges and river channels). The model also utilises a Digital Terrain Model (DTM) based on LiDAR to represent the ground surface. A 2D hydraulics engine is then employed

"The 'lumped' approach has been included as this approach is increasingly common. Parcel boundaries or land-use zones are used to generate sub-catchments and then lumped to a single point."

to calculate surface storage and overland flow paths within the catchment once the piped networks capacity is exceeded.

2.1 Methods compared:

- A single catchment area representing the entire 2.5km^2 catchment (here after referred to as 'single' approach)
- 'Lumped' sub-catchments discharging to a series of inflow points along a dummy channel to represent routing along the channel (here after referred to as the 'lumped' approach).
- The full model of the entire system (here after referred to as 'full' approach)

The 'lumped' approach has been included as this approach is increasingly common. Parcel boundaries or land-use zones are used to generate sub-catchments and then lumped to a single point. This reduces the complexity /time required to generate sub-catchments based on topography and drainage network layout and the need to calculate area weighted values where the sub-catchment crosses multiple land uses.

All hydrological parameters used are consistent between the approaches assessed and have been developed through calibration of the model with observed flow data and historic flood events. Imperviousness is representing using a fixed run-off volume model and SWMM routing whilst pervious areas are represented using the Horton's run-off volume method also with SWMM routing.

To make the comparison fair, an online flood attenuation basin was removed from the full model. All three method assessed also include an additional hydrological model used to represent elevated base flows following rainfall (groundwater influence). This has also been developed through calibration with observed flow data and has minimal impact on peak flow rates.

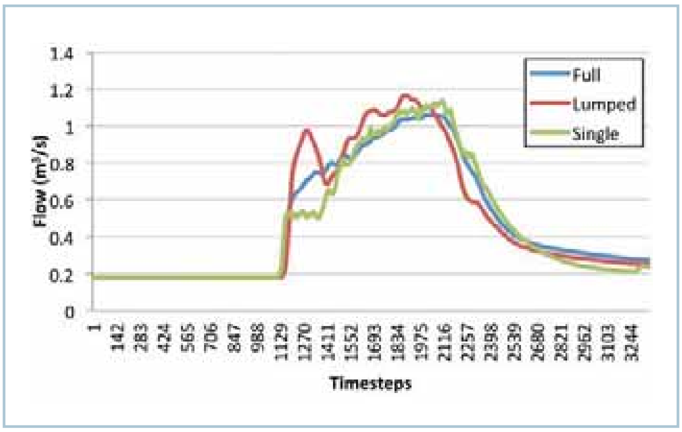
2.2 Calibration

All three methods assessed have been run with observed rainfall (five minute time-step) and validated against the full model which is known to calibrate with the observed flow.

Illustration of Calibration with the observed flow data is unfortunately not possible due to the removal of the flood attenuation basin. However, as the full model calibrates well with observed when the basin is included, the other methods can be assumed to also calibrate if they match the full models prediction without the basin included.

Comparisons of results for each method are shown below. Note they all match reasonably well as would be expected, given they have the same catchment area and employ the same hydrological model and parameters.

Figure 1 – Comparison of predicted flow for each method based on an observed rainfall event used for model calibration (estimated to be a 6 month ARI event)

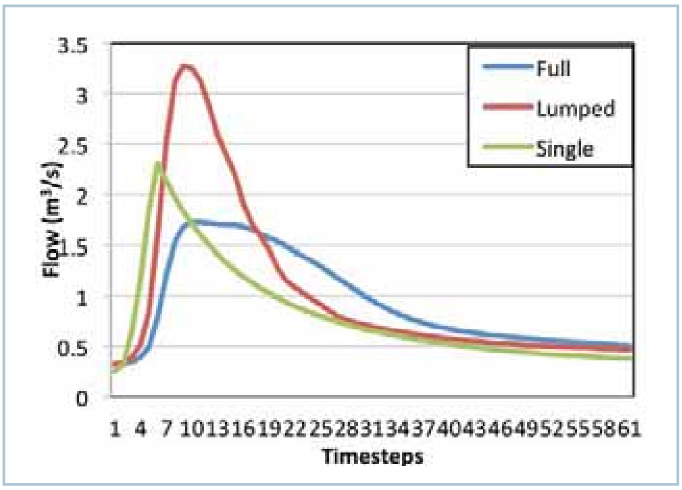


3. Results

Three rainfall events have been assessed with each method, these are compared below. The events are: a high intensity event (20 minute duration, 10% AEP), a two hour duration 10% AEP event and a two hour duration 1% AEP event. The two hour duration represents the critical duration for the catchment in terms of peak river flow and predicted flood extent.

Comparison of the results for each method is shown below:

Figure 2 – Comparison for the 20 minute duration 10% AEP event



"All three methods assessed have been run with observed rainfall (five minute time-step) and validated against the full model which is known to calibrate with the observed flow."

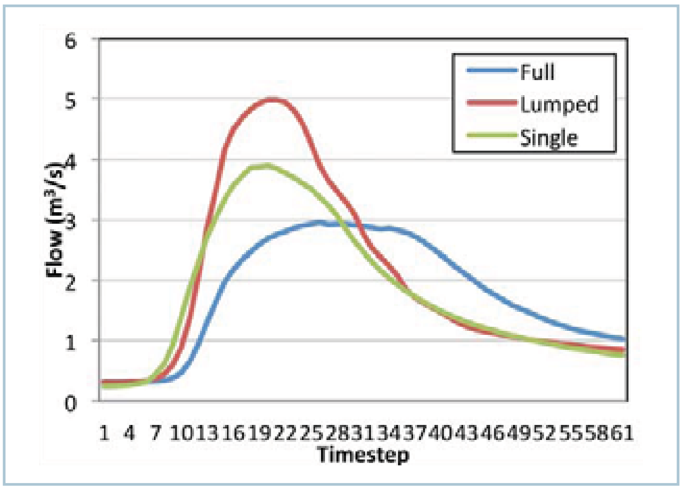


Figure 3 – Comparison for the two hour duration 10% AEP event

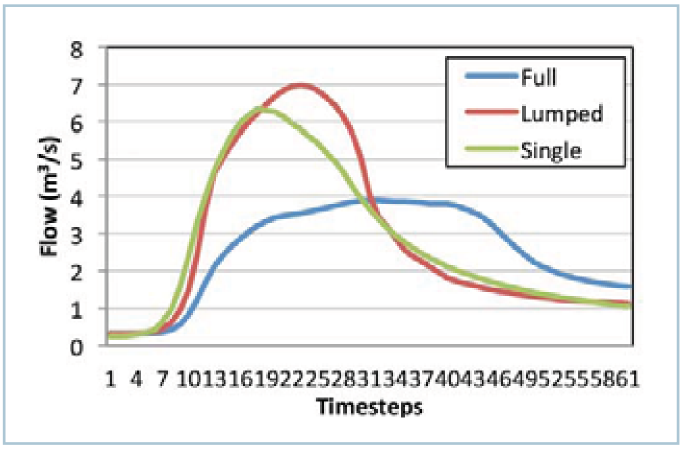


Figure 4 – Comparison for the two hour duration 1% AEP event

From the results above, it is evident that both the 'lumped' and 'single' methods overestimate peak flow compared to the full model. The overestimation also increases with ARI. The divergence between the methods can be expressed by comparing the theoretical growth curves.

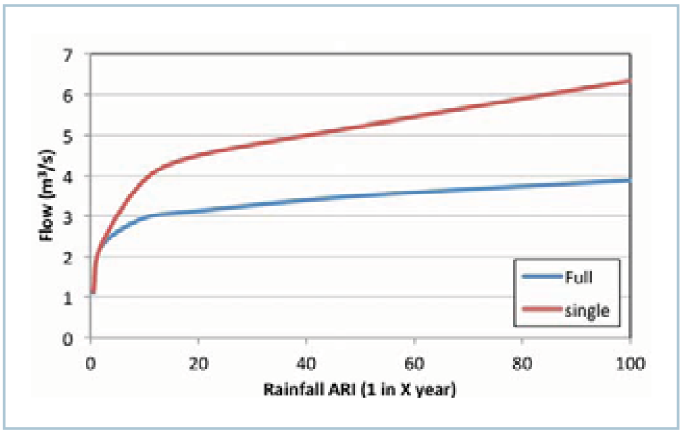


Figure 5 – Comparison of synthetic growth curves for the full and single methods

As can be seen, high frequency events (<10% AEP) yield good comparison as the pipe network is not yet a limiting factor, but once the rainfall event exceeds the pipe networks estimated level of service (1 in 2 – 1 in 5 yr ARI) the predicted flows start to diverge. This can also be expressed as % divergence for each method for a given ARI event.

Table 1: Flow divergence for ARI's considered

ARI (1 in X)	Predicted Flow (m^3/s)		Divergence
	Full Approach	Single Approach	
0.5	1.1	1.13	3%
2	2.24	2.28	2%
10	2.95	3.89	32%
20	3.13	4.5	44%
50	3.5	5.22	49%
100	3.89	6.34	63%

The divergence is due to the attenuation effect of the surcharged pipe network and surface ponding occurring low points within the catchment. As would be expected, lumped hydrological approaches cannot account for this effect, creating the divergence; the difference being most notable for the 1% AEP event. Further, they can only be expected to diverge further with even lower frequency events, where estimation of flood flows are most critical in terms of sizing infrastructure, assessing flood risk and making critical planning decisions.

5. Summary

5.1 Estimation of Peak Flow

Theoretical run-off estimation methods do not account for the attenuation effect of the urban stormwater network during low frequency events; this is expected to be most notable where the urban catchment is relatively flat. In this example, failure to account for the behaviour of the piped network leads to a significant overestimation of flow for the 1% AEP event. This is not a small divergence and could result in significant over estimation of flood risk or incorrect decision making and planning policy.

Given all three methods compare well during a calibration event, there is a clear risk that the lumped hydrological methods could give the false impression that it is a valid method of estimation for predicting flood flows.

Where theoretical run-off models are used to estimate flow for urban river catchments, those involved need to be aware of this potential divergence and convey that uncertainty to the user of the results. Whilst conservative results are often not seen as an issue, in some circumstances the difference may mean no flooding versus significant flooding, which in turn could lead to unnecessary infrastructure, or incorrect zoning of valuable land.

> "When assessing flood risk for a river with a predominantly urban catchment and no gauged flow data is available, theoretical estimation is required as a substitute."

The results of this study clearly demonstrate the value of gauging urban rivers and the use of statistical methods (as upstream physical processes are accounted for) over theoretical approaches, as is comparison with historic flood events where good rainfall data is available. Where accurate estimation of flood risk is required and no good data exists, an integrated model of the river and its upstream piped network appears the better approach. Whilst modelling the entire urban network is costly, the money potentially saved through more accurate estimates of flood risk and associated cost savings may far outweigh the cost of development and result in a better community outcome.

"Where theoretical run-off models are used to estimate flow for urban river catchments, those involved need to be aware of this potential divergence and convey that uncertainty to the user of the results. Whilst conservative results are often not seen as an issue, in some circumstances the difference may mean no flooding versus significant flooding, which in turn could lead to unnecessary infrastructure, or incorrect zoning of valuable land."

It should also be noted that the use of small sub-catchments lumped together to a series of points along a simplified channel tends to over-estimate peak run-off rates during shorter duration events where the rainfall duration is less than the catchments Time of Concentration (Tc). This is due to small catchment with short times of concentration all being assumed to reach a point simultaneously regardless of distance from the point. Whilst this method saves time and money, its tendency to overestimate flow during short duration events must be noted. Manually adjusting the catchment distance may avoid this issue, but that has not be tested.

5.2 Assessment of Climate Change Impacts

A 16% increase in rainfall depth and intensity translated to an 11% increase in peak flow using the 'full' method. This is due to increased surface storage of run-off upstream within the urban catchment. If the influence of the piped network is ignored using a lumped hydrological approach, the increase in flow predicted is almost doubled at 21%. This indicates that the impacts of climate change can be overestimated when the hydrology does not account for the operation of the urban stormwater drainage network; this is particularly an issue where lumped hydrological models are used to generate inflow hydrographs for river modelling packages such as MIKE11 or HEC-RAS.

REFERENCES

Horton R.E. (1940). An approach towards a physical interpretation of infiltration capacity. Proc. Soil Sci. Am., 5, 399–417.

SWMM4 User's Manual (1988). Storm Water Management Model. Version 4: User's Manual. U. S. Environmental Protection Agency, 1988.

Ministry for the Environment (2008). Climate Change Effects and Impacts Assessment: A

Guidance Manual for Local Government in New Zealand. 2nd Edition. Mullan B; Wratt D; Dean

S; Hollis M; Allan S; Williams T, Kenny G and MfE. Ministry for the Environment, Wellington. xviii + 149 p.

Hamilton City's Water-Sensitive Future

Ian McComb – Growth Specialist (Waters), Hamilton City Council

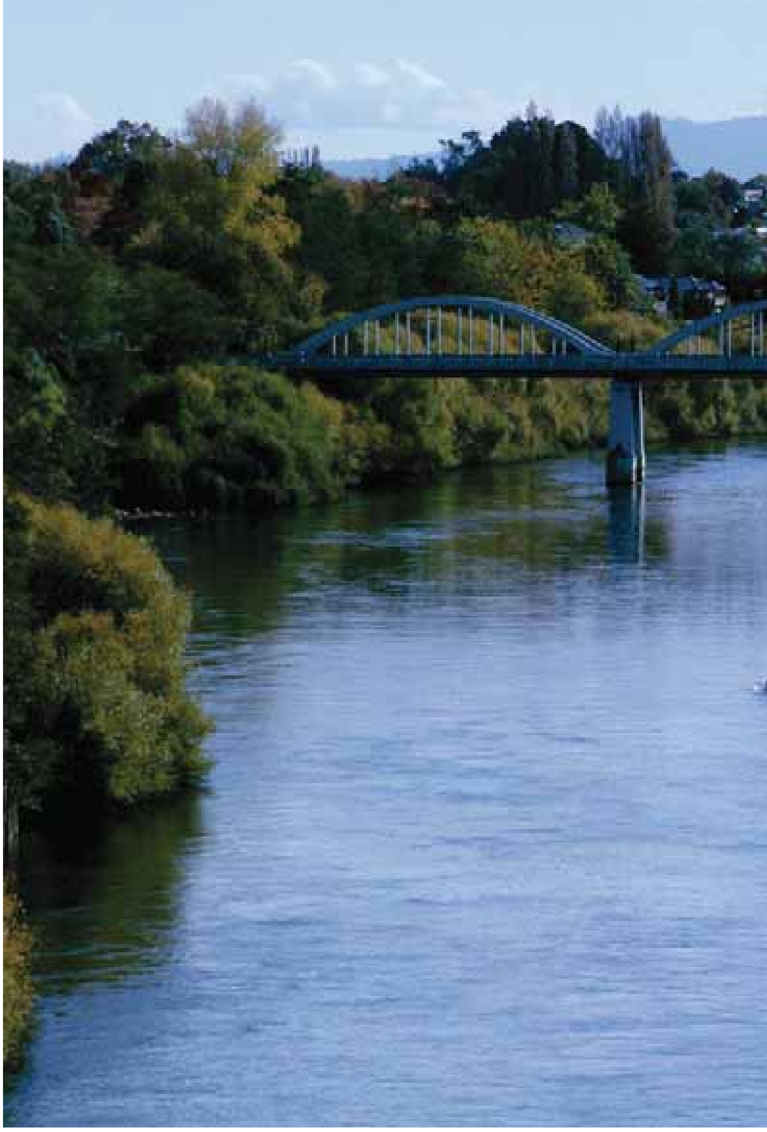
Hamilton City is moving towards a water-sensitive future through the proposed revisions to the District Plan and Infrastructure Technical Specification. These two documents, once finalised, will lock in substantial measures to improve the performance and reduce the impact of the three-waters networks across Hamilton (see Figure 1).

"Council has developed the concept of 'water-sensitive' techniques to incorporate 'green', low impact, sustainable thinking with the requirements of the Waikato Tainui Raupatu Claims (Waikato River) Settlement Act 2010, considering for example, the inclusion of traditional food and fibre plants within riparian areas."

Two of the pressures that led Council to enhance their documents are the continued strong growth of the city and the potential for water extraction rights from the Waikato River to be fully allocated in the Hamilton reach within 5 to 10 years.

To guide this change a new definition of "water sensitive techniques" has been developed and imbedded in both documents (see Figure 2). Council has developed the concept of 'water-sensitive' techniques to incorporate 'green', low impact, sustainable thinking with the requirements of the Waikato Tainui Raupatu Claims (Waikato River) Settlement Act 2010, considering for example, the inclusion of traditional food and fibre plants within riparian areas.

Figure 1 – Hamilton's three-waters integrated planning



Fairfield Bridge spanning the Waikato River in Hamilton – photo courtesy of Hamilton City Council

Planning Measures

The Proposed District Plan was notified in December 2012 and contains, in Chapter 25, the key new requirements which state –

"Integrated Catchment Management Plans will be used as a tool to help manage, at a high level, the form and function of Three Waters infrastructure in an integrated, effective, efficient, functional, safe and sustainable manner.

Over time Integrated Catchment Management Plans (ICMPs) will be developed for existing urban areas. Structure Plans and large scale activities will require an Integrated Catchment Management Plan (as outlined in Volume 2, Appendix 1.5.5). Until this occurs, stormwater, water and wastewater infrastructure must continue to be provided and managed.

Water Impact Assessments are another complementary tool that will be used to assess and ensure Three Waters integration at a more detailed level.

Water-sensitive techniques to sustainably manage stormwater, water and wastewater are included as well as minimum permeable surfaces standards, which are provided in most Zone Chapters of the District Plan.

Where an approved ICMP already applies to an area, development of Three Waters infrastructure shall be undertaken in accordance with it."

"Integrated Catchment Management Plans will be used as a tool to help manage, at a high level, the form and function of Three Waters infrastructure in an integrated, effective, efficient, functional, safe and sustainable manner."

New ICMPs are triggered by developments that exceed 40 residential dwellings or sections or 3ha of land. These comprehensive documents address large areas and require detailed assessment of engineering, ecological, soils, cultural and other inputs. They establish a preferred infrastructure masterplan, document flood hazards and guide acceptable development outcomes. A lesser requirement of a Water impact Assessment has been proposed for smaller developments or subdivisions i.e. those creating:

- Four or more additional dwellings/sections or
- More than 1ha of new development or
- Greater than $1000m^2$ of industrial floor area or
- Greater than $300m^2$ other non-residential floor area or
- A new water requirement greater than $15m^3$ per day

Water impacts assessment require a review of the impacts of the development on the three waters networks and nomination of water sensitive techniques that will mitigate these impacts.

These include a variety of methods designed for water conservation. They include many techniques referred to under other names, e.g. low-impact design (LID), water-sensitive urban design (WSUD), low-impact urban design and development (LIUDD), sustainable urban drainage systems (SUDS), "natural", "green" and "sustainable". A primary aim of water-sensitive techniques is to maximise the achievement of multiple benefits rather than a single engineering technical efficiency measure.

Recognised water-sensitive techniques include:

a. For water supply:
i. Rainwater tanks for tanks for replacing potable use (e.g. toilet flushing and landscape irrigation)
ii. Low-flow fixtures
iii. Leak resistant fixtures and fittings
iv. Automated greywater reuse systems
v. Drought-resistant landscaping (e.g. xeriscape) with low water requirements
vi. Conservation education

b. For stormwater:
i. Rainwater tanks/chambers/ponds for reuse or detention
ii. On-site soakage
iii. Green roofs
iv. Reed beds/wetlands
v. Rain gardens
vi. Vegetative filter strips
vii. Swales and depression landscaping
viii. Gross pollutant traps
ix. Permeable paving
x. Requiring buildings to be built above the freeboard of a 1% annual exceedance probability event

c. For wastewater:
i. Low-flow and leak resistant fittings and fixtures on a water supply
ii. Automated greywater reuse systems
iii. Best practice inflow and infiltration reduction methods

d. Biodiversity:
i. Reed beds
ii. Wetlands
iii. Ponds
iv. Rain gardens
v. Green or living roofs
vi. Water-quality protection and improvement devices
vii. Maintenance or restoration of natural flow regimens

e. Cultural:
i. Traditional food and fibre plants within riparian areas
ii. Water-quality protection and improvement devices
iii. Facilitation of appropriate water body access
iv. Maintenance or restoration of natural flow regimens

Figure 2 – "Water Sensitive Techniques" Definition

Water Efficiency Measures

To drive the changes down to the smallest level of development, the following rule changes are proposed (Figure 3). The requirement to include fixtures within new building created some discussion regarding potential difficulties with the interface with the Building Act. However, the final decision was that this was acceptable in a

"The proposed Infrastructure Technical Specification integrates with the provisions of the Proposed District Plan and provides additional details that aid effective design and implementation of water-sensitive techniques to mitigate developmental impacts."

District Plan as there was a RMA purposes behind the requirement. Specifically the need to conserve water due to the high allocation status of the Waikato River and expanding demand i.e. sustainable use of natural resources to provide for future generations.

a)	**In addition to Low Flow Fixtures, at least one water sensitive technique for each water type shall be incorporated, connected to, achieved or maintained as part of any new development as identified below.**	
WHERE REQUIRED	**WATER TYPE**	**WATER SENSITIVE TECHNIQUES**
i. New residential units ii. Other new buildings containing a kitchen, laundry or bathroom iii. Alterations or additions to any existing building that adds an extra kitchen, laundry or bathroom	Water supply and Wastewater	• Rainwater tank for non-potable reuse system • Automated greywater reuse system • Other equivalent feature
	Stormwater	• Detention of stormwater to 80% of pre-development runoff by an appropriate means • Permeable surfaces protected to achieve at least 20% above the minimum standard of the zone • Rainwater tank for non-potable reuse system • Other equivalent feature

Figure 3 – Proposed rule changes

The drafting team recognised that the above rules would probably lead to an increase in external water tanks within the city and in order to reduce the consequential impact of this on house designers and planners the following provisions were also proposed:

b)	**Rainwater tanks with a capacity of <10,500 litres are exempt from the following bulk and location provisions of the relevant zone.**	
	i.	Site coverage.
	ii.	Permeable surfacing.
	iii.	Rear or side boundary setbacks

Collectively, the proposed new planning rules represent a step change in thinking for the city.

Engineering Measures

The proposed Infrastructure Technical Specification integrates with the provisions of the Proposed District Plan and provides additional details that aid effective design and implementation of water-sensitive techniques to mitigate developmental impacts.

Beyond Soakage

Given the mixed alluvial nature of much of the city's soils, the ability to dispose of stormwater through soakage needs to be tested on a site-by-site basis. This has been a long standing requirement of the development code as a pre-requisite to the granting of a stormwater connection. The new policy direction pushes into the integrated three water space and places water capture for reuse as a higher priority. The new hierarchy is shown in Figure 4:

4.1.6 Stormwater Management Prioritisation

In selecting an acceptable engineering solution to stormwater management the following hierarchy shall be adopted:

a) Retention for reuse
b) Soakage techniques
c) Detention and gradual release to a watercourse
d) Detention and gradual release to stormwater reticulation

All effort should be made to either reuse or provide ground soakage before stormwater design incorporates discharge to a watercourse or stormwater reticulation

Figure 4 – Stormwater Disposal Hierarchy

"The drafting of the new documents has been a long process that required the combined skills of many Council staff and consultants including planners, engineers and legal advisors."

Conclusion: Progress Through Teamwork

The drafting of the new documents has been a long process that required the combined skills of many Council staff and consultants including planners, engineers and legal advisors. While there have been some submissions on aspects of the above, and hence the final provisions are uncertain, the Council direction and drivers are clear and consistent with the roles and responsibilities of Council. Hence the net result will be a progressively more water-sensitive Hamilton!

References

http://www.hamilton.co.nz/our-council/council-publications/districtplans/proposeddistrictplan/Pages/Contents.aspx

http://www.hamilton.co.nz/our-council/council-publications/manuals/Pages/Proposed-Infrastructure-Technical-Specifications.aspx

$10 Million Water Upgrade Averts Economic Loss for Drought-Stricken Hauraki Plains Farmers

A state of the art $10 million upgrade to the 70-year-old Kerepehi water treatment plant on the Hauraki Plains helped to maintain the region's economic production during summer's worst drought on record.

The Kerepehi plant provides drinking water for an estimated 5,000 people and 150,000 dairy cows living on 33,000 hectares of predominantly dairy land in the region.

"The Kerepehi plant provides drinking water for an estimated 5,000 people and 150,000 dairy cows living on 33,000 hectares of predominantly dairy land in the region."

Before the upgrade, which was completed in December, the plant struggled to produce enough water during the high demand period between January and April, and sometimes failed to meet the revised New Zealand Drinking Water Standards, particularly during king tide events.

However, since December, the upgraded plant has produced an additional 3.5 million litres of treated water per day. During the region's worst drought in over 50 years this summer, this increase in production is estimated to have saved $11.5 million in revenue. This would potentially have been lost had farmers been forced to dry their cows off earlier due to insufficient water.

Leading water expert, Harrison Grierson engineer, Iain Rabbitts, was the technical manager and designer of the upgrade appointed by the Hauraki District Council in 2010. Mr Rabbitts said the upgrade had increased capacity by more than 30% to deliver 12.5 million litres of treated water per day to the region.

"We were delighted to complete the project on time and under budget. The final project costs were approximately $3 million less than initial Council estimates. Had the project been delayed for any reason, the economic losses for the region could have been significant during the drought if water demand could not be met during the important milking season."

Raw water for the plant is sourced from the Waihou River. Poor river quality and king tide events created additional challenges for water treatment, with the solids loading in the river water increasing from <100 NTU to over 2,000 NTU during king tides which could not be adequately treated by the old plant.

Iain Rabbitts said the design team considered numerous options before agreeing that the best solution was to replace the plant's sand filters with membrane filters and to convert the existing clarifiers into tube settlers. He said this option delivered far greater reliability of supply and ensured that plant capacity would meet demand.

A key challenge in the upgrade was shutting down several of the existing core treatment processes for rebuilding and linking new components into the main process stream of the plant, which involved the risk of compromising supply to the region at these times.

The core component of the upgrade was the installation of a new membrane filtration system with ancillary chemical cleaning equipment. The membrane filtration system needed to be capable of delivering 12.5 million litres of treated water required per day. In addition to the installation of the new membrane system, the upgrade also included a new flash mixer, flocculation towers,

Drought-stricken farmland during the worst drought on record this past summer

retrofitted clarifiers, re-engineering existing sand filter shells to become membrane balance tanks, a new membrane plant building, a new UV disinfection system, refurbished chemical dosing, a new sludge system and a new electrical and control system.

The upgrade works were completed in December 2012; just in time to supply water to the Hauraki Plains through what proved to be a severe drought throughout the North Island. Had the project been delayed the economic losses for the region could have been significant.

"A key challenge in the upgrade was shutting down several of the existing core treatment processes for rebuilding and linking new components into the main process stream of the plant, which involved the risk of compromising supply to the region at these times."

Kerepehi was officially opened by Hauraki district Council Mayor, Mr John Tregidga, on Friday March 8 2013. The commissioning of the plant was attended by local iwi and the plant was blessed by Kaumatua.

The opening came soon after the first king tide event, where the plant easily coped with solids loads twice as high as the design values. During this event water of over 1,700 NTU fed into the plant emerged from the clarifiers containing only five NTU, and from downstream membrane filtration with less than 0.01% turbidity, complying with the New Zealand Drinking Water Standards. ■

A High-Tech Bike Helps Hutt City Understand its Assets

Steve Hutchison – Senior Water and Waste Engineer, MWH Global

Monitoring the condition of underground assets is a major challenge facing all New Zealand councils. Much of this infrastructure was constructed more than 60 years ago and it is showing signs of age or even approaching the end of its design life.

At the same time, public expectations for minimising rates and improving environmental performance are increasing. For the first time in New Zealand, a state-of-the-art piece of technology has been used to help meet both the needs of a council and the public.

"One of the largest single assets Hutt City Council operates is the Main Outfall Pipeline. This pipeline is 18 kilometres long and takes the (now) treated wastewater from Seaview to Pencarrow, for discharge into the Cook Strait; serving the combined Lower Hutt and Upper Hutt population of 140,000. Commissioned in 1962, the pipeline is made up of more than 4,000 sections of pipe and has an internal diameter of 1.295 metres. It has a high replacement cost of approximately $100 million."

One of the largest single assets Hutt City Council operates is the Main Outfall Pipeline. This pipeline is 18 kilometres long and takes the (now) treated wastewater from Seaview to Pencarrow, for discharge into the Cook Strait; serving the combined Lower Hutt and Upper Hutt population of 140,000. Commissioned in 1962, the pipeline is made up of more than 4,000 sections of pipe and has an internal diameter of 1.295 metres. It has a high replacement cost of approximately $100 million. However, there are practical realities in building a replacement as there is no longer sufficient space in the narrow road that winds around the Eastern Bays of Wellington Harbour, so an alternative route or solution may be required.

The pipeline was built using the best construction technique of the time, the "Rocla" roller suspension method, which is a pre-stressed, reinforced concrete, rubber ring jointed system. Being a pumped pipeline capable of 35 metres pressure, the construction relies on a cold drawn reinforcing wire wrapped around the inner spun concrete and coated in a layer of gun applied shotcrete. Over time, some of the pipe sections have started to show evidence of corrosion. Further investigation of sections of buried pipe found a few corroded wires, but excavation and inspection of the reinforcing wire using these spot checks was expensive, disruptive to traffic and insufficient to get a large enough sample. On top of this, most of the pipeline had significant horizontal curvature with the alignment generally following the shoreline, which also makes excavation problematic.

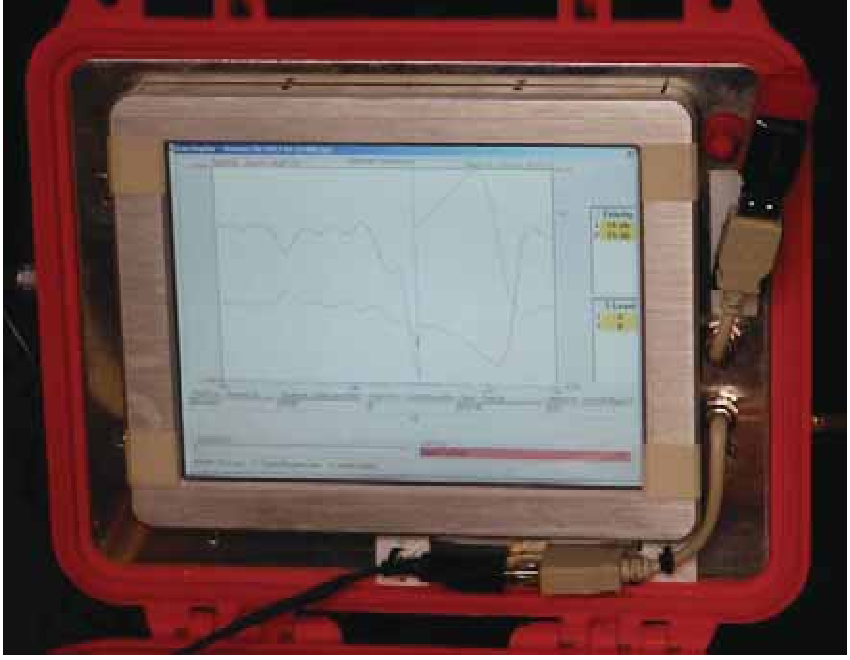
Recently, MWH Global was commissioned by Hutt City Council to investigate the repair or renovation of the pipeline and seek resource consents for pipeline inspection. Assessing the condition of the pipeline was a challenging task but one MWH identified as being best performed using a combination of non-destructive testing technology, internal visual inspection and engineering science and judgement.

The solution to assessing the steel reinforcing lay with Aqua-Environmental; a Pure Technologies company based in Canada, who would bring, for the first time, the Electromagnetic "PipeRider" Bike to New Zealand.

Once calibrated above the ground using spare pipe sections, with one of the pipes having some wires exposed and cut for the calibration, the bike was disassembled and placed in one end of the pipeline – in this case through a pressure lid opening smaller than the size of an A3 piece of paper.

The equipment, which is mounted on a modified recumbent tricycle, carried out an electromagnetic inspection by generating an eddy current and measuring the signal as it conducts through the reinforcing steel within the concrete pipe wall. The data collected will provide an understanding of the condition of the structural component that provides the pipe's strength whilst having been non-destructive to the pipe itself.

Early replacement of major assets like the Main Outfall Pipeline is the lowest risk option; however, the approach Hutt City Council has taken will help to maximise the life of its asset. This is proving to be a good example of the application of engineering judgement, as the rate of failure has been lower than engineers predicted back in the early 1990s and technology for pipe renovation continues to improve.



From left to right – The PipeRider Bike, The PipeRider and its operator demonstrate how the bike works inside the pipeline, The PipeRider collecting the data as it measures the strength of the pipe, Looking through the pipeline at the PipeRider

There will be an increasing need for smart condition assessments in years to come. Understanding the actual economic life of underground assets is a complex but essential part of effective asset management and finding the balance between acceptable risk and early replacement of expensive assets requires good information and judgement. ■

"The equipment, which is mounted on a modified recumbent tricycle, carried out an electromagnetic inspection by generating an eddy current and measuring the signal as it conducts through the reinforcing steel within the concrete pipe wall."

The Right Product at the Right Time in the Right Place

You would be excused for thinking that HTC Specialised Tooling had access to a crystal ball when the company made the decision to offer for hire and sale SAVA Pipe Sealing Bags from their Auckland and Christchurch facilities.

In Christchurch, the demand for the pipe sealing bags from contractors, civil engineers and municipal authorities has been high with both the Hire and Sales division of HTC being very active. Used in the process of testing and replacing earthquake damaged pipe, the SAVA Sealing plugs help to isolate a section of pipe so that it may be inspected, repaired, or pressure tested.

The SAVA Leak Stopper

Bypass bags have a pipe through the centre, which allows fluid or air to flow even when inflated. Generally these are used to test pipes however larger diameters units can be supplied to redirect fluid.

"Used in the process of testing and replacing earthquake damaged pipe, the SAVA Sealing plugs help to isolate a section of pipe so that it may be inspected, repaired, or pressure tested."

Their lightweight and short length makes these tough pipe plugs easy to manoeuver and install. All SAVA pipe plugs are tested at three times their working pressure (required inflation pressure) to ensure durability and safety.

Both the Bypass and Blocking pipe plugs are multi-size and perform equally well in several different pipe sizes, reducing the number of plugs needed. ■

Hach Launches DR 900 Handheld Colorimeter

Hach Company has developed the next great multi-parameter handheld instrument for testing water in the field, the DR 900 Handheld Colorimeter. The DR 900 allows for quick and easy access to your most used testing methods, and is field ready in every way possible.

"The colorimeter provides the ability to test 90 of the most commonly tested water methods, while putting your favorite methods at your finger tips. By improving the user interface and method selection options, ease of testing is the standard and not the exception for this instrument."

"The DR 900 is a great improvement on our very successful DR/800 series of handheld colorimeters," said Tom Siller, Hach's Global Product Manager for Handheld Instruments.

"By improving the user interface and menu selections, we have made it very easy for operators to access the most standard water testing methods in fewer than 4 clicks, which is a huge time saver when testing in the field."

Time savings is the main driver behind the new DR 900. The colorimeter provides the ability to test 90 of the most commonly tested water methods, while putting your favorite methods at your finger tips. By improving the user interface and method selection options, ease of testing is the standard and not the exception for this instrument.

The DR 900

The DR 900 is made for use in harsh and challenging field environments. Ruggedly constructed, waterproof, dustproof, drop tested and shock resistant, this colorimeter ensures reliability in all conditions. The instrument has a backlit display option for use in low light areas with the push of a button. The DR 900 can store data from up to 500 tests, and comes with a USB port for easy data transfer to a PC or laptop after a day in the field. ■

Water New Zealand Conferences & Events

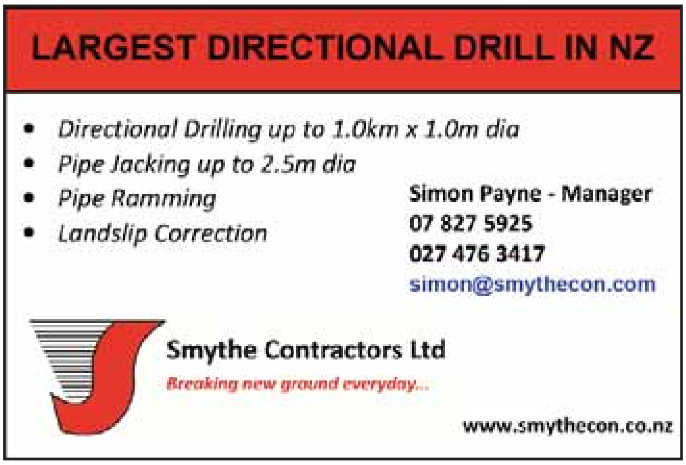
Water New Zealand Annual Conference & Expo 2013 – Changing Currents
16 – 18 October 2013
Claudelands Event Centre, Hamilton, New Zealand
For more information visit www.waternz.org.nz
or contact Hannah Smith hannah.smith@waternz.org.nz

For more information on *Water New Zealand* conferences visit www.waternz.org.nz

Other Conferences

86th Annual Water Environment Federation Technical Exhibition and Conference
5 – 9 October 2013
McCormick Place South, Chicago, Illinois, USA
For more information visit www.weftec.org

Pacific Water Conference & Expo 2013
13 – 15 November 2013
Rarotonga, Cook Islands
For more information visit www.pwwa.ws



Advertisers Index

Excelling in the provision of electronic data capture systems, meter reading technologies and accurate metering solutions. Ensuring the sustainability of our most important resource.

Because Every Drop is Precious.

www.adriley.co.nz

Arthur D. Riley & Co. Ltd.

fieldsmart technology

Auckland: (09) 444 2350
Wellington: (04) 472 7614
Christchurch: (03) 379 2628