WATER

Issue 182. November 2013

Changing Currents – Water New Zealand's Annual Conference; Awards and Conference Report

Hynds Paper of the Year 2013 – Conquering Extreme Turbidity

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On the Cover

Water New Zealand News

Features and Articles

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Steve Couper

Sustaining Sustainability

What is sustainable? Used by many of us in the water/environment business, this word might conjure up images of a pot smoking hermit living off the land in the corner of Great Barrier Island; long hair (counts a few of us out) home grown vegetables, perhaps with a few chickens to lay eggs, a couple of sheep, goats, a cow to milk, living in an eco-friendly house with wind or solar power along with wood from a small forest block to provide heat. For transport he/she might have a donkey with a cart to carry products to market, the dung is recycled back to the vegetable patch, probably votes Green (if he votes at all) – sustainably living with nature? Hard to repeat on a national, let alone global scale and do many of us respect what this person is doing to save our planet, or do we see them as some sort of crazy outcast ?

So what does sustainable actually mean? Here is the dictionary definition.

Oxford English Dictionary: *Sustain – to keep (something) going over time or continuously, and Sustainable – able to sustain.*

To evaluate the sustainability of an activity we need to consider both a time period over which it is performed, and identify a measurement to evaluate the difference in the state of the system before and after the activity. According to the dictionary definition there is no end, but logic suggests nothing is sustainable forever.

What does the science say? – It tells us that nothing is truly sustainable and that even without humans the world, and indeed the universe, is in a slow but steady state of decay as expressed by the second law of thermodynamics. This states that – *"the entropy of an isolated system never decreases, because isolated systems spontaneously evolve toward thermodynamic equilibrium – the state of maximum entropy"*. Entropy is a measure of the number of microscopic configurations corresponding to a macroscopic state (sometimes referred to the amount of order or dis-order in a system). Because thermodynamic equilibrium corresponds to a vastly greater number of microscopic configurations (more dis-order) than any non-equilibrium state, it has the maximum entropy, and the second law follows because random chance alone practically guarantees that the system will evolve towards such thermodynamic equilibrium.

Basically at a practical level this means that every time we use a resource to make "stuff" we are slowly but surely increasing the entropy of our system. Put another way the lower the entropy difference for a given process the more sustainable the process will be. If we consider that energy is what provides the driving force behind a process (e.g. converting resources into products) the lower the energy requirement the more sustainable the process will be.

It is therefore energy that is the key. Energy allows us to do most things and make the "stuff" we need. It follows, therefore, that a fully sustainable system will be one that uses no energy and, like the perpetual motion machine that our forefathers searched for, does not exist. However can we get closer than we are now? Most of us know the inconvenient truth to this answer; the less energy we use or the "cleaner" the energy we use, the closer to sustainability we will be. But does society behave in this way and strive at every point to minimise energy use and go for the clean green option.

When do each of us decide that enough is enough, that we no longer need to keep expanding our footprint, our businesses, our material goods including plastic toys for our kids. And where is the model for satisfaction, where society is happy with a flat line economy enabling the world and its resources to be sustained over a longer period of time? Do we need a catastrophic failure of the system to convince us? Or can we, through technological advances, sustain this party for some time to come?

Our desire to shop, especially at Christmas, is a case in point. While many of us understand that what we are doing is detrimental to our planet because it is just creating more "stuff" we continue to behave in this counterproductive way. There are, however, some subtle changes we can make to help save the planet. "*Trade Me*", for instance, is an excellent example of improvement towards a more sustainable path. Each time we purchase or sell second hand goods on its platform, we are potentially saving the world from producing more "stuff" that cost us entropy to make and which ends up degrading in a land fill and leaching into our water ways. By contrast large barn style outlets retailing lots of packaging and imported plastic toys do little to make our world more sustainable.

Surely, therefore, it is behavioural change that is required to make a real difference and this is unlikely to be initiated by corporate or governmental policy makers without incentive. Perhaps it is up to us all, to curb our consumption, or at least consider how and what we consume providing a behavioural change that over time will drive a market response leading the way to a more sustainable path.

Have a happy Christmas and see you in the New Year. ■

Steve Couper
President, Water New Zealand

New Members

Water New Zealand welcomes the following new members:

EAMON SULLIVAN
MARIE MCINTYRE
NEIL MCCANN
STUART CHAPMAN
JOHAN THIART
AIDAN COOPER
ROBERT COYLE
ANTHONY STEEL
DERRICK RAILTON
MARK STONE
RYAN ORR
SIMON COPP
KEVIN HEALY
DANIEL GAPES
CHRIS MAGUIRE
HELEN CHURTON
GALLO SAIDY
MIKE CORDELL
LIPING PANG
PAUL SLATTERY
PETER ROSS
ANI SATTERTHWAITE
DAVID BOWMAN
WAYNE HARRISON
MIKE DAVIES
BRUCE OLIVER
PETER MORA
CASPER KANDORI
IAN BOWEN
NEAL YEATES
ROSS DILLON
BRYAN VAUTIER
ELLIOT DUKE
JEREMY REES
ROBERT LEI
NEIL REIVE
JOHN WINTER
RICHARD LITTLE
GURU PARKAR
TONY BULLARD
GILLIAN BULLOCK
IAN MARSHALL
JACOB LEE
BERNICE CHIAM
PAUL BOWIE
MARK TUCKER
JULIAN WILKINSON
MURRAY SMITH
IAN GIBSON
MIKE WILLIAMS
JUSTIN RALSTON
IAN INKSON
EVAN OU YANG
MARIA UTTING
BRENT DOUGLAS
GEOFFREY TITMUSS
SALVE VELASCO
RYAN ROSE
NOEL ROBERTS

Murray Gibb

Reflections On 2013 and the Challenges Ahead

Our organisational purpose is to be the pre-eminent organisation in New Zealand for promoting and enabling the sustainable management and development of the water environment. As the year draws to a conclusion it is timely to reflect on whether we are achieving our purpose, what has been achieved over the past 12 months and the challenges that lie ahead.

Firstly, in order to be able to function, and therefore have any chance of achieving our purpose, we need funding. The Board policy is to keep financial barriers to membership low, which means the Association earns less than one fifth of its income from subscriptions. Every year we have to earn the balance from other activities such as events, advertising and project work, before we even think about how we go about achieving our purpose in life.

On the positive side, over the past few years the Association has traded profitably and reserves have built up. Board policy is to accumulate between 60 and 80 per cent of annual expenses as reserves. Currently reserves sit at just on 80 per cent of annual expenses, meaning we have more flexibility in funding project work. Simply accumulating profits in a not for profit membership organisation beyond prudent reserves, is wasteful use of resource.

To achieve our purpose we divide our work into three areas; representation, promotion of standards and the provision of member services. Balancing activities under each of these headings is a juggling act for us.

To assist we have a process for allocation of funding. All Special Interest Groups are asked to make requests for funding for project work prior to the start of each financial year. This enables us to budget for the year ahead and allocate funds accordingly.

On the representative front, water continues to feature high on the public policy radar and will do so in the foreseeable future. It has been a solid year of monitoring and providing input into proposed reforms to improve New Zealand's water governance system.

Reform of the Resource Management Act will include establishment of a national objectives framework for water quality and quantity, making provision for use of collaborative processes for decision making, and providing a statutory role for iwi/Maori in water governance.

A comprehensive independent environmental reporting was announced during the year.

The Government's *Fresh start for Freshwater* policy programme continues to be rolled out with Crown funding providing a catalyst for taking irrigation projects to consenting stages. A Crown Irrigation Company was set up to part fund irrigation infrastructure.

The *Better Local Government* reform work programme continued during the year. Of note was a report by a Local Government Infrastructure Efficiency Expert Advisory Group, which made 63 recommendations relating to this infrastructure.

Promoting standards benefits both members and society. Under the standards banner we've made progress during the year. With the appointment of a technical coordinator our workload has expanded. The Water Services Managers Group has agreed its priorities, and we have a clearly defined work programme in place. Projects in hand include our annual process benchmarking exercise for water utilities plus revision and updating of a number of codes and guidelines.

We continue to supply members to Standards New Zealand committees. That said, the Government has decided to disband Standards New Zealand and place its functions into a Ministry. We expect that these changes will lead to more standards being developed outside of the ISO framework, and more work in this area for *Water New Zealand*.

Membership services make up the third leg of our activities stool. It provides the most tangible benefits for members' investment in subscriptions. These include our publications, event programmes, communication tools, the administrative services provided for our SIGs and other forums, along with our awards programme.

During the year our conferencing and seminar programmes were well attended. We revised the offering at our recent Annual Conference which attracted a record number of delegates and exhibitors. Our SIGs have again been active in running local events during the year. We also held some "one off" seminars to discuss the drinking water grading system and consistency round resource consent conditions.

> "During the year our conferencing and seminar programmes were well attended."

Early 2013 a new customer relationship management tool was installed. Members are now able to log in through our website and set up their own profiles, access the membership directory, and view company profiles of corporate members. These changes have increased our administrative efficiency and we have shed half a full time equivalent administrative position as a result. In addition the website was refreshed and we embraced social media through Facebook and LinkedIn.

So are we achieving our purpose? The answer is "no." What are we doing about it? We have three immediate objectives in mind.

The first is to continue to grow our membership. The "Rising Tide," a group of young water professionals, has been founded in Auckland. We intend to foster the formation of similar groups in all the main centres and envisage young professionals participating in regional activity for *Water New Zealand*.

The second is to prepare us for the day when more water utilities in New Zealand are aggregated up to achieve scale economies. Last month we put out a discussion document proposing a revised governance model for *Water New Zealand* to meet future representative need. The document was recently posted on our website and sent to members. We invite your feedback.

Lastly we're thinking about how and what we communicate. It can be resource hungry activity, but well done, is always a good investment. ■

Murray Gibb
Chief Executive, Water New Zealand

CHANGING CURRENTS
2013 WATER NEW ZEALAND'S ANNUAL CONFERENCE & EXPO
Claudelands Event Centre, Hamilton 16–18 October

Changing Currents – *Water New Zealand's* Annual Conference Conference Report

Water New Zealand's annual conference opened on the morning of Wednesday 16 October at the revamped Claudelands Event Centre. First up was a Powhiri from local iwi and then the conference attendees were welcomed to Hamilton by recently re-elected Mayor Julie Hardaker.

This was then followed by two full days of policy and technical papers and a successful Forum discussion on the Friday morning. Wednesday had five streams of papers and four on the Thursday. Delegate numbers were high and there were a record number of exhibitors set up in the spacious and airy exhibition hall.

The Opening Keynote was delivered by Professor Robert Costanza, an internationally acclaimed academic and author of numerous publications looking at natural resource use. Professor Costanza's presentation was essentially an overview of the global situation, highlighting areas where resource use and habitat survival were increasingly under threat and, in some cases, at the tipping point.

"All in all, delegates had a choice of some 83 sessions to attend. Included in these on the Wednesday was a dedicated Modelling stream put together by Water New Zealand's Modelling Special Interest Group, and on both Wednesday and Thursday a stream dedicated to operations matters."

Other presenters discussed flooding and the climate, moving to more sophisticated asset management techniques, the Christchurch re-build, and the work of the Waikato River Authority. A particularly interesting presentation, while not specifically addressing water issues, was given by Mike Pohio, CEO of Tainui Group Holdings (TGH). TGH is the commercial arm of the Tainui iwi and is currently involved in a major development project in the Ruakura area. The most significant part of that development involves the construction of a large inland port and distribution centre featuring rail and road links with both the ports of Auckland and Tauranga. The presentation illustrated the increasing role of iwi in the social and economic development of "NZ Inc."

"Social events were again a big feature of the conference and included a Welcome Reception, Modelling Dinner, Operations Dinner, and the Conference and Awards Gala Dinner."

Thursday morning's keynote featured Graham Dooley, President of the Australian Water Association, discussing the rationale for and the outcomes from the various water reforms that have occurred in that country.

Elsewhere delegates could view a wide ranging set of technical presentations covering everything from sludge management to filtration technologies, biosolids research, water metering practice, trade waste charging, raw sewage discharges post the Christchurch earthquakes, the importance of performance reviewing, and an update on the fluoride issue. All in all, delegates had a choice of some 83 sessions to attend. Included in these on the Wednesday was a dedicated Modelling stream put together by *Water New Zealand's* Modelling Special Interest Group, and on both Wednesday and Thursday a stream dedicated to operations matters. Meanwhile, on Thursday the Small Wastewater and Natural Systems Special Interest Group held a management committee meeting.

The Friday Forum featured a useful and thought provoking discussion on iwi rights and interests in water. Tainui was represented by Tim Manukau and he was joined by constitutional lawyers Stephen Franks and John Harbord. It was a reasoned and non-confrontational discussion that hopefully improved peoples understanding of matters that often become shrouded in emotion and misinformation.

This year, for the first time, a smart phone conference app was introduced intended to allow delegates to navigate the conference programme, sessions and social events. Being a "first shot" there were a few teething issues but these will be refined at future conferences.

Social events were again a big feature of the conference and included a Welcome Reception, Modelling Dinner, Operations Dinner, and the Conference and Awards Gala Dinner.

All were well patronised with the Modelling Dinner again featuring the popular quiz session, while the Conference and Awards Dinner included the vivacious and energetic music of the Beat Girls – a little noisy for a number of delegates perhaps but the venue's foyer offered a refuge. But, hey, why not a little change every now and again?

Representatives for the six premier sponsors are (from left to right) – Adrian Hynds – Hynds, Tim Gibson – City Care, Iain Peffers – Downer, Colin Hooper – Applied Instruments, Keith Martin – Veolia and Craig Gilmore – Xylem

"This year, for the first time, a smart phone conference app was introduced intended to allow delegates to navigate the conference programme, sessions and social events."

One notable exception to the general success of the social programme was a less than satisfactory Operations Dinner. We were unfortunately badly let down by the venue organisers but, rest assured, all stops will be out next year to return it to its status of one of the highly regarded conference events.

Thank You

Many thanks go to our premier sponsors, session chairs, presenters, and the technical committee, who all go to ensure a successful conference for the delegates and exhibitors. And, of course, a special thanks to our conference organisers, Avenues Event Management, who again delivered a relatively seamless and successful event.

We look forward to seeing you all again in 2014! ■

Peter Whitehouse, Water New Zealand

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Top row – left to right: Orica Operations Prize – Steve Couper, Graeme Colquhoun and Russell Dean; AWT Poster of the Year Award – Murray Gibb, Jason Ewert and Robert White; Ronald Hicks Memorial Award – Mark Milke, Peter Browne and Steve Couper; Middle row – left to right: Opus Trainee of the Year Award – Rob Blakemore, John Miles and Steve Couper; Technical Committee – the group; CH2M Beca Young Water Professional of the Year Award – Steve Couper, Simon Mason and Clive Rundle; Bottom row – left to right: ProjectMax Young Author Award – Blair Telfer, Christopher Maguire and Steve Couper; Hynds Paper of the Year Award – Adrian Hynds, Nicky Smallberger, Ian Rabbitts and Steve Couper; Exhibitors – Best Stand Award – Best Stand: IPLEX Pipelines

Water New Zealand Awards 2013

Congratulations to all Water New Zealand award winners for 2013

Orica Operations Prize

Russell Dean – Manawatu District Council

AWT Poster of the Year Award

John McCann, Razin Mahmud, Rosanne Simpson, Robert White and Dave Dixon – *'Backfilling Redundant Pipe Under Critical Rail Infrastructure'*

Ronald Hicks Memorial Award

Peter Browne – *'Overcoming Rotorua Lakes Ecological Challenges'*

Opus Trainee of the Year Award

John Miles – *'Christchurch Wastewater Treatment Plant'*

Technical Committee

Ian Garside (Chair), Rebecca Fox (Deputy Chair), Steve Apeldoorn, Dukessa Blackburn-Huettner, Rob Blakemore, Neal Borrie, Ashish Deshpande, Louis Du Preez, Roly Hayes, Kelvin Hill, Sarah Lothman, Rob Murray, Victor Mthamo, Rob Potts, Kees Swanink, Louise Weaver, Wendy Williamson and Chris Wium.

CH2M Beca Young Water Professional of the Year Award

Simon Mason – Downer

ProjectMax Young Author Award

Christopher Maguire – *'How Too Many Cooks Can Create Solutions – SCIRT Lessons Learnt'*

Hynds Paper of the Year Award

Gold: Ian Rabbitts, Nicky Smallberger and Mike Charteris – *'Conquering Extreme Turbidity'*

Silver: Reuben Bouman – *'Tahuna WWTP – An Innovative Conversion of Primary Sedimentation Tanks to the High Rate Activated Sludge Process'*

Bronze: Christopher Maguire – *'How Too Many Cooks Can Create Solutions – SCIRT Lessons Learnt'*

Exhibitors – Best Stand Award

Best Stand: IPLEX Pipelines

Highly Commended: Streat Control and Pipe & Infrastructure Limited

Other Awards

Modelling SIG Best Paper Award

First: Jessie Watts and Gavin Hutchinson – *'Dynamic Modelling of Pressure Sewerage Systems'*

Second: Louisa Sinclair – *'Dunedin Rural Networks – Wastewater & Water Modelling'*

Best Presentation Award

First: Keith Woolley – *'Strategic Framework for Water Model Development'*

Second: Jeff Mclean – *'Innovative Approach to Fire Flow Assessment for the Christchurch Water Supply Rezoning'*

Wasted on Water

Sam Judd – Young New Zealander of the Year and Founder of Sustainable Coastlines

The other day in the middle of a rather important meeting I excused myself to go to the bathroom. As I dispatched the contents into the wastewater system by flushing the loo, the button from my pants fell into the bowl and disappeared into the wastewater system.

This experience not only made the rest of my meeting really quite embarrassing, but it made me think about where all of the material that we all flush away goes – welcome to the dirty world of wastewater.

Every day, millions of tons of inadequately treated sewage, industrial and agricultural waste enters the world's waterways. Each year 1.8 million children under five years old die because of water related diseases and over half of the hospital beds in the world are occupied because of water-related disease.

The stench of poorly managed wastewater is almost like a keystone indicator of poverty – 90% of all wastewater in developing countries is discharged untreated directly into rivers, lakes or the ocean.

You would think that treating our bodily discharge would be of a high priority. The damage untreated sewage does to the environment, economy and human health is hideous including "dead zones" in the ocean from eutrophication, bans on fishing and swimming and disease.

Globally, the value of the freshwater ecosystems is estimated by academics at over $400 billion USD.

But despite the huge value that our water has there are many places in New Zealand, such as Dunedin where only "primary treatment" is carried out on the wastewater that comes from 126,000 people.

For your information, "primary treatment" just means running the waste through a screen to pull out tampons and condoms – clearly doing nothing for water quality and disease.

> "Globally, the value of the freshwater ecosystems is estimated by academics at over $400 billion USD."

And in Auckland, the Council tells us not to swim for 48 hours after rain and to avoid areas such as stormwater outfalls and stream mouths.

Even since the legendary Auckland mayor Dove-Myer Robinson diverted the wastewater from the Hauraki Gulf to a treatment facility in Mangere in 1960 which the city still uses today, we still have "permanent health warning" signs at several Auckland beaches.

Cox's Bay, The Wairau Outlet, Meola Reef and Weymouth Beach are all supposedly too dirty to ever go near and in Dunedin despite the perfect waves, surfers have to avoid going to Tomahawk Beach for fear of getting sick.

Frankly this is an embarrassment.

Effective monitoring and policy is an obvious one for public wastewater and in some place, like along the Waimea Inlet near Nelson where my dad lives, new developments are forced to install reticulation systems where the sewage is treated so well that potable water comes out.

When you multiply this by all the residents in an area, it will have a significant impact, but industry also has a major part to play and we can influence this through our purchasing choices.

To avoid high labour costs and environmental compliance many manufacturers have exported their environmental water problems to other countries such as China.

The clothes we wear are one of the biggest cultural statements we make every day and some of you may be shocked to see some of the brands that are not up to scratch when it comes to monitoring their supply chains. Even Puma – who have recently been showered with praise for their approach towards sustainability with their chairman Jochen Zeitz being one of the founders of the B Team who are trying to promote sustainable business – have been criticised for contracting companies that pollute the groundwater in China.

Once again, we must look to innovation to solve these difficult problems and start recognising that wastewater is a resource. Even the strongest sewage is 99% water and much of it has not had excrement in it as it has come from the basin or shower.

One simple solution that will help the wastewater challenge and also save you on your water bill is to reticulate the water from your basin into the cistern on your toilet.

Even more promising on a bigger scale is the inspiring Nelson-based Aquaflow Bionomic Group. Their inspiring team is harvesting algae from sewage ponds and using it to create biofuel that is refined enough to use on planes.

The other piece of good news is that the United Nations Environment Program has set up the Global Wastewater Initiative – which will share best management practices and tools that will help communities tackle the challenge of dirty water.

Only time will tell whether these innovations will serve to help us win the challenge of wastewater which is huge and urgent. You can always sew another button onto your pants, but there is no replacement for an area in the ocean that becomes a "dead zone", or for a child who perishes because of dirty water before they have even had the chance to go to school and learn how to look after it. ■

LAST ISSUE OF WATER FOR 2013

This is the last issue of WATER for 2013. Water New Zealand would like to thank all those that have contributed articles, images and ideas over the past year.

The next issue of WATER will be published in March 2014.

If you wish to contribute please contact the editor, Robert Brewer, robert@avenues.co.nz. The themes and deadlines for the 2014 issues will be confirmed in December – check www.waternz.org.nz for more details.

Clean Water Initiative for Low-lying Pacific Islands

Prime Minister John Key has announced a $5 million initiative to help five low-lying Pacific countries vulnerable to water shortages to better manage their fresh water resources.

"For a number of Pacific countries, access to safe, clean drinking water is not guaranteed. Ensuring communities and businesses can access clean drinking water will go a long way to improving people's health and livelihoods," Mr Key said.

"As part of a practical solution, we have entered into a new five-year partnership with the Secretariat of the Pacific Community (SPC) to improve water security in Tuvalu, Tokelau, Kiribati, the Cook Islands and the Republic of the Marshall Islands.

"This project will focus on practical steps such as ensuring gutters are properly connected to storage tanks, maintaining storage facilities and training national water security officers to monitor water levels and help communities be better prepared for water shortages," he said.

Low-lying island nations are particularly susceptible to salt water inundation. The lack of natural catchments, ground water, rivers, streams, and a vulnerability to extreme weather events all compromise these countries' water resources.

"On top of the human and health difficulties, water issues hold these economies back, through everything from crop failures, to the difficulty of establishing tourist industries when they can't rely on a good supply of safe water," Mr Key says.

Funding will go to the SPC and be allocated to activities in each country. New Zealand's Ministry of Foreign Affairs and Trade will help develop implementation plans for each country.

The programme is expected to start within six months, with funding spread across the full five years.

"New Zealand's commitment to improving water infrastructure and management in the Pacific is an important part of our climate change support to the region. We have committed to, and invested more than $40 million over the last three years in a range of practical water related initiatives," Mr Key said.

"At last year's Forum, we announced that New Zealand would work with the Cook Islands and Chinese governments to improve the water infrastructure on Rarotonga. This major project will deliver safe drinking water to all homes and businesses on Rarotonga, the tourist and economic hub of the Cook Islands, by 2015.

"In Kiribati we have helped improve rainwater harvesting and collection facilities, resulting in the total storage capacity on Tarawa and Kiritimati Islands increasing by a million cubic litres.

"New Zealand has also provided emergency assistance following droughts in Tuvalu, Tokelau and the Republic of the Marshall Islands since 2011, and unfortunately low rainfall and limited water infrastructure place these nations at further risk of water shortages.

"We will always be on hand to support our Pacific neighbours when they face challenges such as water shortages. However, the aim of New Zealand's investments in the region and today's announcement is to help communities better manage their water resources and become more resilient to the droughts and extreme weather associated with climate change," Mr Key said.

Obituary – David Gladstone Downey 1922 – 2013

David Downey

David Downey, who died on 18 July 2013, was a leader among engineering consultants in Auckland until his retirement in 1987 as the Chairman of Directors of Worley Group Ltd, now part of the international consultancy AECOM.

After being brought up on a remote back country farm near East Cape, he attended school in Napier, leaving Napier Boys High School in 1938 with School Certificate and University Entrance qualifications. He then returned to the family farm at Waitangirua as a shepherd until 1944, except for a short time in 1942 in the Army at Waiouru where he was rejected for overseas service by short-sightedness. Ralph Worley (1890–1965), a celebrated consulting engineer and registered surveyor in Auckland, often holidayed with the Hindmarsh family at Parkia Station not far from the Downey farm at Waitangirua. Understanding David's wish for more company and intellectual stimulus, David's mother asked Ralph Worley if he would take David as an engineering cadet. Early in 1944 he was duly invited to join Ralph Worley's consulting practice in 1944. His first task as a chainman was to run levels for several miles along each side of the Waikato River through Manuka, gorse and scrub along steep river banks for the proposed Lake Karapiro.

The survey work continued until David commenced his engineering studies, starting part-time at Auckland University and finishing his degree at Canterbury University in 1950. Here he was a member of Rolleston House governing council and Secretary of the Students Association Executive committee. On returning to Auckland, he became Ralph Worley's right-hand man taking charge of the design and supervision of many local body water supply and sewerage schemes. These included the towns of Hikurangi, Kaiwaka, Manurewa, Whakatane and Opunaki as well as may others in the Bay of Plenty and Taranaki. Ralph Worley had a reputation for being most approachable for clients at any time, and got on well with everyone. David attributed much of his skill to following Ralph Worley's training and example. David was also known to all as the perfect gentleman.

Ralph Worley was appointed as Engineer to the North Shore Drainage Board in 1951 when the local bodies on the Shore were opposed to a move by the Auckland Metropolitan Drainage Board to take over drainage works on the North Shore. After Ralph died in 1965 David took over his role to lead the programme until his retirement. David's development of North Shore's sewage reticulation and sewage treatment plant led on to further major sewage reticulation and treatment systems in Tauranga, Wanganui and Waitara.

"After retirement in 1987 David and his wife Barbara purchased a 10ha block of land at Kerikeri where they enjoyed growing Kiwifruit, Oranges and Tamarilos."

In 1968 David was invited to join a New Zealand Trade Mission to the Far East, the first occasion a consulting engineer had joined a trade mission. In this year David was President of the Water Supply and Waste Disposal Association and a member of Overseas Markets and Exporting Committee for the National Development Conference. David recognised on his return that in order to compete for overseas engineering work, larger companies were needed. To achieve this he was responsible for the formation of ENEX (acronym for Engineering Export) to involve consortiums of New Zealand companies getting together to bid for World Bank and Asian Development Bank projects. Eventually Worley Downey Muir and Associates, as the firm was then known, were successful in a sewage project at Ipoh in Malaysia. Later in association with Beca Carter there followed highway projects in Malaysia. However the burden of preparing very detailed proposals for overseas work that often came to nothing after significant expense was very disheartening.

During his professional career and after his retirement, David undertook a great deal of voluntary work for various organisations. From 1958 to 1960 he was a member and Secretary of the Auckland Branch Committee of IPENZ. Later from 1969 to 1971, he was the New Zealand Director of the Water Pollution Control Federation (USA) who presented him with a special Service Award. David was Chairman of the ENEX Public Health Consultants Committee from 1979 to 1982 while at the same time being a member of Committee of Association of Consulting Engineers New Zealand. In 1986 he was a specialist Consultant to Asian Development Bank. David was a Member of the Institution of Civil Engineers (UK), a Member Royal Society of Health (London) and a Fellow of the Institution of Professional Engineers of NZ (elected 1979). He was author of "North Shore Main Drainage System, Auckland", published in New Zealand Engineering Volume 17, 1962.

He was a member of the Holy Trinity Cathedral committee during the construction phase from 1968 to 1980 and a member of the Tongariro Park Board from 1976 to 1980. He was a member of Ruapehu Ski Club Committee and Vice President between 1966 and 1975. He was a member of the Vestry, St James Church, Glendowie, Auckland in 1967 and 1968.

After retirement in 1987 David and his wife Barbara purchased a 10ha block of land at Kerikeri where they enjoyed growing Kiwifruit, Oranges and Tamarilos. David became involved in many local organisations in Kerikeri including Probus, Seniornet and helping with children's art exhibitions. After 11 years in Kerikeri, David and Barbara returned to live in Auckland where David became a proficient artist as well as being a founding member and tutor at Seniornet Eastern Bays. Along with Jeffrey Wilson, David was able to complete a history of his company which is soon to be published (2013). ■

Prepared by John La Roche

References

David G Downey "What's the Weather Like: The story of a New Zealand Pioneer Family" Auckland 2004, ISBN 0-476-00592-2

Oral History & Abstract by John La Roche August 2010

Downey D G "North Shore Main Drainage System, Auckland" New Zealand Engineering Volume 17 1962

Fluoride Imperative to Good Oral Health

The New Zealand Dental Association (NZDA) strongly supports community water fluoridation and is encouraging residents to join their local dentists in voting for fluoride to be added to water in upcoming referenda in Hamilton, Bay of Plenty and Hawke's Bay.

NZDA CEO Dr David Crum says that the science on community water fluoridation is well-established. In New Zealand decay rates are approximately 40% lower among children living in areas with community water fluoridation. The safety of this public health intervention has been intensively researched for over 65 years. Research from New Zealand, Australia, Europe, the UK and the USA has consistently found no evidence of adverse general health effects from community water fluoridation provided at optimal levels as practiced in New Zealand. Community water fluoridation costs just 50 cents per person per year. The cost of a single filling is around $130.

"Research from New Zealand, Australia, Europe, the UK and the USA has consistently found no evidence of adverse general health effects from community water fluoridation provided at optimal levels as practiced in New Zealand. Community water fluoridation costs just 50 cents per person per year. The cost of a single filling is around $130."

"Community water fluoridation is effective, safe, affordable and benefits everyone in a community. Those are important success criteria for any public health intervention and the fact that it passes the mark on all these criteria, no matter how you look at it, is hugely beneficial," says Dr Crum.

"This is why the NZDA takes this unequivocal stand in support of fluoridation."

"We encourage those wanting to know more about water fluoridation to check out evidence-based information sources, like the new Ministry of Health Fluoride Facts website" said Dr Crum.

Announcements

2013 – 2014 *Water New Zealand* Board

Congratulations to Kelvin Hill on his election to the Board and to Hugh Blake-Manson on his re-election.

The 2013/2014 Board is:

Steve Couper – President
Hugh Blake-Manson
Adrian Hynds
Kelvin Hill
Brent Manning
Dukessa Blackburn-Huettner

New Water Source for Raetihi Given All Clear

The Ministry of Health has given the all clear for Raetihi residents to use water from a new source after the town's supply was contaminated by more than 15,000 litres of spilled diesel.

Ruapehu District Council chief executive Peter Till said the Makotuku Stream, Raetihi township's water source, is likely to be contaminated for the next three months and perhaps up to a year.

In a recent statement, the council said the Ministry of Health had given the all clear to use an alternative water supply from another source – the Makara Stream.

"It was hoped that soon it would also be suitable for laundry and showering, but not for drinking."

This follows concerns raised by Mr Till that because of previous sawmilling close to the Makara, the council would first need to do extensive testing for harmful compounds, including 1080. A council spokesman said the approval from the Ministry of Health meant water from the Makara could now be used to flush the contaminated water system.

It was hoped that soon it would also be suitable for laundry and showering, but not for drinking.

The spokesman said that long term there may not be enough water in the Makara Stream to meet the town's needs but it was an adequate short term solution.

STORMWATER 2014 CHRISTCHURCH 14 – 16 MAY

Water New Zealand's 2014 Stormwater Conference 14 – 16 May

The *Water New Zealand* Stormwater Group is pleased to announce that the 2014 Conference is coming to the South Island for the first time. The Conference will be held at the new Rydges Hotel, Latimer Square, Christchurch from 14 – 16 May 2014.

The 2014 Conference proper will be held on Wednesday 14th and Thursday 15 May with optional site visits around Christchurch on the morning of Friday 16 May. More information is available on the *Water New Zealand* website: www.waternz.co.nz

The aim of the Stormwater Conference is to provide delegates with an opportunity to:

- Upskill in various areas of stormwater science and management
- Network with peers
- Hear new and cutting-edge stormwater information

The *Water New Zealand* Stormwater Group has again teamed up with the Modelling Group and the Rivers Group, which is the joint technical interest group of IPENZ and *Water New Zealand*.

Themes for the Stormwater Conference include:

- Catchment Management Planning
- Stormwater Treatment, Quality and Monitoring
- Flooding Hazards and Damage
- Emergency Planning and Recovery
- Stormwater Management
- Water Resource Management
- Stormwater Design
- Low Impact Design
- Asset Management
- Landscape Planning & Engineering
- Innovations in Stormwater Maintenance
- Christchurch Infrastructure Recovery
- Stormwater Modelling
- River Management
- River Modelling
- Canterbury Rivers
- Technology
- Regulation and Legislative Controls

WATER is pleased to reproduce this paper in its Annual Conference edition as the winner of the Hynds Paper of the Year Award – Ed.

Conquering Extreme Turbidity

Mike Charteris – Hauraki District Council; Iain Rabbitts and Nicky Smalberger – Harrison Grierson

Abstract

The Kerepehi Water Treatment Plant is subject to extreme turbidity (1700 NTU +) caused by King Tides in the Hauraki Gulf and low river flows. This paper looks at the technology selected to deal with this extreme turbidity as well as methods for reducing the impact, and recounts the first two King Tide events to hit the plant after commissioning.

This paper will look at the technology selection process, the options considered and will build upon last year's paper "King Tides – A Royal Problem" by Nicola Brown, Harrison Grierson (2012). It will examine how the existing plant and originally proposed upgrade was unsuitable for the raw water conditions. It will also provide an in-depth and detailed assessment of two different technologies and explain how a saving of over $3 million dollars was achieved on the initial estimates.

The paper will focus on the close collaboration between Hauraki District Council and the design engineers at Harrison Grierson and how investment and the beginning of the project led to savings being achieved in the final designed delivered to the client.

The project has produced a plant that has exceeded the expectations of the designers and Hauraki District Council. During the one-in-70-year drought over the summer 2012/13, water supply did not restrict milk production as it may have done many summers past.

Keywords

Water Treatment, Membranes, Clarifiers, Turbidity Removal

1. Introduction

The Kerepehi Water Treatment Plant was originally constructed in the 1960s to supply water the Hauraki Plains Scheme and is key infrastructure in the region, supporting the significant local dairy farming. The plant originally consisted of coagulation followed by two blanket clarifiers and two sand filters. In the late 1990s one of the blanket clarifiers was converted into an absorber clarifier. This clarifier worked well when the turbidity was below 20 NTU. However, at higher turbidities, the absorber clarifier ended up in perpetual backwash leading to heavily restricted water production and intensive operator input to keep the plant running.

The raw water source – the Waihou River – not only suffers from freshes in the way rivers normally do after heavy rainfall but also from the King Tide effect. The causes and effects of King Tides at the Waihou Pump Station are clearly described in Nicola Smalberger's (nee Brown) 2012 paper, "King Tides – A Royal Problem" and are not repeated here other than to reiterate that the river turbidity can exceed 2000 NTU. The confounding factor of these events is that they occur during dry periods when demand is at its highest.

The main focus of "King Tides – A Royal Problem" was the avoidance of extreme turbidity events reaching the plant. This was achieved by stopping pumping at the peak of the tide, when the turbidity was worst, and pumping at a higher rate as the tide dropped. This reduced the treatment requirement for incoming turbidity to about 700 NTU.

2. The Design Process

2.1 Initial Cost Estimates

The upgrade initially proposed was to build an additional absorber clarifier and more sand filters. Hauraki District Council (HDC) had been advised that the capital cost of this upgrade would be approximately $13–15 million. This solution would have allowed a plant capacity increase bud did not solve the problem of the poor performance of the absorber clarifiers in high turbidity conditions.

"The paper will focus on the close collaboration between Hauraki District Council and the design engineers at Harrison Grierson and how investment and the beginning of the project led to savings being achieved in the final designed delivered to the client."

2.2 Optioneering

Harrison Grierson had a brief discussion with HDC regarding the utilization of the Actiflo process by Veolia to treat the high and extreme turbidity experienced in the Waihou River. Anestimate was produced of around $13 million utilizing this process. At this stage Harrison Grierson were engaged to design a 12.5 Mld upgrade of the plant (from the nominal 6.25 Mld) based upon the Actiflo process. The objectives of the upgrade for Hauraki District Council were:

- To provide a reliable and robust plant capable of continuously producing 12.5 Mld of treated water
- To make the plant more resistant to high turbidity events
- To comply with the Drinking Water Standards of New Zealand 2005 (revised 2008) and in particular to increase the WTP's disinfection rating to 5 log for protozoa

An intense period of optioneering around the layout, hydraulic profile and various configurations was then started. These investigations included:

- Re-pumping from the Actiflo plant to the existing filters
- Placing the Actiflo on top of the existing clarifiers
- Re-using the existing clarifiers and retrofitting with Actiflo
- Retaining the existing plant and installing a smaller parallel Actiflo plant (6.25 Mld) and a new filter
- Installing a completely new Actiflo plant and sand filter system

In all, 10 different options were evaluated, combining and comparing re-use of existing plant with new process units. A high level costing was undertaken for each option and a multi-criteria analysis was carried out to select the preferred option. The top three options were then further analysed to produce the preferred option going forward. About this time, Harrison Grierson put forward an alternative option of converting the existing clarifier shells to tube settlers (to increase throughput) and installing a membrane filtration plant. Two further options were then considered, converting the clarifiers and installing a 12.5 Mld membrane plant or leaving the existing treatment plant and integrating a new 6.25 Mld treatment plant.

As part of the preliminary design phase, a visit was arranged to Oropi Road WTP (36 Mld Siemens Pressure Membrane System) in Tauranga for the operators and engineers of HDC. This visit let them get a feel for the technology and quiz the operators about the performance of the plant. However, some of the operators remained unconvinced at this point.

After the production of the preliminary designs, the process technology package was put out for tender – Actiflo to Veolia and the membranes to Siemens, Pall and GE. Of the membrane suppliers, Siemens were the least expensive although the pricing was very tight. Whole plant costs were then compared between the membranes and the Actiflo plant.

As Hauraki District Council was interested in whole life cost and not just initial capital cost, a 20 year Net Present Value (NPV) was carried out on both the Actiflo and the membrane offers. The two figures for the 20 year NPV were so close it was inconsequential (<0.3%). The operating costs for the membrane also included the costs for a service agreement with Siemens. It was understood by all parties that both technologies would provide the treatment quality required and therefore the selection was based on the falling cost of membranes (albeit the rate of fall has slowed over the past few years) and that this was not accounted for in the NPV costs. Additionally, the membrane option had the lower capital cost of the two options.

The initial concept designs and options studies were started in April 2010 and the technology supplier selected in February 2011. This optioneering process took a significant amount of time and effort by all parties involved and was comprehensive in examining all the possibilities, even the less likely ideas. The preliminary cost estimates for the plants showed a capital saving of between $1.5 and $5 million. Given the initial savings identified by the preliminary design report cost estimate, the time and effort spent up front was already showing a significant value.

2.3 Detailed Design

Once the above decision was made and the membrane supplier appointed, the detailed design commenced.

There were two major design issues to be overcome:

1. The ground conditions in the Kerepehi area are very poor with the ground water level being about half a metre below ground level in the winter
2. The structural integrity of the existing buildings and clarifiers was unknown. The existing buildings had to achieve 67% of the New Building Standard (NBS) as they are regarded as critical infrastructure by HDC

2.3.1 High Ground Water

Given that the ground water was so high, the major problem was how to backwash the membranes without putting a deep waste tank in the ground. The solution was to design a shallow tank below the floor of the membrane building (not more than 1.5 metres deep) that had the capacity for the backwash water and the clarifier sludge. This avoided excavating into the groundwater table but the structural engineering required to achieve the loadings in the building was challenging and involved the construction of significant floor beams in the tank. There were two tanks built underground:1) the CIP neutralization tank, and 2) the backwash and clarifier sludge tank. The second tank was divided so that the backwash water could be separated from the sludge tank , should wash water recycling be considered in the future.

2.3.2 Structural Integrity of the Existing Buildings

Hauraki District Council had good records of the original buildings and a detailed structural analysis of the buildings showed that compliance with 67% of the NBS was already achieved. This meant that no additional strengthening was required.

The clarifier information was lacking and therefore core samples were taken from the part of the clarifiers not currently in use. These cores showed the concrete and reinforcing-bar to be adequate and in good condition with no additional strengthening required.

2.3.3 Other Design Issues

In terms of design, there were no other major issues to overcome, although the proposed layout did require the demolition of two small reservoirs on site. The key points of the design were:

- Integration between the balance of plant design and the membrane plant
- Foundations for new structures (flocculation tanks) and settling of new structures
- Structural integrity of the raw water storage tank
- Maintaining the plant flow during construction and commissioning, particularly when re-using equipment for a new purpose (transfer pumps)
- Gravity flow during normal operation with pumped assistance during King Tides
- Re-use of existing plant and structures (filters became membrane feed tanks)
- And no chlorine contact time available on site

3. Final Plant Design

The following schematic shows the overall plant process selected to meet the project objectives.

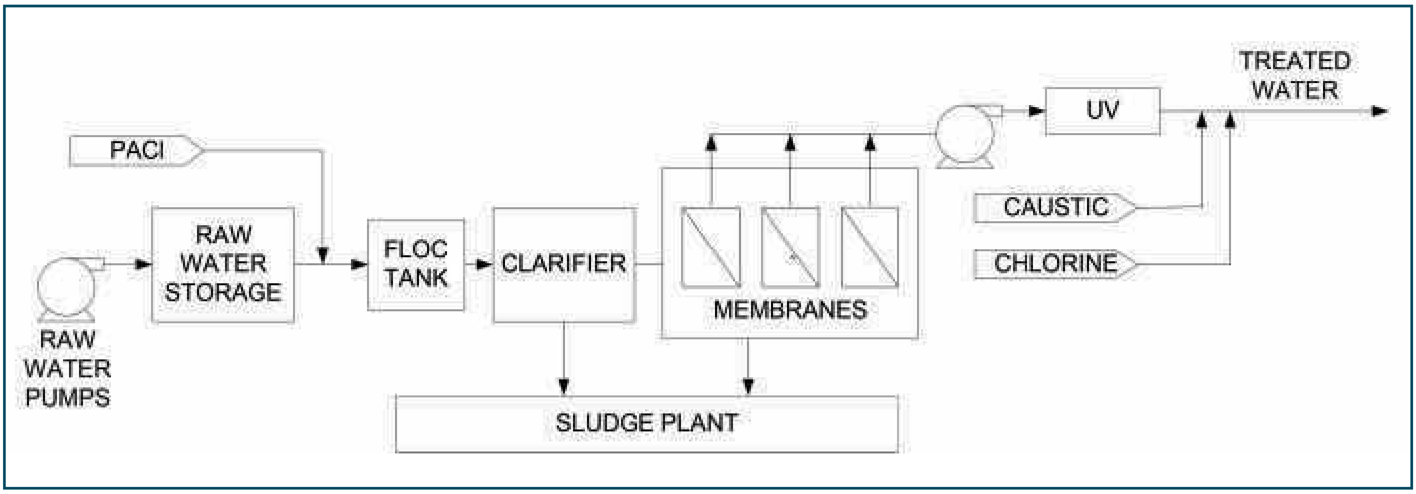
The inlet to the plant and the control of the raw water storage have been addressed in Nicky Smalberger's (nee Brown) paper, "King Tides – A Royal Problem" and are not repeated here.

This plant had some key differences in philosophy from the pre-upgrade plant.

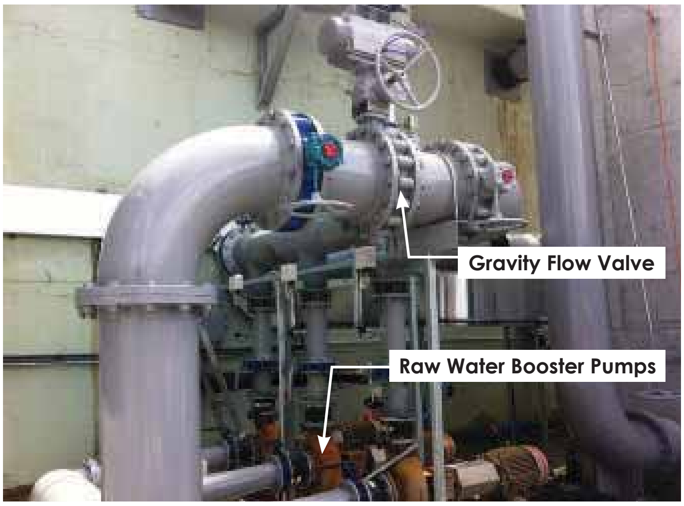
3.1 Gravity Flow

The first major change was that the hydraulics of the plant from the raw water storage tank. Under normal conditions, with the raw water storage tank at high level, it was possible to gravity flow from the raw water tank to the plant. However, if the raw water tank level reduced due to a King Tide event, then pumping was still required. This required a carefully designed system that could automatically change from gravity flow to pumped flow, whilst not causing cavitation on the pumps due to a low pumping head and the re-use of the existing pumps. The reduction in pumping costs produces a saving for Haruaki District Council over the original philosophy. The photograph below shows the arrangement of three duty pumps and a bypass gravity system.

Figure 1 – Kerepehi Plant Schematic



Photograph 1 – Raw Water Booster Pumps and Gravity Flow Valve



3.2 Flash Mixing and Flocculation

The second difference was the flash mixing of coagulant and the separate flocculation tanks. The pre-upgrade design relied on the use of polymer to enhance flocculation for the existing blanket clarifier and was required as a principle of operation for the absorber clarifier. Given that tube settlers have no integral flocculation zone, separate flocculation is required.

Jar testing of the raw water indicated that the use of polymer had little or no effect on the size and settle-ability of the floc. Therefore by moving to tube settlers, there was the initial disadvantage of the additional flocculation towers but the advantage of potentially removing polymer from the dosing stream completely. As shown in the schematic above, the plant was designed without polymer but with the ability to add it at a later date if required. At the time of writing (August 2013), polymer has still not been used in the upgraded plant.

Photograph 2 – Flocculation Tank Mixers

3.3 Re-use of Existing Structures

The main items to be re-used were the existing building for chemical storage and dosing, the existing clarifiers (converted to tube settlers), the existing filters being used as the membrane feed tanks and the existing clear water tank becoming the clarifier to waste tank. The majority of the existing structures were used with only minor modifications. In most cases, this consisted of adding an outlet pipe and valving. In the case of the clarifiers, significant internal modifications were made; however, the existing shells were largely untouched.

3.3.1 Clarifiers

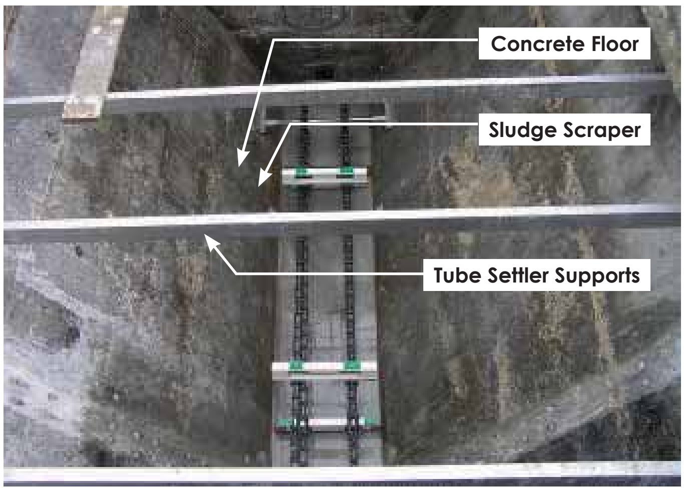
The existing clarifiers had originally been two blanket type clarifiers approximately 11 metres long by 5.5 metres wide. In the early 1990s, one of the clarifiers had been converted into an absorber clarifier by halving the length of the clarifier – with a cast in-situ concrete wall – and installing the necessary mechanical equipment.

Whilst the original blanket clarifier performed well within its design limits, the absorber clarifier did not perform well with turbidities over 20 NTU without constant manual intervention. Both clarifiers were converted in this upgrade to horizontal flow tube settlers.

Photograph 3 – Original Clarifiers

To ensure the plant could continue to treat water during the upgrade, the blanket clarifier was decommissioned and upgraded first, leaving the absorber clarifier to take the full plant flow. The upgrade involved removing all the internals and pouring a concrete base in the bottom of the 'V' of the clarifier (see photo below). A sludge scraper was then installed to scrape the sludge to the inlet end of the clarifier.

Photograph 4 – Clarifier Concrete Floor and Sludge Scraper



Once the first clarifier had been completed and commissioned, the absorber clarifier could be decommissioned and upgraded.

3.3.2 Filters

The existing sand filters served as a water tank with a top water level sufficient to drive the clarified water through the pre-screens and into the membrane cells. The only modifications to the filters were removing the old media and installing a new clarified water outlet to the membrane pre-screens. The photo below shows the new outlets and the pre-screens as installed.

Photograph 5 – Membrane Pre-screens

3.4 New Plant and Structures

A new building was constructed to house the new membrane plant and the new UV disinfection system. As discussed above, the membrane plant and building was to be built over the sludge/backwash and CIP neutralization tanks. Each of these tanks were about 70m³ with a maximum depth of about 1.5 metres. The photo below shows the construction of these tanks. The depth of the tanks is clearly indicated by the men standing inside them.

The new building housed not only the membrane plant (including the CIP chemicals and the UV disinfection) but also the electrical room, control room, locker and shower facilities for the operators, and a meeting room.

"The new building housed not only the membrane plant (including the CIP chemicals and the UV disinfection) but also the electrical room, control room, locker and shower facilities for the operators, and a meeting room."

The membrane plant is a Memcor submerged membrane plant consisting of three cells, each with 144 membrane modules, and has a capacity of 12.5 Mld output. The feed for the membranes was clarified water from the converted filter tanks via the pre-screens to the membrane cells. The hydraulic head available to drive the water through the screens to the membrane cells was approximately 4.8 metres. This achieved two goals: 1) to refill the membrane cells quickly after backwash; and 2) to provide sufficient head to drive through the pre-screens. This available head was a result of re-using the existing clarifiers and filters to feed the membrane plant installed at grade.

Photograph 6 – Construction of the Sludge/Backwash and CIP Tanks

Photograph 7 – Membrane Cells

3.5 Final Plant Cost

The final plant cost inclusive of all internal HDC and external costs was approximately $10.2 million dollars. This cost was within 2% of the preliminary design cost estimate and approximately $3–5 million less than the initial concept costs. Again, it highlights the significant savings that can be achieved through thorough concept analysis, which far outweigh the time spent in the optioneering phase.

4. Plant performance in Extreme Turbidity

Two of the key requirements of the plant was to produce 12.5 Mld and provide resistance to high turbidity events. Clearly the primary method of achieving this goal is to avoid, as much as possible, those high turbidity events. As described in "King Tides – A Royal Problem", the high turbidity events correspond to periods of low rainfall, high demand, low river levels and a King Tide in the Firth of Thames. The plant was initially commissioned in December 2012 at the start of the drought and continued to run throughout this period.

4.1 Extreme Turbidity Event January 2013

In January 2013, the first King Tide event occurred with turbidity in the river exceeded 1000 NTU. As designed, the raw water pumps on the Waihou River shut down at 500 NTU (the setpoint at the time) and remained off for approximately four hours. Over that time the plant was fed from the raw water tank and the tank level dropped. When the turbidity dropped back under 500 NTU, the raw water pumps restarted at a high rate to replace the water used from the raw water tank in eight hours. The tank was filled as expected. Throughout the entire event, the plant maintained an output of 12.5 Mld. The changeover from gravity to pumped flow at the plant was seamless and the clarified water turbidity never exceeded 1 NTU.

4.2 Extreme Turbidity Event February 2013

The second high turbidity event occurred from Monday 11th February to Wednesday 13th February 2013. The predicted tide height in the Firth of Thames was 3.5 metres and the Hauraki District was in the grip of the worst drought for 70 years. Very high turbidities were expected in the Waihou River. As shown in the photograph below, the high tide occurred as predicted and almost submerged the intake structure.

Photograph 8 – Waihou Intake February 2013

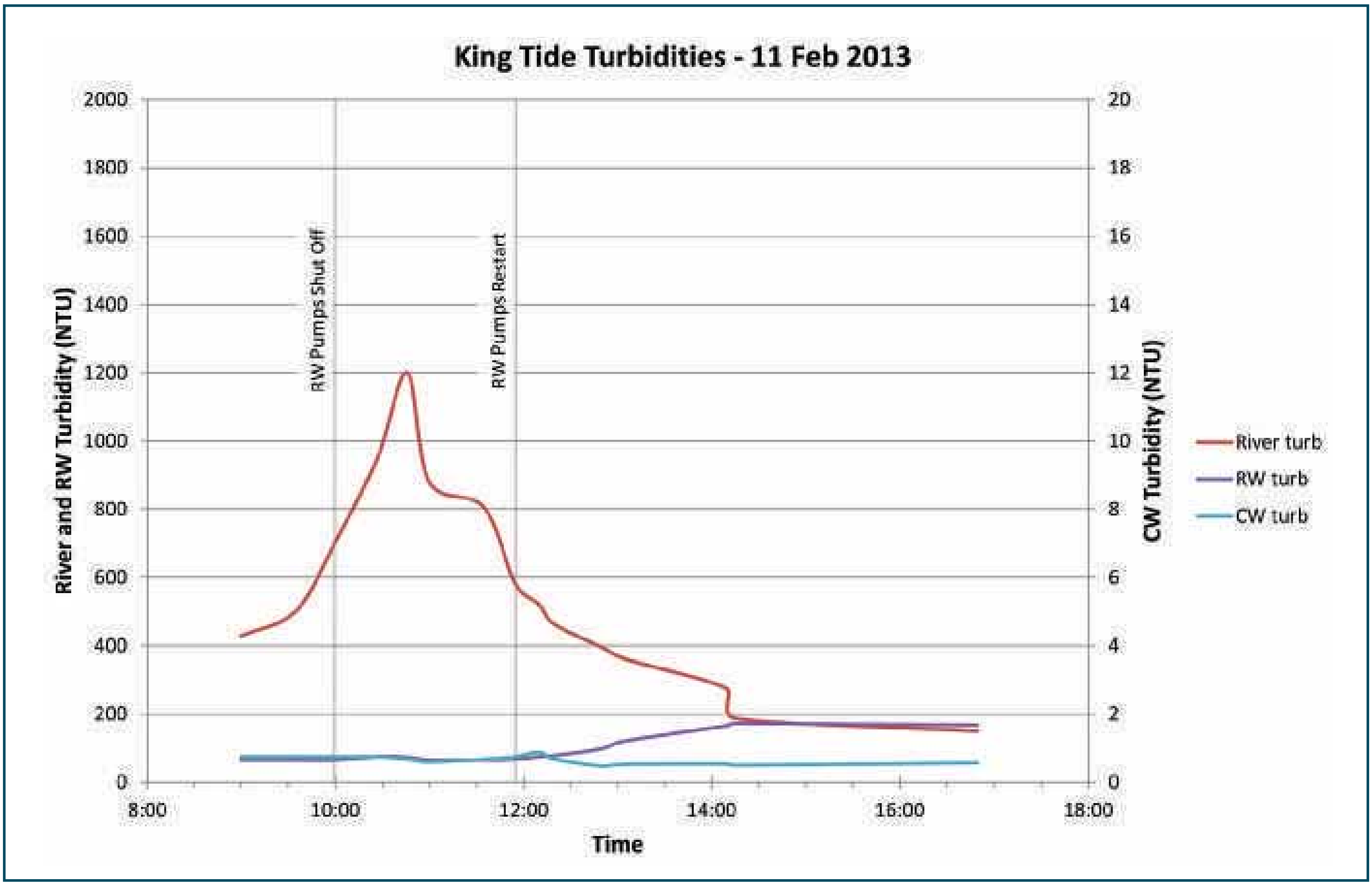


Figure 2 – King Tide Event 11th February 2013

4.2.1 February 11th 2013

The idea of the trial was to challenge the plant with high turbidity. The turbidity rose as expected with the peak turbidity in the river at about 11:00am being about 1200 NTU. The raw water pumps switched off at approximately 10:00am when the river water turbidity exceeded 700 NTU. The raw water being fed from the raw water tank peaked at about 170 NTU but the trend was severely flattened out as expected by the buffering effect of the raw water tank.

The raw water pumps were restarted at approximately 11:45am. The level in the raw water tank dropped to a minimum level of 78% from the starting point of 91%. Figure 2 below shows the turbidities into the plant and from the clarifier. What is interesting is that the clarified water turbidity does not vary over this time.

4.2.2 February 12th 2013

High tide in Auckland was predicted to occur at 09:47am on Tuesday 12th February. Peak turbidity was reached at approximately 11:30am at the Waihou intake. Given that the previous day, the maximum turbidity recorded into the plant was approximately 170 NTU, the decision was taken to bypass the raw water tank and pump water direct from the river into the plant inlet. Due to the need to be able to desludge the raw water tank, this facility had been programmed into the software. However, the intention had been to use this facility at times when the river was clean and allow the plant to treat river water. It did provide the function that allowed us to put extreme turbidity directly into the plant without filling the Raw Water Storage Tank with high turbidity water.

The decision to by-pass the raw water tank was taken only when it became apparent that the raw water in the storage tank was not likely to exceed the readings of the previous day. In preparation for this bypass, a sample of river water was taken and a jar test performed to select the optimum coagulant level. The Raw Water Storage Tank (RWST) bypass valves were then opened and river water turbidity fed into the plant. The raw water entering the plant peaked at around 925 NTU for a short period. Figure 3 below shows the turbidity results for the day. Again, the clarified water turbidity was not affected.

“It did provide the function that allowed us to put extreme turbidity directly into the plant without filling the Raw Water Storage Tank with high turbidity water.”

After the success of this trial it was agreed that the Raw Water Storage Tank would be by-passed for the full period of the tidal effect the next day.

4.2.3 February 13th 2013

High tide on the Wednesday was approximately 10:35am. By the time the jar testing had been completed, the by-pass was not opened until 11:55am. The graph below shows the turbidity traces from the river, the raw water into the plant and the clarified water turbidity.

There are a number of interesting areas to address in the graph above. The first is the problem of the raw water turbidity meter at the plant having a range of 0 to 1000 NTU. The dotted line is a best guess at the turbidity that actually came into the plant, estimated at over 1400 NTU. The second issue is the delay between the turbidity reading in the river and the turbidity reading in the plant (in the order of two hours). This can partially be attributed to the transit time in the raw water pipeline which is approximately five kilometres long.

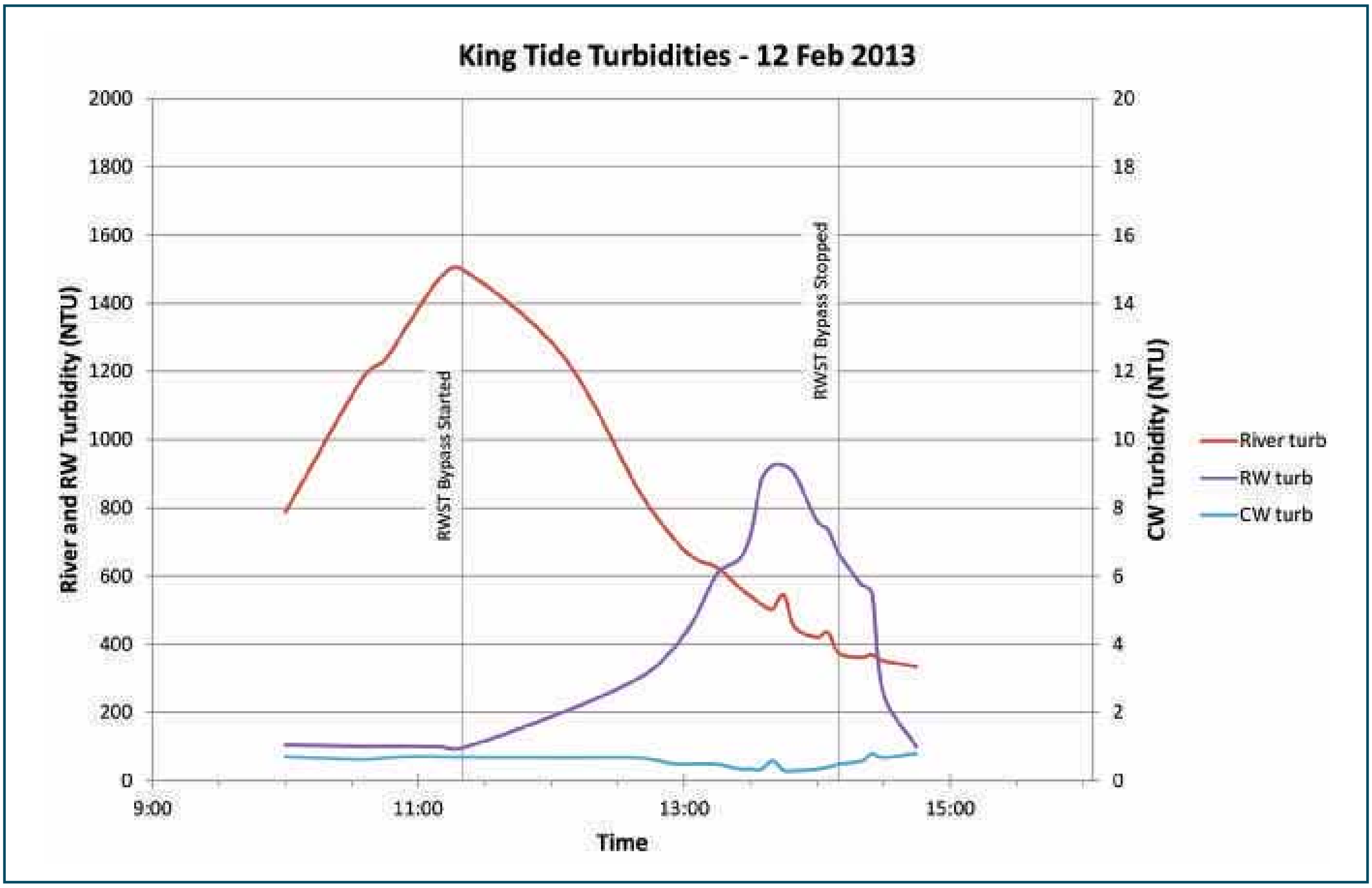
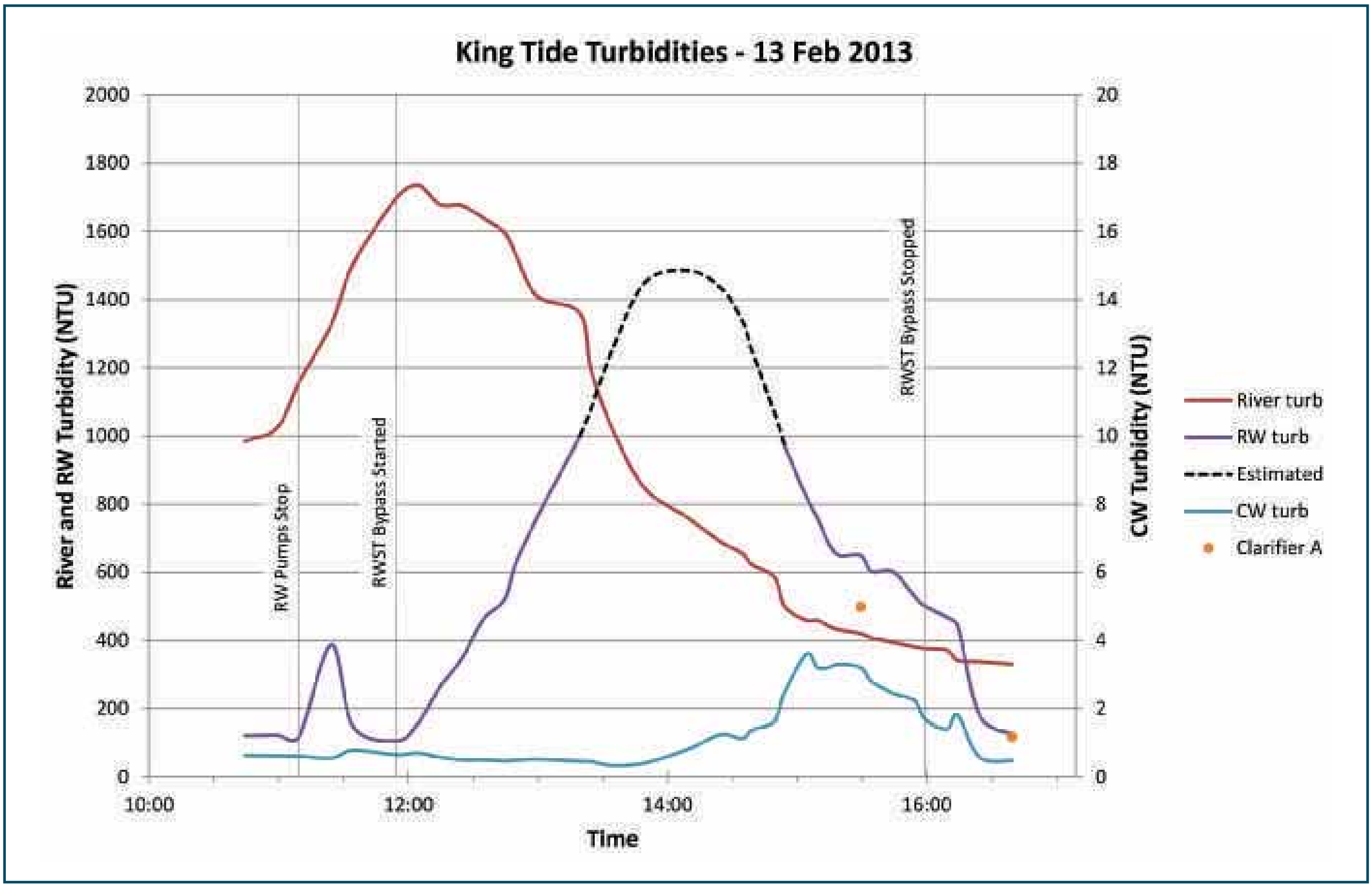


Figure 3 – King Tide Event 12th February 2013

Figure 4 – King Tide Event 13th February 2013



Photograph 9 – Clarifier Inlet February 2013

During this event, the turbidity into the plant exceeded the design inlet conditions of 700 NTU for approximately two hours. The clarified water turbidity was mildly affected and rose to approximately 5 NTU on one of the clarifiers. Given that what was being put into the clarifier was roughly the same as the sludge normally discharged, the ability of the clarifiers to remove the sludge was compromised. The design had been for a certain solids loading and the plant was treating roughly double that amount. Solids were building up in the clarifier despite the frequency of desludges and the duration being increased. It was of interest that at the time of the turbidity spike, sludge was seen by the commissioning engineer coming out the tubes at the far end of the clarifier, possibly indicating that the sludge scraper had been over-loaded and unable to remove the amount of sludge produced in the clarifier sufficiently quickly.

4.2.4 Membrane Plant Performance

During the King Tide event in February, the membrane supplier was on site monitoring the performance of the membrane plant. During the whole period, the membrane plant feed did not exceed 5 NTU from the clarifiers. The report produced by Mason's Engineers says, "After reviewing the Memlog trends for the period between the 10th and 13th Feb, we can see little or no effects of this at the membrane plant".

There was certainly no filtered water turbidity spike and no real change in trans-membrane pressure (TMP). The intention was to challenge the membrane plant with this event but the performance of the upstream processes exceeded expectations to the extent that a turbidity breakthrough of the clarifiers was achieved only so far as 5 NTU – not really a challenge for the membranes.

4.3 Performance Throughout the 2013 Drought

The plant continued to produce 12.5 Mld throughout the 2013 drought and successfully protected the dairy farming in the Hauraki district against the worst of the drought. Just by producing an additional 3.5 Mld, it has been calculated that this enabled an additional $11.5 million in milk production for the region. This number does not make any allowance for the times when the previous plant would have had to shut down due poor water quality.

5. Conclusions

There are many areas where this project exceeded expectation. However, there are four key lessons to come from this process.

The first major item of note is the amount of time and effort spent in the examination of options. Clearly this time had a major impact on the duration of the project and at times ideas that seemed unlikely to proceed were pursued. However, it is worth noting that Hauraki District Council has a group of consumers who have been involved in the Plains Water Supply for – in some cases – over 50 years and take a healthy interest in the development of the supply. These consumers want to see the best use of resources and maximisation of the existing asset. As such they need to be convinced that all options, no matter how unlikely, have been investigated and discussed. This investigation of all options provided a capital saving to Council of approximately $3–5 million and a preliminary design estimate to within 2% of the final cost. It is therefore hard to argue with the approach adopted by Council and Harrison Grierson.

The second item is how and when to re-use existing structures and processes. There was a great deal of time spent on looking at re-using the existing filters. The problem with the filters was that they needed significant upgrades (filter to waste, improved backwashing, conversion to flow control, etc) to meet the current standards and best practice for sand filtration. So whilst the filters seemed like a valuable asset, the value of the asset was in the filter shells only. These shells were eventually re-used as membrane feed tanks. In another example, the clarifier shells having a length to width ratio of approximately 2:1 were ideally suited to conversion to tube settlers.

In terms of plant performance, the plant was designed to avoid the extreme turbidity events and has been demonstrated to do so effectively, making up the water in the Raw Water Storage Tank when the turbidity drops very effectively. However, the plant was challenged with an extreme turbidity event and treated the water successfully for the duration of the event. From the data, it could

"In terms of plant performance, the plant was designed to avoid the extreme turbidity events and has been demonstrated to do so effectively, making up the water in the Raw Water Storage Tank when the turbidity drops very effectively. However, the plant was challenged with an extreme turbidity event and treated the water successfully for the duration of the event."

be argued that the plant could not sustain the performance if the event had lasted longer. The major issue that the plant had with extreme turbidity was the removal of sludge from the clarifiers. When the water coming in has the turbidity equal to the normal sludge stream, then continuous desludging may be required. The other major problem was the capacity of the sludge scraper being able to remove the sludge from the far end of the clarifier quickly enough. If the turbidity event had been sustained, the design capacity of the sludge scraper would have had to be increased to cope with the higher solids load. Given that the plant was designed to cope with a peak turbidity of 700 NTU over a series of tides, the plant performed well beyond expectations when more than double that turbidity was taken from the river.

The last major and perhaps most important result of the project and the King Tide testing was that the operators are not only happy with the plant but have confidence in its ability to treat all the possible water qualities in the source water. The resistance to membrane technology is gone and HDC are now actively developing membrane technology upgrades for two further plants, Waihi and Paeroa.

The close co-operation of Hauraki District Council and Harrison Grierson during the Kerepehi WTP optionioneering and design was a long process that:

- Delivered a plant that met the project objectives
  - » To provide a reliable and robust plant capable of continuously producing 12.5 Mld of treated water;
  - » To make the plant more resistant to high turbidity events; and
  - » To comply with the Drinking Water Standards of New Zealand 2005 (revised 2008) and in particular to increase the WTP's disinfection rating to 5 log for protozoa
- Reduced the capital cost of the project by 30%
- Provided water throughout the worst drought in 70 years and enabled an additional $11.5 million of milk production.
- And delivered a plant that the Councillors and ratepayers were proud of. ■

References

Brown, N.; Harrison Grierson (2012). King Tides – A Royal Problem. Paper presented at Water New Zealand's Annual Conference, Rotorua, 24 – 28 September, 2012.

A Further Update on Legislation Amendments and an Analysis of the Horizons One Plan High Court Decision

Helen Atkins – Partner and Vicki Morrison-Shaw – Senior Associate, Atkins Holm Majurey[1]

RMA Reforms

The Resource Management Reform Bill has been halted in its tracks by the withdrawal of support from both the Maori Party and United Future. United Future's Peter Dunne and the Maori Party express concern over the changes to the purposive Part Two of the Act. Mr Dunne's media release claimed that the previously unassailable principle of sustainable development is being replaced by a forceful focus on job-creation which echoes Muldoon's 'think big' policies, and expresses suspicion over a simple 'projects equal jobs' argument – "it is beginning to sound like footsteps down a pathway we have travelled once before."[2]

The Maori Party agree with Mr Dunne that changes to Part Two could undermine the whole purpose of the Act:

"The changes do far more than rebalance the Act to make consenting procedures more efficient. We say the changes to remove emphasis on the 'maintenance and enhancement of the quality of the environment' fundamentally rewrite the Act and put a spanner in the works of the legal system that will take years of litigation to fix up."

Moreover, the Maori Party expressed concerns that the merging of Sections 6 and 7 will undermine the role of tangata whenua as kaitiaki (guardians) to maintain and enhance the quality of the environment.[3] The two parties have written to Environment Minister Amy Adams withdrawing their support. The joint statement of the parties indicated they were open to negotiation on their support, but that they could not back the legislation in its current form.[4]

ACT's John Banks was disappointed at the delay in 'fixing' the legislation. Banks cited the "costly and unwieldy red tape" of the RMA as "stopping investment, growth and jobs." For Banks, "doing nothing is not an option," and he has urged the Maori Party and Peter Dunne to offer some constructive solutions to their reservations rather than to let the Bill languish unpassed.[5]

Reactions to the Reform Bill have been mixed. Early in the discussion stages of the Reform Bill, the Parliamentary Commissioner for the Environment warned that the RMA "is not, and should not become, an economic development act."[6] However Business NZ has defended the reforms, claiming that the RMA is not effectively balancing both environmental and development factors. The abandonment of the arguably hierarchical order of the environmental section 6 and the development-oriented section 7 is considered to further the ability of the RMA to balance competing issues, and "to lift our vision of sustainable management up from the minutiae and to what is strategically important." Chief Executive Phil O'Reilly further noted that there are sound appeal processes "if a good balance isn't achieved." [7] Federated Farmers NZ also support the Bill, considering that "without [a robust cost-benefit analysis]...the RMA was increasingly trending towards perfection as a benchmark and that is as unaffordable as it is unobtainable."[8]

"The changes do far more than rebalance the Act to make consenting procedures more efficient. We say the changes to remove emphasis on the 'maintenance and enhancement of the quality of the environment' fundamentally rewrite the Act and put a spanner in the works of the legal system that will take years of litigation to fix up."

Sir Geoffrey Palmer QC noted in an opinion for the NZ Fish and Game Council that while the 'process-oriented' changes will improve the system with little negative impact on environmental protection, "the proposed changes to Part 2 will significantly and seriously undermine environmental protection under the RMA."[9] The Environmental Defence Society endorsed Sir Geoffrey's opinion, and welcomed the withdrawal of support of the Maori Party and United Future, claiming the changes to Part 2 are "simply unacceptable."[10]

Case Note: Horticulture New Zealand v Manawatu-Wanganui Regional Council [2013] NZHC 2492 [24 September 2013]

This case dealt with appeals concerning the legitimacy of Manawatu-Wanganui Regional Council's combined regional policy statement and regional plan – the proposed "One-Plan" (referred to as POP). In part the POP intended to address the consequences of nitrogen leeching into waterways from the use of fertiliser in agriculture. Excess nitrogen can cause eutrophication (the overloading of waterways with nutrients causing growth of algae) and hypoxia (depletion of oxygen which adversely affects fish and animal life). Horticulture NZ and Federated Farmers NZ appealed against a decision of the Environment Court in 2012 which set aside the Decision Version of the POP in favour of the originally notified version – the NVPOP. The Decision Version had reduced limits on nitrogen leaching from intensive sheep and dairy farming, cropping and commercial vegetable growing, which are major industries in the region. The Environment Court rejected the lesser limits, reinstating the NVPOP.

The appellants argued 19 errors of law in the Environment Court decision. The respondent Council, as well as Wellington Fish & Game Council and Manawatu farmer Andrew Day, disagreed, claiming that the wider version of the scheme gives proper effect to s5 of the Resource Management Act (the Act). Kós J delivered a judgment tightly confining the jurisdiction of the High Court as the appellate body from the Environment Court, dismissing the appeals save in one limited respect.

Facts

Following notification of the NVPOP, a hearings panel considered submissions and delivered recommendations that intensive sheep and dairy farming, cropping, and commercial vegetable growing from the 'Land Use Capability' (LUC) nitrogen-limit scheme proposed in the initial notified version of the POP, recommending instead for dairying a "reasonably practicable farming practices" test – the Decision Version. On appeal to the Environment Court, the initial version which placed all four intensive land uses under the original LUC scheme was reinstated. The LUC scheme imposes limits based on a calculation of cumulative nitrogen leaching values, capping the leaching limits at year 1, and thereafter at years 5, 10 and 20.

Held

Nineteen questions of law were posed to the High Court by Horticulture NZ and Federated Farmers NZ. Four were abandoned, fourteen were dismissed, and one half of one was successful. Kós J delivered a judgment which set out the lower Court's reasoning for each questioned decision, as well as finding the High Court's jurisdiction limited to true questions of law.[11]

The one part of the appeal which was allowed related to the definition of 'erosion' in Policy 5-2A(a) of the POP which had required the Regional Council to regulate to prevent any increase in erosion. The EnvC permitted the removal of the words 'any increase in.' Kós J agreed with Federated Farmers that this substantially changed the meaning of the section, so as to widen the scope from human-caused erosion, to include naturally-occurring erosion. The Judge in allowing the appeal on this point required that the words in question be reinserted, or the phrase 'accelerated erosion' be inserted, being a term of art defined as human-caused erosion.[12]

The findings of the Court can be distilled into three categories:

1. **The Environment Court had carefully examined the evidence and was entitled to reach its decision:**

   In response to questions 1, ..., Kós J held that the EnvC had been aware of all the relevant evidence, was permitted to rely on evidence from joint witness conferencing agreements,[13] and had not made errors of law in ...

   Regarding Q1[14], the Court distinguished Man O'War Station[15] in which only passing reference had been made to the original Council decision, holding instead that the Court acknowledged that not all parties had agreed in alternative dispute resolution but the Court had nonetheless paid the changes from the appealed version "exhaustive attention."[16] The Judge considered that a narrow interpretation of the EnvC's jurisdiction under cl 14, Sch1 of the Act was not necessary,[17] and reiterated this throughout the judgment.[18]

   Regarding Q4, Kós J held that the EnvC was entitled to accept the evidence they wished, particularly in the balancing act of an s32 assessment on the practicality and cost effectiveness of requiring parties to achieved resource consent. Kós J reiterated that the standard of appeal was a high one, almost irrationality, and the EnvC came to a legitimate conclusion.[19] Qs 5 and 6 regarding relevant considerations were decided the same way,[20] as were qs 7.[21]

Where interpretation of a policy was disputed, the EnvC had jurisdiction to clarify the interpretation by adding in clearer language.[22]

"Regarding an argument that the POP did not give effect to the National Policy Statement on Freshwater Management (NPSFM), Kós J held that due to the preparations for the plan having begun in 2007, and the NPSFM coming into force in 2011, implementation where 'practically reasonable' did not require implementation before 2014."

Regarding an argument that the POP did not give effect to the National Policy Statement on Freshwater Management (NPSFM), Kós J held that due to the preparations for the plan having begun in 2007, and the NPSFM coming into force in 2011, implementation where 'practically reasonable' did not require implementation before 2014.[23] However, the Judge noted that if the Council were to fail to give effect to the NPSFM in future, parties could seek declaratory relief or judicial review at that point.[24]

2. **The Environment Court had jurisdiction to make its decision as long as a submission to the Court had raised the issue to which the decision related**

   Regarding Q2,[25] Kós J held that the EnvC was entitled to permit the Council to add into the POP a 'deposited sediment limit,' as although the earlier versions of the POP had not included such a reference, three factors brought it within the EnvC;'s jurisdiction under Sch1, RMA:

   a. It was responsive to the core monitoring responsibility of the Council under s35(2);
   b. It was responsive to submissions by Fish & Game in support of the inclusion; and
   c. It was not evidently causative of prejudice to any party.[26] This reasoning was repeated throughout the judgment, firstly relying on the no prejudice prong,[27] and secondly regarding jurisdiction as stemming from a concern raised in submissions.[28]

3. **Simple rejection of points of appeal on the facts:**

   Kós J rejected the arguments put forward under questions 9 and 10 as not disclosing the effect alleged by the appellants. The difficulty ascribed to a generic reference to a computer modelling system, OVERSEER, which operates in specific versions, was held to be overstated as the Code of Practice included in the regime could assess the sufficiency of any one version.[29] Additionally, the claim that OVERSEER was a system to be applied to pastoral land use, and inappropriate for commercial vegetable growing was rejected as parties agreed that the system could be applied to vegetables effectively, and the argument tended not to advance the intended outcome that commercial vegetable growing not be included in the LUC scheme.[30]

Comment

The decision is thorough, and clearly details the evidential and jurisdictional support for each decision. The appellants have an understandable and tangible interest in resisting limits, but as the case points out through its strict adherence to jurisdiction, it is the Council's prerogative to set these limits, and little the Court can do to change policy at the appeal stage. The decision highlights the distinction between the political submissions process, which provides wide scope for changing proposed plans and expressing views, and the more restrictive judicial process which follows. A reader of the judgment is encouraged to look out for linguistic rarities such as 'bailiwick' and 'apostasy' in Kós J's vocabulary. ■

Footnotes

[1] Our thanks to Phoebe Mason who greatly assisted in producing this article
[2] Peter Dunne Changes to RMA (Press Release, United Future: 1 October 2013).
[3] Maori Party RMA Changes Strike a Rock (Press Release: 10 Sept 2013).
[4] Maori Party RMA Changes Strike a Rock (Press Release: 10 Sept 2013).
[5] John Banks, Doing Nothing on Resource Management Reform is Not an Option (Press Release, ACT New Zealand: 11 Sept 2013).
[6] Parliamentary Commissioner for the Environment Proposed Changes Unbalance RMA (Press Release, PCE: 1 March 2013).
[7] BusinessNZ RMA Reforms Misunderstood (Press Release: 13 Sept 2013).
[8] Federated Farmers NZ RMA Reform Bill Third Reading 'a reform entree' (Media Release: 4 Sept 2013).
[9] Sir Geoffrey Palmer QC Memorandum to Bryce Johnson, Chief Executive Fish & Game (22 May 2013).
[10] Environmental Defence Society EDS welcomes Maori Party and United Future opposition to RMA reforms (Media Release: 11 Sept 2013).
[11] At [28] and throughout.
[12] At [148–159].
[13] Regarding Q3 on the treatment of joint witness conferencing evidence, at [56–64].
[14] The argument that the Environment Court should have considered the sections of the POP which had been altered in negotiations pre-hearing, as they were not unconditionally agreed, at [33].
[15] Man O'War Station Ltd v Auckland Regional Council [2001] NZRMA 235 (HC) at [57] and [67]
[16] At [42].
[17] At [49–52].
[18] Regarding q19 at [173].
[19] At [73].
[20] At [84]; at [85].
[21] At [87].
[22] Regarding q15, at [140–146].
[23] At [100].
[24] At [102].
[25] Whether the Environment Court failed to consider and determine whether it had jurisdiction to include the deposited sediment limit in the POP, at [44].
[26] At [56–57].
[27] Regarding q12 on the jurisdiction of the EnvC to add in a policy, at [128].
[28] Regarding q18 [160–172].
[29] At [115].
[30] At [119–120].

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Tahuna WWTP – An Innovative Conversion of Primary Sedimentation Tanks to the High Rate Activated Sludge Process

R. W. Bouman and H. E. Archer – CH2M Beca Ltd, B Turner – Dunedin City Council

Abstract

CH2M Beca Ltd was engaged by Dunedin City Council (DCC) to undertake the concept and detailed design of Stage 2 of the Tahuna Wastewater Treatment Plant (WWTP) Upgrade. The population served is 120,000 and the peak wet weather flow is 4,000L/s. Prior to the Stage 2 upgrade, the WWTP consisted of primary sedimentation and chlorine disinfection. The Stage 2 upgrade to secondary treatment was required to improve the effluent quality and allow ultraviolet light (UV) disinfection to replace chlorination.

The liquid stream upgrading included the new processes of Grit Removal, and High Rate Activated Sludge (HRAS). The length of the existing primary sediment-ation tanks (PSTs) allowed establishment of three zones (grit removal, aeration, sedimentation) using new partition walls and a modified inlet. Conversion of the PSTs included a number of novel approaches such as; converting former sludge hoppers to grit hoppers, rubber-lined grit pumps, suction removal of sludge from rectangular tanks, modification of existing travelling bridge scrapers, coarse screw collection of scum, submerged tube launders coupled with a weir at the sedimentation tank out-let, and very high speed aeration blowers with direct-coupled motors and integral variable speed drives (no gearboxes).

This paper describes the methodology and reasons for selecting the HRAS process, the innovations and other unique features required for the conversion of the PSTs to this process, and how the process has performed.

Keywords

Wastewater treatment, primary sed-imentation, tank conversion, high rate activated sludge process, high speed aeration blowers, grit removal, Tahuna Wastewater Treatment Plant, Dunedin

1. Introduction

1.1 Tahuna WWTP

Dunedin City Council's (DCC) Tahuna Wastewater Treatment Plant (WWTP) serves a population of 120,000 and the design peak wet weather flow is 4,000L/s, making it the second largest treatment plant in the South Island. Recently, the plant was upgraded to improve the effluent quality and enable ultraviolet light (UV) disinfection to replace chlorination.

1.2 Stage 1 Upgrade

The Musselburgh Pump Station delivered wastewater from most of Dunedin to the Tahuna WWTP where wastewater was settled in three relatively large (16 m wide by 75 m long) Primary Sedimentation Tanks (PSTs) housed in a building. Settled effluent was dosed with chlorine (sodium hypochlorite) at a flow measurement flume.

The Stage 1 Upgrade entailed installation of a 1,100m-long Ocean Outfall and Outfall Pump Station to replace a short sea outfall (at Lawyers Head), with work completed in 2009. Disinfected flow could travel by gravity to the Ocean Outfall, or via boost pumps at the Outfall Pump Station during wet weather flows or during outfall flushing. Prior to the outfall is the Papatuanuku Junction Chamber (PJC), which has large rocks in the base to fulfil the Papatuanuku function of "contact with Mother Earth" that makes the discharge of wastewater to the ocean more culturally acceptable.

> "This paper describes the methodology and reasons for selecting the HRAS process, the innovations and other unique features required for the conversion of the PSTs to this process, and how the process has performed."

1.3 Stage 2 Upgrade

The Stage 2 upgrade to secondary treatment was required to improve the effluent quality and enable UV disinfection to replace chlorination.

The liquid stream upgrading involved inlet fine screening with Suboscreens (relocated from those at the Musselburgh Pump Station, which were replaced by coarse screens), Grit Removal, a High Rate Activated Sludge Process (within the former primary sedimentation tanks), Biotransformation Trickling Filters (BTFs), and UV Disinfection – refer Figure 1.

The solids stream upgrading involved gravity belt thickeners and centrifuges at the Tahuna WWTP. Dewatered sludge cake is either combusted in the existing Tahuna incinerator, or transported to DCC's Green Island WWTP which had spare digestion capacity due to industry closures. Some sludge is taken directly to the Green Island Landfill.

1.4 Flow Capacities

Design average flow is 500L/s and maximum flow to the HRAS Process is 2,800L/s (or 5.6 times average flow). Flow greater than 2,800L/s bypasses the HRAS process via an actuated penstock. Flow up to 2,800L/s receives grit removal, HRAS aeration and sedimentation.

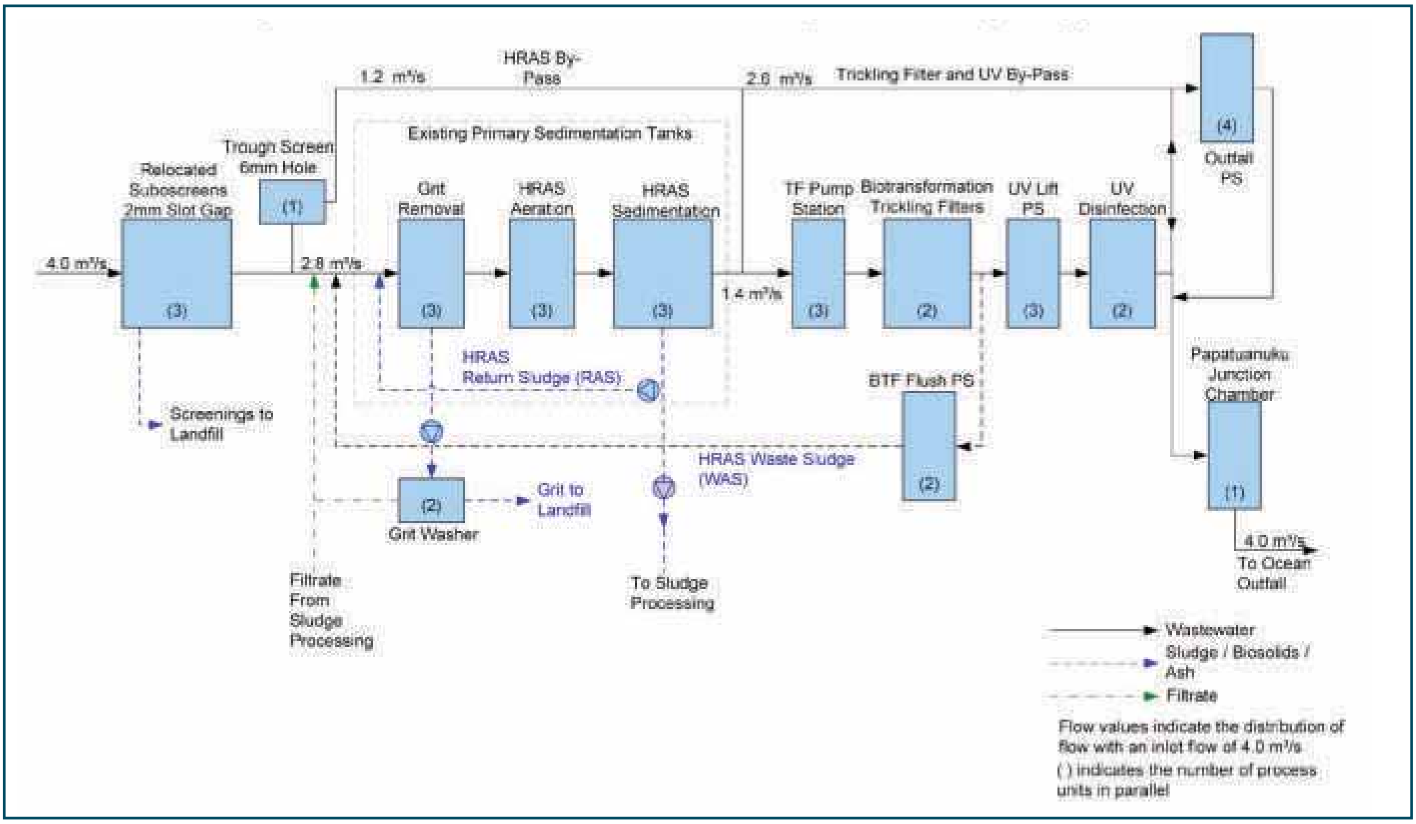


Figure 1 – Tahuna WWTP Process Flow Diagram of the Stage 2 Upgrade

The Chorine Contact Tank is retained as a blind tank to store volume for Outfall Flushing. The existing chlorination system has been retained as a backup if a discharge to the former Lawyers Head Outfall is ever required.

HRAS-treated flow is pumped to the BTFs along with any recirculation flow from the BTFs. Flow up to 1,400L/s is pumped to the BTFs and UV disinfection stage. Flow greater than 1,400L/s is spilled to the Outfall Pump Station. Treated flow from secondary treatment (BTFs and UV) is recombined with the BTF Feed Bypass flow and either passes to the Papatuanuku Junction Chamber by gravity, or is pumped to the Papatuanuku Junction Chamber by the Outfall Pumps.

The Treatment Plant operates in one of three modes at any given time. These are:

- Normal Treatment Mode (minimum night time flow to peak wet weather flow of 4,000L/s)
- BTF Flushing Mode (once daily for each BTF at 375L/s for 40 minutes duration)
- Outfall Flushing Mode (once daily at 3,200L/s for 10 minutes duration)

Each BTF is sequentially flushed for a period of 40 minutes once a day to control the biofilm within the BTFs. The flushing of each BTF is normally undertaken during the late evening or night to avoid conflict with daily Outfall flushing and to coincide with lower influent flow and load. The timing of the BTF flush can be adjusted to select the desired incoming flow conditions for flushing.

The Ocean Outfall is flushed daily to scour settled solids and trapped air. The Ocean Outfall flushing is undertaken mid-morning to coincide with the diurnal peak incoming flow (dry weather conditions Qi of 500 to 800L/s) to assist achieving the desired flush duration (10 minutes) and flow rate (3,200L/s).

The remainder of this paper focuses on the HRAS process. Archer *et al.* (2013) provides a more detailed description of the complete upgrade. Glasgow *et al.* (2013) discusses the BTF aspects of the process.

2. HRAS – an Advanced Primary Treatment Process

2.1 Why HRAS?

Treatment options for the Stage 2 upgrade were analysed extensively. Considering all practical treatment processes, a long list of 29 liquid treatment options was generated. This was reduced to a short list of nine options for more detailed analysis. These options were evaluated on a quadruple bottom line basis (cultural, economic, environmental, and social), the results of which are shown in Figure 2. From this analysis, three options were carried forward as preferred. These were:

- Contact Stabilisation and UV disinfection – Option 6
- Biotransformation Trickling Filter (BTF) and UV Disinfection (no secondary clarifier) – Option 7
- High Rate Activated Sludge, BTF and UV Disinfection (no secondary clarifier) – Option 9

Further analysis of these options was presented to DCC, with the HRAS process being selected for implementation. The main advantages of the HRAS process in this case were:

- Reducing the biochemical oxygen demand (BOD_5) load on the downstream BTF, and so reduce its size (and cost)
- Enabling the BTF to treat the wastewater to meet the consent conditions
- Enabling the BTF to produce wastewater that is able to be disinfected by UV irradiation without the need for a secondary clarifier
- The ability to convert the existing PSTs into an HRAS process

2.2 Partitioning the Existing PSTs

The length of the existing three PSTs, 75m, enabled the partitioning of the tanks into three zones for grit removal, aeration and sedimentation. The key to this is that the HRAS process only required 1 – 2 hours of hydraulic retention time in the aeration zone and can be loaded up to 2.5kg BOD_5/(m^3.d). Thus, the size of the aeration zone does not need to be large. The partitions are shown in Figure 3. The lengths of the zones are 4m grit removal, 12m aeration, and 59m sedimentation.

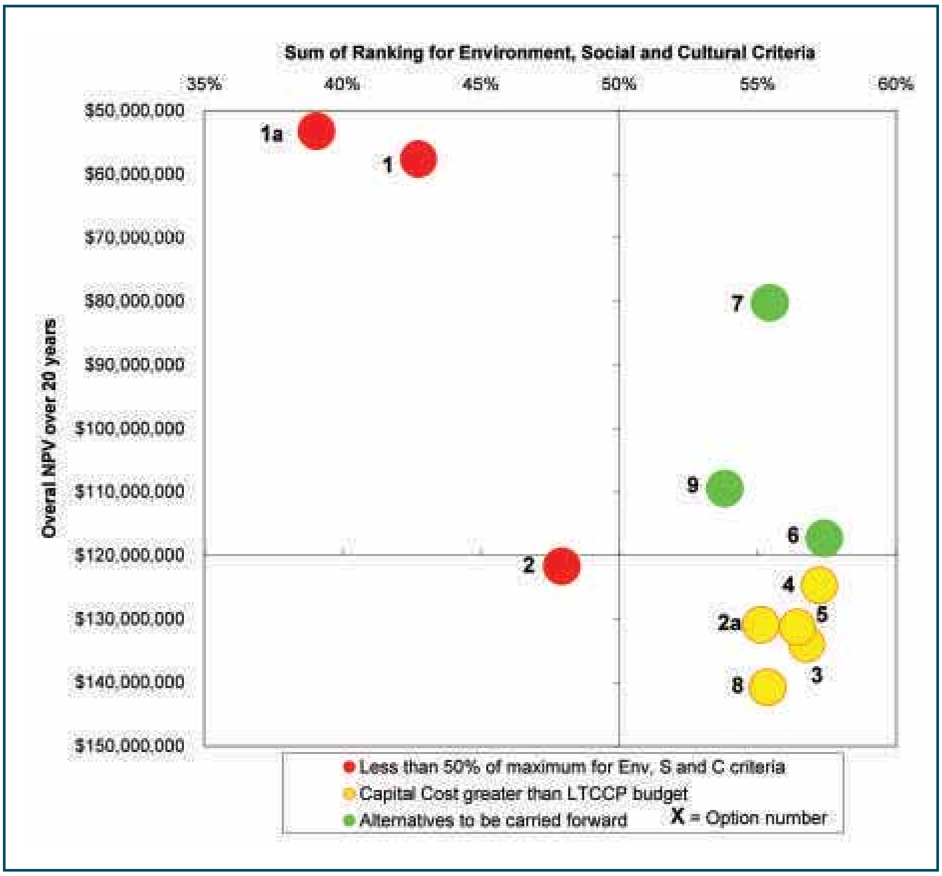


Figure 2 – Tahuna WWTP Summary of short list evaluation

2.3 Grit Removal

2.3.1 Overview

The original plant did not have a separate grit removal process. Grit was removed along with sludge and incinerated. In wet weather, the grit quantities increased substantially and, due to the greater inorganic content, the sludge could not be incinerated. Because the proposed upgrading required recirculation of sludge and centrifuge dewatering, a grit removal stage was needed, as is normal practice to avoid excessive wear of equipment.

The inlet end of the former rectangular PSTs was modified with partition walls and flow distribution alterations, to become grit removal tanks. Grit settlement is achieved by inducing a 'roll current' using coarse bubble aeration, which acts to sweep settled grit into the former sludge hoppers. Grit is pumped from the grit hoppers to the grit washer/classifiers on a timed sequence, where the grit is washed and dewatered. Dewatered grit is discharged to skips for disposal to landfill.

2.3.2 Grit Pumps

The grit pumps handle an abrasive liquid, which has the potential to cause significant pump wear over time. Pump wear occurs as grit particles impact at speed on the pump impeller and casing. Pump wear has a significant effect on pump performance over time and therefore selection of the grit pumps was carefully considered to save replacement costs, and reduce maintenance hours and downtime.

The standard methods identified to reduce pump wear and improve a pump's service life for abrasive liquid pumping include:

- Reduce pump speed – Slowing the pump down reduces the impact energy of the grit particles on the pump impeller and casing, thereby reducing pump wear. Studies indicate impeller wear is roughly proportional to the cube of the speed ratio (i.e. half the speed equals six times the pump life). Slower speeds also generally require heavier, larger diameter impellers, which spreads the impact energy that causes wear over a greater area.
- Hardened materials – Harder materials are less susceptible to wear. The bigger the difference between the hardness of the pump and the grit particle, the longer the pump will last. Typically, high chromium alloy metals are used for abrasive liquid pumping.

As an alternative, a recent technology for abrasive liquid pumping that has gained favour in Europe and the United States, is rubber-lined pumps. Research and experience show that when a hard grit particle meets a soft and flexible rubber surface, the rubber will partially compress to temporarily absorb, and then return, the energy generated by the impact of the grit particle. This allows the pump to operate with minimal damage to the rubber components. Kuhn (2009) compared the performance of a hard chromium alloy cast iron pump versus a ceramic coated pump and a rubber lined pump in an abrasive wastewater grit pumping application, demonstrated that the rubber lined pump had the longest service life.

Experience in the mining industry shows that rubber-lined pumps are susceptible to damage from sharp particles and particles larger than 7mm. Sharp particles can cut the rubber, which can eventually cause it to fail. Larger particles have higher impact energy than the rubber can absorb, which can result in a heat build-up in the rubber, causing it to harden and crack. Large particles were not anticipated at Tahuna WWTP because of the 2mm aperture Suboscreens.

Rubber-lined pumps for abrasive liquid pumping have a proven track record in the mining industry, and wastewater treatment applications in Europe and the United States. The Tahuna WWTP incinerator ash pump is also a rubber-lined pump that has been operating effectively for many years. Therefore, rubber-lined pumps were selected for the grit pumping duty and since installation, they have performed well. During construction, 20 – 50mm concrete construction debris made its way into a working grit hopper, causing rubber impeller damage. Since replacing this impeller, however, no further damage or interruptions have occurred.

2.4 HRAS Aeration

2.4.1 Overview

Downstream of the Grit Tank, the wastewater enters the HRAS Aeration Tank; a further section of the old PSTs modified with partition walls, and fitted with grids of fine bubble air diffusers. The HRAS aeration stage is a short-retention, highly-loaded, aeration process that reduces BOD by incorporating colloidal solids in the recirculated biomass. Some soluble BOD reduction occurs with associated biomass growth.

The required air flow to each Grit Tank is fixed. Conversely, the required air flow to each HRAS Aeration Tank varies according to the Dissolved Oxygen (DO) concentration to maintain it within a range of 0.1 to 1.0mg/l. This is lower than conventional activated sludge processes because the HRAS process is a primarily a 'contact process', which relies on mixing and flocculation of colloidal solids into the biomass, rather than the full treatment of soluble and solid contaminants. Some references refer to the HRAS process as being anoxic (i.e. near zero DO), or facultative (i.e. functioning in both aerobic and anoxic conditions).

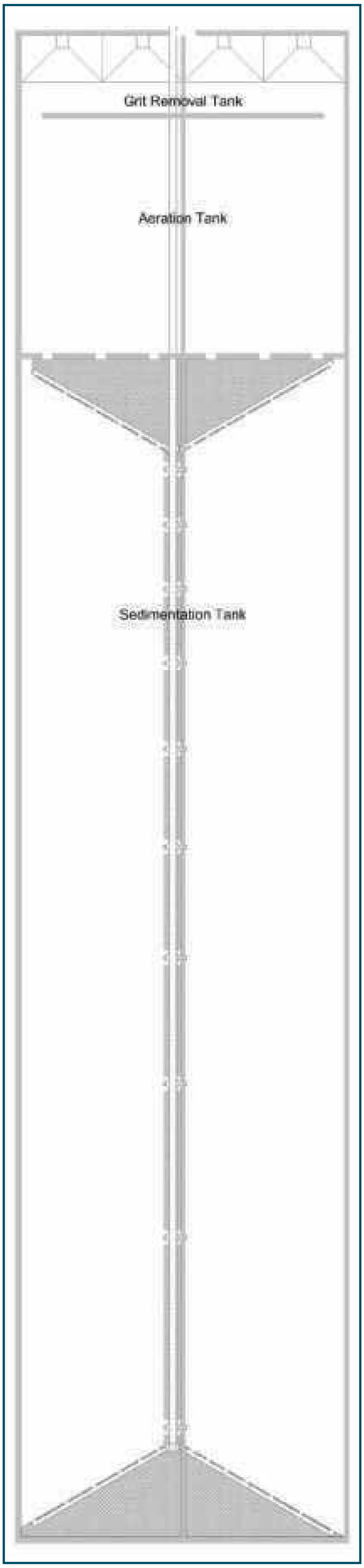
Air is delivered from the blowers via a common discharge pipeline, and then dedicated lines with modulating control valves supply air to each tank. The modulating control valves are automatically controlled between 30 and 70% open, to maintain the DO set-point range within its associated tank.

Air discharge from the Grit and HRAS Aeration Tanks is malodorous. Thus, the tanks are fitted with low level covers and the air is continuously extracted to the odour control system – refer to Photograph 1.

2.4.2 Very High Speed Aeration Blowers

Very high speed K-Turbo aeration blowers were selected to supply air for the grit tanks and HRAS aeration tanks. These high

Figure 3 – Plan showing partitioning of PSTs



"Travelling bridge scrapers are rare in New Zealand, but common in Europe."

speed blowers are the first of their type in New Zealand. The blowers operate around 35,000rpm with an efficiency of 68%. The 37kW blowers are compact – refer Photograph 2 – at 0.7 × 1.0 × 1.2m including the acoustic enclosure, and weigh 630kg. This enabled the blowers to be located within the existing building space and use a mobile davit crane for maintenance, as opposed to installing a gantry crane.

Photograph 1 – Looking to the inlet end of the empty HRAS tank showing the scum removal screw, closer spaced sludge removal ports and covered aeration tank in the background

Photograph 2 – K-Turbo High Speed blowers at Tahuna WWTP

The blowers do not have gearboxes, and have direct-coupled motors with integral variable speed drives. The K-Turbo blowers have an air foil bearing, such that when running there is no contact between the bearing and shaft. This gives the blowers very low maintenance requirements as well as enabling the high efficiencies to be achieved. Some other high speed blowers use a magnetic bearing to achieve this. When housed in their acoustic enclose the blowers are quiet, producing 78dBa at 1m, which allows for a conversation to be heard.

2.5 HRAS Sedimentation and Sludge Removal

2.5.1 Background

The remaining area of each former PST, and the existing travelling bridge, are used in the sedimentation section of the HRAS process.

Travelling bridge scrapers are rare in New Zealand, but common in Europe. Because the original units had required minimal maintenance (in comparison with chain and flight scrapers used in other major plants in NZ) and were in reasonable condition, it was decided to adapt the travelling bridge scraper to remove sludge from close to where it settles, rather than moving the sludge to one end of the tank. This required unique features to be designed.

2.5.2 Sludge Removal Options Considered

The constraints and requirements for the new sludge removal system were:–

- No sludge hoppers available (as these would be expensive to retrofit due to the tank base being below groundwater level)
- Suction removal, from near where the sludge settled, preferred over scraping to one end of the long tanks, because of the risk of the activated sludge aging and becoming gas buoyed
- Equipment located in an existing building which has a low ventilation rate, and hydrogen sulphide corrosion would affect complex electrical equipment such as variable speed drives, if mounted on the travelling bridges
- Increased odour release into the building space could not be tolerated, so sludge could not be exposed to the building atmosphere.

Suction removal of sludge is seen as beneficial because the sludge is removed from where it settles (or with minimal travel distance). This can be compared to moving sludge the full length of long rectangular tanks which could result in the "activated sludge" becoming buoyant and releasing odours as it ages. It is noted that most of the recent secondary clarifiers in conventional activated sludge plants in NZ, have suction removal in circular tanks; e.g. Mangere, Hamilton, Christchurch and Invercargill (15 tanks in total). The suction systems have been of the 'Tow-Bro' type by Envirex/US Filter/Siemens, or close variants from Westech or Smith & Loveless. There are three main types of suction removal which would comply with the above constraints, either in full or partially.

a. Existing travelling bridges retrofitted with angled scrapers moving sludge to multiple withdrawal ports in a fixed suction header, with Return Activated Sludge (RAS) pumps mounted in existing Pump Gallery
b. Return Activated Sludge (RAS) pumps mounted on existing travelling bridges with the RAS discharged to troughs above water level and gravity flow of RAS to the aeration zone inlet
c. Removal of existing travelling bridges and replacement with chain and flight scrapers with suction headers in the floor slab at approximately 10m intervals, and RAS pumps installed in the existing Pump Gallery (hydraulic suction removal portion of the Siemens Envirex "TransFlo" concept).

The features of each option are summarised in Table 1.

From a qualitative evaluation, and discussions with the client, Options B and C were not favoured for these key reasons:

- Option B; increased odour risk; unreliable electrical supply to pump VSDs mounted on the travelling bridges; and the individual RAS systems with separate MLSS characteristics for each HRAS train
- Option C; much higher cost, approximately $1.2 million additional to either Options A and B.

Option A was selected for these key reasons: RAS pumps would be located in the existing main Pump Gallery for ease of maintenance; no odour would be released from RAS pipework; and common RAS manifold and therefore common MLSS characteristics, which would avoid variability in biomass between the three HRAS trains.

continues on page 36...

Table 1 – Comparison of RAS removal options

Option	Retains Bridges	RAS Pumps Location	RAS Removal Method	Advantages	Disadvantages
A	Yes	In main pump gallery	Angled scraper to the half-height central suction pipe with 12 inlet ports with actuated valves, which are opened one at a time as the angled scraper passes each port. The RAS pumps discharge to common manifold which discharges into the main inlet channel.	• Fully enclosed RAS pipework with no odour release • RAS pumps in gallery for ease of maintenance • RAS discharge into main influent channel will "smooth" the RAS concentration and will produce a common biomass across all three tanks • Cost moderate	• Site specific design • Submerged valves need tank to be emptied for maintenance (expected to be at similar intervals required for tank maintenance)
B	Yes	Mounted on the travelling bridges	"Vacuum cleaner" type suctions, or angled scraper to vertical suction pipes, discharging continuously to gravity troughs mounted above water level, which return the RAS to the aeration tank inlets.	• Cost moderate • Used in Europe	• Exposed RAS in troughs would release odour and would need to be covered with a sliding seal and ventilated to odour treatment • VSDs mounted on bridges would suffer corrosion • Larger cable feeds to travelling bridges would have high maintenance • Difficult access for RAS pump removal with safety risks • Individual RAS systems for each tank could result in biomass instability in individual tanks
C	No – replaced by chain and flight scraper	In main pump gallery	Chain and flight scraper to suction ports at 10m (approximately) intervals, embedded in the floor slab with suction piping to RAS pumps. Each suction header would be controlled by a valve to a sequence.	• Proprietary system • Fully enclosed RAS pipework with no odour release • RAS pumps in gallery for ease of maintenance	• High cost (approximately $1.2M for chain and flight scrapers alone) • Extra concrete layer (300mm) required on floor of tanks to embed the suction pipe which would reduce water depth and cost approximately $0.4M

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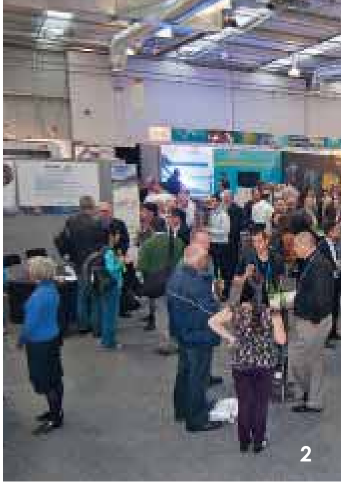

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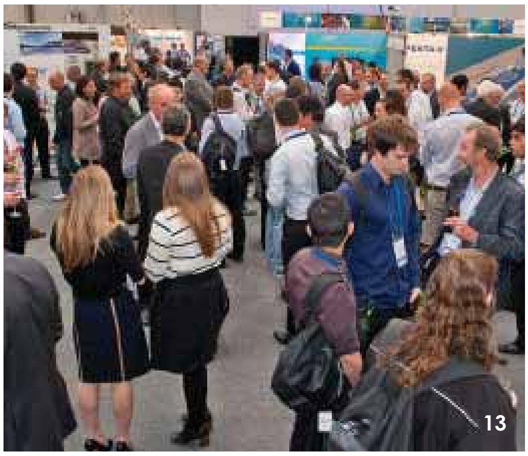

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1) Conference MC, Nick Tansley, greets delegates, 2) Delegates and exhibitors mingle at the Welcome Reception, 3) Keynote Speaker, Graham Dooley talks about water reform, 4) Conference Dinner and Awards Presentation table centre pieces, 5) Water New Zealand President, Steve Couper, speaks at the Welcome Reception, 6) The Beat Girls entertain delegates at the Conference Dinner, 7) Conference Dinner set up, 8) There was plenty of 'serious fun' at this year's conference! 9) The Water New Zealand stand in the exhibition area, 10) Delegates vote online following a session, 11) Awards dinner ready for delegates, 12) A powhiri started proceedings as the conference kicked off at the Claudelands Event Centre, Hamilton, 13) As in previous years, the Welcome Reception proved popular, 14) The Water New Zealand team find time to smile for the camera; from left to right – Cherish Low, Amy Aldrich, Hannah Smith and Linda Whatmough, 15) Water New Zealand President, Steve Couper, presents the Best Stand Award to a representative from IPLEX Pipelines, 16) Water New Zealand president, Steve Couper, speaks to delegates during the Best Stand Award presentation, 17) The IPLEX Pipelines stand which won this year's Best Stand Award, 18) Conference Welcome Function held in the Expo Hall at the Claudelands Event Centre, Hamilton, 19) Opening Keynote speaker, Robert Costanza talks about valuing ecosystems, 20) Trophies ready to be handed out to worthy recipients, 21) Robert Costanza's Opening Keynote address, 22) Delegates responding in real time to a presentation at conference, 23) The Friday Forum panel take questions from the audience, 24) Premier Sponsors at the conference, 25) Delegates register for the conference on Day 1, 26) The Beat Girls get delegates dancing at the Conference and Awards Dinner

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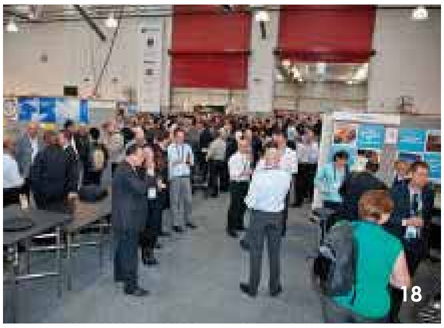

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CHANGING CURRENTS

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Claudelands Event Centre, Hamilton 16–18 October

Photograph 3 – Angled Scraper

2.5.3 Sludge Removal Solution

Sludge is pushed towards central walls at two-thirds of the liquid level by an angled scraper hung from the travelling bridge, where it is removed by intakes at 12 pairs of wall ports that withdraw sludge as the angled scraper passes. A key design feature is that the wall ports are spaced in a tapered fashion to accommodate the fact that a majority of the sludge settle near the inlet of the tank – see Photograph 1, and refer to Section 2.5.5 for more details. The scraper is angled in both directions so that sludge is pushed to the central wall in both bridge travel directions – refer to Photograph 3. The angled scraper creates a 'dead zone' at each end of the tank and this was filled with concrete benching to avoid sludge aging in the dead zones and becoming gas-buoyed – refer to Photograph 1 and 4.

The bridge travels at the same speed in both directions. Two range finders on each bridge are set up to detect excessive bridge skew.

The RAS suction manifolds in the middle of each tank have intakes in each of the 12 wall ports as described above. Each intake has an air-actuated pinch valve, which fails open on loss of air. One valve on a suction manifold is open at all times. Each valve opens when the range finder senses that the travelling bridge is in the opening range for that valve. Once the next valve has opened, the previously opened valve closes. The RAS pumps were retrofitted into an existing gallery. The layout of the RAS pumps was designed to preserve access and clearance for maintenance of these pumps and the other equipment located in the gallery.

2.5.4 Sludge Removal Calculations

Design of the scraper blade was based on four main reference documents:

- Korrespondenz Abwasser (KA) (1988) *Sludge Removal Systems for Secondary Sedimentation Process*
- German Association for Water (2000) *Standard ATV-DVWK-A 131E – Dimensioning of Single-Stage Activated Sludge Plants*
- Beca Steven Design Guideline for Circular Wastewater Clarifiers, 12 March 1997
- Wang *et al*. (2008) *Three-Dimensional Simulation on the Water Flow Field Suspended Solids Concentration in Rectangular Sedimentation Tank*

The ATV reports were used for calculating the sludge thickening height and settled sludge concentration.

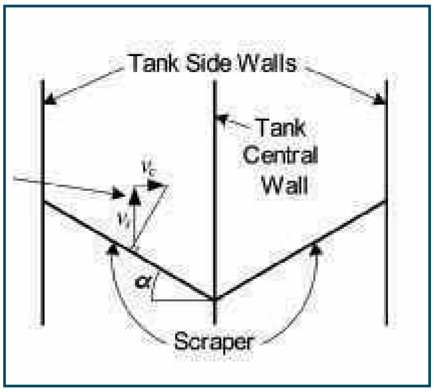
The Beca Steven Report has a formula for calculating sludge velocity towards the sludge withdrawal point, $v_c = f_1.v_s.\tan\alpha$. Where: v_c is the velocity of sludge towards to wall, f_1 is the efficiency of sludge transport, allowing for slippage etc., v_s is the velocity of scraper blade and α is the angle of the scraper blade from perpendicular to direction of travel. Also refer to Figure 4 for definitions. (Note: only one travel direction shown for simplicity, scrapers will function in both directions.)

Combining the thickened sludge height or the scraper height (whichever is less) with the length of the scraper blade, gives an area of sludge movement. Then multiplying by the sludge velocity gives a volume movement of sludge, and finally multiplying by the sludge solids content gives the dry solids mass movement of sludge to the central wall. Note this assumes that that the liquid above the sludge blanket contains no solids, so is likely to be an underestimate.

The main factors affecting sludge transport to the central wall are the velocity and angle and height of the scraper blade, although height only has an effect at high loads. A greater scraper angle transports more sludge, but slower scraper speeds can transport more sludge up to a point. This is due to the fact that slower scraper speeds allow the sludge blanket solids content to increase and thus a higher mass of solids can be moved in each pass until the sludge blanket is above the scraper blade.

Using the average flow design parameters, gave a thickened sludge height of 0.13m, with a concentration of 12kg/m³ (1.2% DS), and a total solids flow to the wall of 907kg/hr. This results in build-up of sludge of 1,058kg/hr, which ultimately will increase the sludge blanket level to 0.28m to balance the sludge flow.

Figure 4 – Sludge Scrapper Design Definition



2.5.5 Withdrawal Port Spacing Calculations

Two ports at each end of the tank connect to suction headers that run the width of the tank at the base of the benching – refer to Photograph 1 and Figure 3. This is to remove any remaining sludge at the tank ends. At either end of the sedimentation tank, the penultimate two ports are positioned a metre from the end suction headers. These are on the central wall and remove the sludge that has been transported to the wall, to avoid overloading the end ports. The remaining eight ports are distributed along the central wall, biased to the inlet end. Modelling done in Three-Dimensional Simulation on the Water Flow Field Suspended Solids Concentration

"Combining the thickened sludge height or the scraper height (whichever is less) with the length of the scraper blade, gives an area of sludge movement."

in Rectangular Sedimentation Tank by Wang *et al*. (2008), shows that approximately half of the solids settle out in the inlet third of a rectangular sedimentation tank. Thus, the remaining wall ports are spaced so that half the ports are in the inlet third of the tank, and half are in the remaining two-thirds, with the spacing between ports progressively increasing. Figure 5 shows the distribution of these wall ports.

The final design of 12 ports per tank is a cost balance between having a larger number of valves (which would imitate nearly continuous withdrawal but would be too expensive) and having a smaller number of valves and relying on the scraper to move RAS to the suction ports.

2.5.6 RAS Port Valve Selection

The suction pipework and port valves have to be submerged. The most suitable valves for submerged duty are 'pinch valves' which are fully enclosed with only an air pipe connection needed to 'pinch' the internal sleeve.

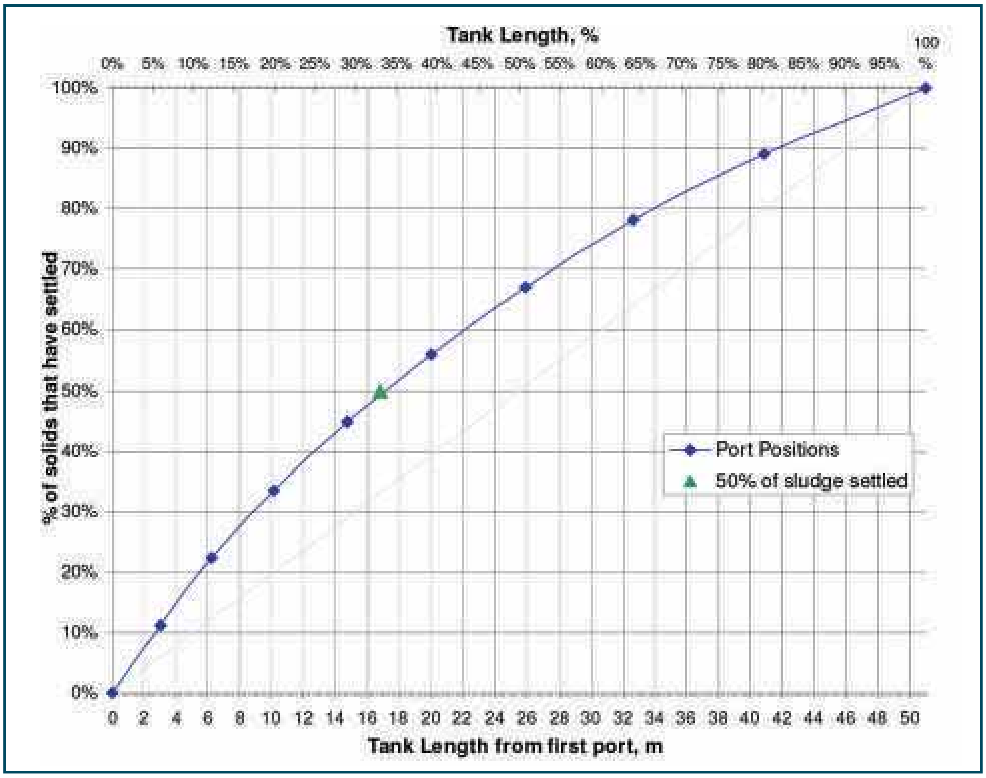


Figure 5 – Location of Sludge Withdrawal Wall Ports (excluding end ports)

Air pressure is needed to close the valves and the air solenoid valves are located in groups at each end of the tanks, for ease of access and maintenance.

Pinch valve suppliers indicated that the sleeves should last for decades in this duty, and routine maintenance of valves can be effected when a tank is emptied for routine maintenance of the scraper's flexible blade wiper and travelling bridge; expected to be once a year.

2.5.7 Range Finder Control

Two laser and reflector sets are installed on each bridge to determine its position in the tank and relative to the suction ports. Each valve opens when the range finders sense that the travelling bridge is in the opening range for that valve. Once the next valve has opened, the previously opened valve closes. Having two range finders provides redundancy, but they are also used to determine if the bridge has skewed and will stop the bridge in extreme cases of skewing.

2.5.8 Coarse Screw Collection of Scum

A Tschuda floating screw scum collector is located at the inlet end of the HRAS sedimentation tank (see Photograph 1). These were supplied from Austria and this is thought to be the first use of these in Australasia.

Scum that floats to the surface in the sedimentation tank, is moved to the scum screw by the travelling bridge. The coarse screw can remove scum derived from both the sedimentation tank and the aeration tank.

The screws concentrate the scum around the surface of small scum sipping troughs at one side of the tanks. The screw and trough floats so that the trough is always at a fixed distance below water level. A submerged scum pump, adjacent to the trough, discharges to the Gravity Tank Thickener (GTT).

Photograph 4 – Outlet end of HRAS tank during construction, showing the submerged outlet launder tubes

2.5.9 Outlet Weir with Submerged Tube Launders

The original PSTs had a simple weir along the end wall of the tank. The overflow rate per metre length of weir was much higher than recommended to minimise solids carryover caused by upwelling currents below the weir. In order to overcome this, submerged tube launder pipes were retrofitted to reduce the upflow velocity, in addition to the end weirs. During average flows, wastewater flows out through the launder tubes only. At high flows, the level rises and some water flows over the end weir as well as through the launder tubes.

3. Results

The first PST was converted to the HRAS process and commissioned on wastewater in September 2011. The final tank was commissioned on wastewater in October 2012. The BTFs started to receive wastewater at the beginning of 2013. The overall process train was producing consistent results around May 2013. Figure 6 compares the results of the previously-used primary sedimentation process to the newly-installed HRAS process. This shows significantly improved BOD_5 removal from 36% to 66%, as well as some improvement in TSS removal from 66% to 74%.

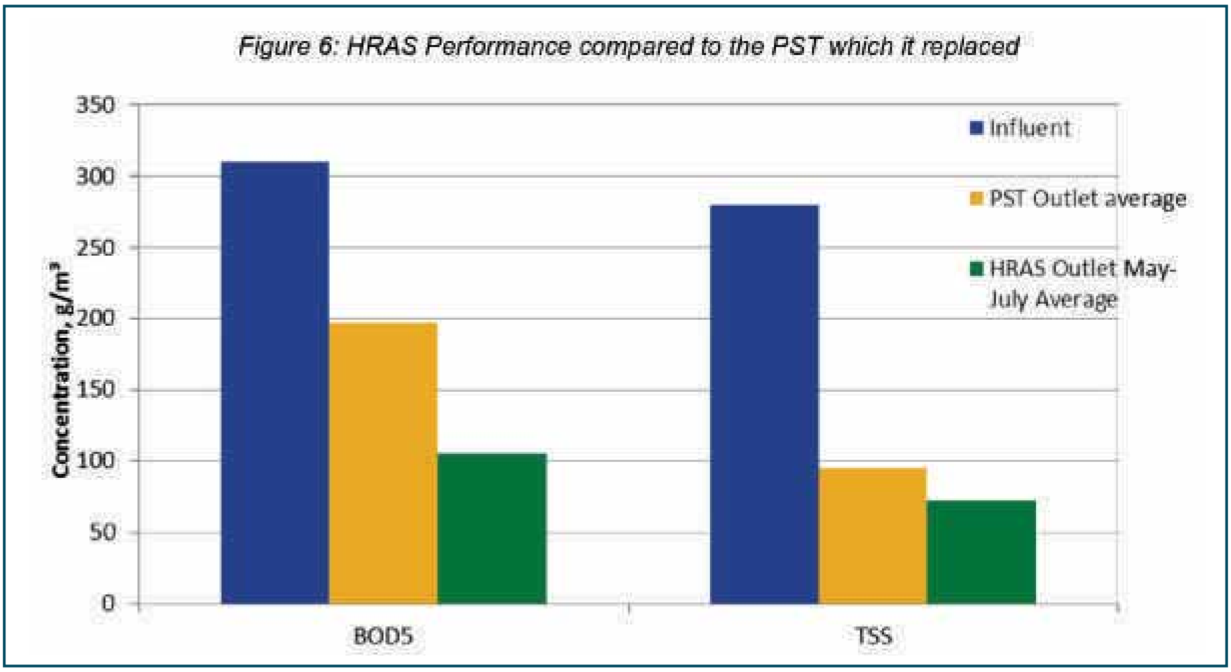


Figure 6 – HRAS Performance compared to the PST which it replaced

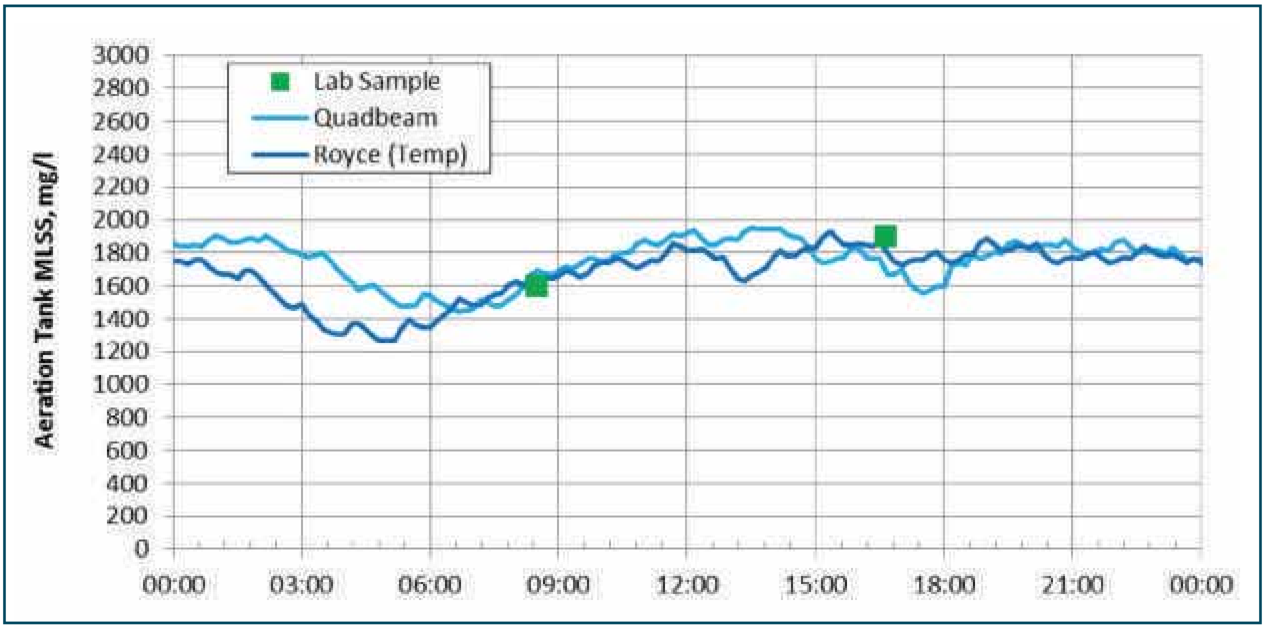


Figure 7 – Mixed Liquor Suspended Solids (MLSS) variation over a day

The sludge removal system has been effective with no observable rising sludge blanket level. The variability in MLSS has been acceptable, with a small typical variation of 100mg/l over the 1-hour cycle time of the travelling bridge, as shown in Figure 7.

> "Scum that floats to the surface in the sedimentation tank, is moved to the scum screw by the travelling bridge. The coarse screw can remove scum derived from both the sedimentation tank and the aeration tank. The screws concentrate the scum around the surface of small scum sipping troughs at one side of the tanks."

Increasing the Ultra-Violet Transmissivity (UVT) is primarily a function for the BTFs. However, it is worth noting that the HRAS process itself has improved the UVT to a typical value of 19% compared to 13% achieved by the PSTs. This reduces the performance requirement for the BTFs, which increase the UVT to around 35%.

4. Conclusion

The conversion the existing Primary Sedimentation Tanks to a High Rate Activated Sludge process at the Tahuna WWTP has contributed to Dunedin City Council being able to meet its new effluent discharge consent. The implementation of the HRAS process in the existing PSTs required the combination of recent technologies and unique design features in a novel way:

- Converting former sludge hoppers to grit hoppers
- Use of rubber-lined grit pumps
- Suction removal of sludge from modified rectangular tanks using angled scraper and fixed wall ports
- Modification of existing travelling bridge scrapers
- Use of a floating coarse screw for scum collection, the first of this type in Australasia
- Submerged tube launders coupled with a weir at the sedimentation tank outlet
- Very high speed aeration blowers with direct-coupled motors and integral variable speed drives (no gearboxes), their first usage in New Zealand.

The conversion achieved all of the client's requirements within the constraints, i.e.:

- Capital and operating costs are minimised by using the existing PSTs and retaining the existing travelling bridges which had required minimal maintenance
- Significantly improved BOD_5 removal compared to the previously used primary sedimentation process
- Suction removal provides recycling of fresh sludge, which is essential for activated sludge systems
- Grit removal prior to sludge removal to protect sludge process equipment
- Odour release is minimised by not exposing the sludge at any point to the building atmosphere ■

Acknowledgements

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- Chris Henderson, DCC Treatment Plant Manager
- Terry Dodd, DCC Process Engineer
- Richard Bennett and the team at MWH

References

Archer, H. E.., Crosbie, R., and Turner, B. Tahuna Wastewater Treatment Plant Stage 2 Upgrade Project, Ingenium Conference Proceedings, 2013

German Association for Water, Standard ATV-DVWK-A 131E – Dimensioning of Single – Stage Activated Sludge Plants, May 2000

Glasgow, G., Bennett, R., and Loughran, P., Biotransformation Filters: Low Technology Solution for the 21st Century, Ingenium Conference Proceedings, 2013

Korrespondenz Abwasser (KA), Sludge Removal Systems for Secondary Sedimentation Process – Working Report of the German ATV Specialist Committee 2.5 "Sedimentation Processes", Issue 13, 1988, pg 182–93

Kuhn, W. Rubber Cuts Sewage Pumping Costs, World Pumps, October 2009

Wang, X., Yang, L., Sun, Y., Song, L., Zhang, M., and Cao, Y. Three-Dimensional Simulation on the Water Flow Field Suspended Solids Concentration in Rectangular Sedimentation Tank, Journal of Environmental Engineering, p902–11, Nov 2008

Water Quality Issues and Management Solutions of an Iconic Urban Lake

Rebecca Bibby – BECA Ltd

Abstract

Pukekura Park lies in a central location within the city of New Plymouth. In recent years, the water quality of the Park's lakes has been significantly impacted due to progressive development in the wider catchment. The aim of this study was to identify the major water quality issues of the Park and prepare a catchment management plan which could be used to mitigate the effects of these through low impact solutions. The study found that the Park's watercourses were nutrient enriched with some high bacteriological counts, zinc concentrations and accumulated sediment. Catchment management solutions included both installation of stormwater treatment devices on each of the major contributing tributaries and point source control to improve the water quality of the park's water bodies. Other methods include gross pollutant removal from urban areas, the dredging and removal of fine sediment, the immediate removal of lawn clippings from the Park's mown areas as well as a community education programme to involve the wider community in playing a role in sustainability of the Park's water resources. This paper presents the methodology, outcomes and the resulting work which sought to link water quality issues with their causes, and to then identify mitigation and improvement solutions.

1. Introduction

Pukekura Park, New Plymouth, was officially opened in 1876, and is administered and managed by the New Plymouth District Council (NPDC). The Park comprises Brooklands Park and three main lake systems, set within an area of native and indigenous vegetation. Pukekura Park, together with Brooklands Park (referred to jointly as the 'Park' herein) together contain significant areas of indigenous and native plant collections, character water features as well as an outdoor stadium, zoo, nursery, amphitheatre and other facilities. The high amenity and aesthetic qualities of the Park ensure that it is a valuable resource to the local community and wider region of north Taranaki.

The Park's lakes were originally excavated from swamplands to provide a park for competitive swimming and aquatic sports. However, progressive urban development in the wider catchment area since the 1950's has seen degradation of the Park's water resources. Urban lakes are particularly vulnerable as they are both small relative to the surrounding land area, have long hydraulic residence times and tend to act as sinks for accumulation and deposition of sediment and urban contaminants.

In order to re-establish and maintain the ecological, recreational and aesthetic values of the Park on a long term basis, a draft catchment management plan for the Park was prepared. The purpose of this study was to identify issues for water management within the Park and its wider catchment area, and to recommend appropriate methods and management practices for remedying and/or enhancing the water assets of the Park. The primary objective of this study is to assist the NPDC in development of long-term management practices which maintain and enhance the aesthetic nature and function of the Park's water bodies. Changes to the District Plan are being considered through a complementary NPDC/Beca study addressing catchment wide land use practices that impact on the water quality of the Lakes.

The growth of weeds and algae is generally controlled by flow, the amount of available light, and the bioavailability, concentration and form of nitrogen and phosphorus. An increase in nutrient levels may lead to a proliferation of algae and plant growth in lakes and eutrophication. Typically, a resultant increase in algae or plant growth removes oxygen from the water. In addition, when algae or aquatic vegetation dies, decomposition by bacteria consumes oxygen and the water may become oxygen depleted, particularly in bottom waters or temperature stratified systems. Consequently, in areas with high algal growth and high bacterial decomposition, oxygen levels can drop to very low levels which may have detrimental effects on aquatic life. The approach taken in this study was to identify the source and/or sources primarily responsible for over-feeding the lakes in terms of nutrients and suggest actions to mitigate these.

Above left: Photograph 1 – Bowl of Brooklands; Above right – Photograph 2: TSB Stadium and Car Park; Opposite page: Photograph 3 – Main Lake during Summer Months

2. Catchment Description

Pukekura Park's catchment encompasses an area of 164 hectares and consists of four major sub-catchments with different degrees of urbanisation and land use. The four main tributaries and their sub-catchment areas are as follows (see Table 1 and Figure 1):

Table 1 – Pukekura Park Catchment Major Sub-Catchment Areas

Sub-Catchment	Total Area (ha)	Impervious Area (ha)	%
Brooklands Arm	51	10	20
Vogeltown	61	22	36
Kaimata Street	28	9	32
Stainton Dell	24	3	12
Total	164	44	27

The Brooklands Arm tributary drains the easternmost headwaters of the catchment. Water flows through approximately 800 metres of native bush from its headwaters before passing through Bowl Lake and Lily Lake. A sediment trap located approximately 160 metres south of Main Lake receives all drainage upstream of the Brooklands Arm sub-catchment. The Bowl of Brooklands comprises an outdoor sound stage and a large grassed amphitheatre (Photograph 1).

The substantially-sized Vogeltown sub-catchment drains the southernmost and southwest mostly residential areas of the catchment. Located in the centre of the sub-catchment is Vogeltown Park, an active sports field. Water from the Vogeltown sub-catchment flows north to Main Lake by way of the Truby King Dell sediment trap, combines with Kaimata Street tributary and passes through Goodwin Dell before discharging to Main Lake.

The Kaimata Street tributary receives drainage from the zoo, nursery and residential area to the south of the Pukekura Park catchment. The wash-water and sewage from the zoo are discharged to sewer lines that run through the park. All other surface water runoff drains into either the Brooklands Arm or Kaimata Street tributary.

The fernery, TSB stadium complex (Photograph 2) and Stainton Dell ponds are situated in the Stainton Dell sub-catchment. The Stainton Dell tributary discharges into the channel connecting Main Lake and Fountain Lake. While the racecourse (used as a training facility on a daily basis) drains northeast, it is likely that there are significant subsurface flows into the Park from this area.

Almost all drainage in the catchment passes through Main Lake (Photograph 3) and Fountain Lake before final discharge through a water wheel outlet in the northwest of the catchment. A water fountain, controlled by a pump switch which is activated by the public, is centrally-located in Fountain Lake.

Figure 1 – Major Catchment and Hydrological Features of Pukekura Park

2.1 Water Quality Issues of the Lakes

A pungent odour is noticeable from Main Lake during summer months, suggesting possible anoxic conditions. This, together with significant quantities of benthic organic matter, increases the potential for weed and algal growth. While there has been no discernible proliferation of blue/green algae in any of the Park's water bodies, abundant aquatic weed growth in Main Lake is likely to contribute to its poor water quality. Fountain Lake is reportedly of better water quality than Main Lake although a fountain in the middle of the lake, which operates on a push-button basis, provides more oxygen to the water body of this lake. The lakes in Pukekura Park have a maximum water depth of approximately 4 meters making them shallow lakes.

Sedimentation has been a key issue for Pukekura Park lake management. In response to rising sediment levels, two sediment traps were installed on two of the major tributaries off Main Lake. In 1955, a silt trap was constructed at Truby King Dell and in 1979 a silt trap was built on the Brooklands Arm tributary below Lily Lake. It is thought that a blow-out underneath this latter structure has rendered this device almost ineffectual. Both the area upstream and downstream of the Brooklands Arm sediment trap, and the Truby King Dell pond, are heavily silted, with neither being maintained in terms of sediment removal.

3. Methdology

In order to gather a baseline of information of the Park's water resources, three technical investigations were carried out between September and December 2008. These comprised:

- Flow monitoring
- Bathymetric survey
- Water quality assessment programme

The results of the technical investigations were used to develop a plan for management of the Park's water resources.

3.1 Flow Monitoring

Three v-notch weirs were placed upstream of Main Lake: the first on the common tributary downstream of the convergence point of Vogeltown and the Kaimata Street tributaries, the second and third weirs both upstream and downstream of the Bowl on the Brooklands Arm tributary. The remaining weir was placed at the outlet of Fountain Lake. The water level at each weir was recorded daily and the flow rate calculated.

3.2 Bathymetric Survey

A bathymetric survey was undertaken on both Main Lake and Fountain Lake in order to calculate depths and volumes. The survey was undertaken by using probes and measuring the silt layer thickness at regular intervals. Digital terrain model (DTM) data were generated as well as top and bottom silt layer contour drawings. From this information, silt layer thickness plans, and cross-sectional transects of key points in the two lake system were calculated.

3.3 Water Quality Assessment Programme

The water quality assessment programme comprised the following two parts:

- Preliminary investigation
- Water quality monitoring

The preliminary investigation was undertaken to provide an initial assessment of basic water quality of the Park's water bodies and to assist in identification of contaminant sources. The investigation included collection and analysis of water and sediment samples at selected sites (refer to Figure 1) during low flow conditions.

Water quality monitoring was undertaken to obtain a baseline of water quality information from which temporal variability of selected

> "Sedimentation has been a key issue for Pukekura Park lake management. In response to rising sediment levels, two sediment traps were installed on two of the major tributaries off Main Lake."

water quality parameters and contaminant loads/budgets could be assessed. The water quality monitoring programme comprised collection of grab water samples from each main tributary at the inlet end of Main Lake and at the outlet of Fountain Lake as shown in Figure 1. Note that on occasion, water samples could not be collected from the TSB stadium sampling site (P14) due to insufficient water levels, in which case, samples were collected from the Stainton Dell (P3) ponds instead. Samples were collected at fortnightly intervals over a four month period. In addition to fortnightly water sample collection, a grab water sample was also collected during two storm events. The collection of fortnightly water samples commenced on 11 August 2008.

The results of sediment and water quality sampling collected as part of this study, where applicable, were compared to the corresponding trigger values in the Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) Guidelines for Fresh and Marine Water Quality in order to assess the current water and sediment quality in the Park. This was undertaken by assessing the field sampling results in terms of the following:

- Toxicant levels
- Risk of adverse effects due to nutrients
- Sediment Quality

The bacteriological counts were compared to the Ministry for the Environment (MfE, 2003) Microbiological Water Quality Guidelines for Marine and Freshwater Recreation Areas to assess the waters in terms of ecosystem health.

4. Results

4.1 Flow Monitoring

The results of the flow monitoring showed that a significant quantity of rainfall is conveyed as surface runoff from the combined Vogeltown and Kaimata Street sub-catchments (P10) leading to increased stream response storm flows. These urban sub-catchments are a significant catchment area in terms of both size and impervious surface area. The flow through the Brooklands Arm tributary showed lower peak flows, however the sub-catchment is both smaller (51ha versus 89ha) with less impervious cover (20% versus 35%). The peak flow response at the outlet of Fountain Lake was not significantly attenuated by the main lake system.

4.2 Bathymetric Survey

The results of the bathymetric survey showed that sediment accumulates in the central and western margins of Main Lake to a thickness of approximately 2 metres. The estimated water volume of Main Lake was 20,797m^3 and the sediment volume, 9,412m^3. For Fountain Lake, the estimated water volume was 1,871m^3 and the silt volume of 1,795m^3. On the basis of the water volume and the lowest monitored outflow, the hydraulic residence time of Main Lake was estimated at 11 days while that of Fountain Lake, 4 days.

4.3 Water and Sediment Quality

4.3.1 Preliminary investigation

The results of the preliminary investigation showed that in general, waters in the Park were nutrient enriched, had variable


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bacteriological counts, and relatively low suspended solids and metal (copper, lead and zinc) concentrations (Table 2 and Figure 2). The nitrate concentrations at all sites sampled exceeded the ANZECC (2000) toxicity trigger of 0.700mg/L by up to 12 times. The measured dissolved zinc concentrations also exceeded the corresponding trigger value at several sites sampled.

The nutrient concentrations were compared to the corresponding default trigger values in the ANZECC (2000) guidelines to assess the risk of adverse effects due to nutrients. The results showed several exceedances of the corresponding default trigger value (Figure 2). The total nitrogen and total oxidised nitrogen concentrations exceeded the trigger value by up to four and eight times respectively at all sites sampled except for the Stainton Dell Pond sampling site (P3). The dissolved reactive phosphorus concentrations in Main Lake (P8 and P9) and the watercourse joining Main Lake and Fountain Lake (P7) exceeded the default trigger value by between 7 and 10 times. The total phosphorus concentration exceeded the default trigger value at only two sites, the site draining runoff from the stable (P4) and the main tributary upstream of the stage (P12).

The E. coli results were compared to the MfE (2003) guidelines for freshwaters. Counts between 260 and 550 per 100mL are classified as 'alert amber level' and those > 500 per 100mL, 'action red mode'. Two sites had E. coli counts > 500 per 100mL (Figure 2). These were the runoff drain from the stables (P4) and the site between Bowl and Lily Lakes with counts of 1400 and 2600 per 100mL respectively. The Truby King Dell (P6), which receives drainage from Vogeltown area, had counts of 300 per 100mL. All other sites had counts < 260 per 100mL.

There appeared to be some differences across the Park in terms of the water quality with the identification of several key point sources of contamination. While almost all sites sampled had high nutrient concentrations, waters draining the Vogeltown area (P6) had relatively high suspended solids and ammoniacal nitrogen with little apparent mitigation of these as the combined flow passed through Goodwin Dell area (P10). High ammoniacal nitrogen levels at the Vogeltown sampling site may suggest some leakage from the main sewer line which passes through the Park.

The water samples collected from the Brooklands Arm tributary had some high bacteriological counts. The source of these appeared to be mainly in the area of Bowl Lake. The stables (P4) appeared to be a point source of contamination to the Pukekura Park with high suspended solids (49mg/L), organic matter (29mg/L), high bacteriological counts (E. coli 1400cfu/100mL) and nutrient concentrations. Lower levels of bacteriological counts in the vicinity of Brookland Arms sediment trap suggest some mitigation of these as water passes downstream of Lily Lake.

The water quality of Main Lake and Fountain Lake appeared to reflect the tributaries draining to them. The suspended solids and E. coli counts were low however the nutrient concentrations were generally elevated (Figure 2). The foremost difference in the water quality of the lakes with that of the tributaries they drained was the dissolved reactive phosphorus (DRP) concentration, which was up to seven times higher in the lake waters (P9 and P8) and the outlet of Main Lake (P7). The Stainton Dell ponds (P3) which discharges between Main and Fountain lakes did not appear to be a major source of contaminants, with relatively moderate bacteriological counts, low suspended solids and nutrient concentrations.

Table 2 – Concentrations of Selected Water Quality Parameters during Base Flow Conditions

	ANZECC (95%)	P1	P2	P3	P4	P5	P6	P7
TSS (mg/L)		< 3	< 3	< 3	49	3	4	< 3
E coli (cfu/100mL)	260–550[a]	46	92	170	**1400**	18	**300**	49
DRP (mg/L)	0.010	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0.10**
TP (mg/L)	0.033	0.017	0.025	0.018	**0.097**	0.022	0.018	0.020
NO3 (mg/L)	0.700	**4.8**	**7.0**	**1.3**	**7.0**	**8.4**	**5.7**	**4.4**
TOxN (mg/L)	0.444	**1.54**	**1.92**	0.345	**2.37**	**2.71**	**1.67**	**1.60**
TN (mg/L)	0.614	**1.40**	**1.70**	0.44	**2.42**	**2.25**	**1.58**	**1.46**
NH4-N (mg/L)	0.021	**0.023**	**0.046**	0.020	0.008	0.020	**0.15**	0.016
Total Zn (mg/L)	0.008	**0.009**	< 0.005	< 0.005	**0.010**	< 0.005	**0.008**	0.007
		P8	P9	P10	P11	P12	P13	
TSS (mg/L)		< 3	< 3	< 3	10	20	< 3	
E coli (cfu/100mL)	260–550[a]	9	62	36	5	2	**2600**	
DRP (mg/L)	0.010	**0.15**	**0.07**	<0.05	<0.05	<0.05	<0.05	
TP (mg/L)	0.033	0.015	0.017	0.017	0.024	**0.036**	0.024	
NO3 (mg/L)	0.700	**7.0**	**5.3**	**6.2**	**7.0**	**7.5**	**6.2**	
TOxN (mg/L)	0.444	**1.71**	**1.73**	**1.97**	**1.94**	**2.55**	**1.92**	
TN (mg/L)	0.614	**1.52**	**1.56**	**1.78**	**1.74**	**2.19**	**1.82**	
NH4-N (mg/L)	0.021	**0.025**	**0.039**	**0.089**	< 0.01	**0.05**	**0.10**	
Total Zn (mg/L)	0.008	0.007	< 0.005	**0.009**	< 0.005	**0.016**	**0.009**	

Note: Values in exceedance of the ANZECC (2000) guideline value in bold and red type.
[a]Ministry for the Environment (MfE) Microbiological Water Quality Guidelines for Marine and Freshwater Recreation Areas (June 2003).

> "There appeared to be some differences across the Park in terms of the water quality with the identification of several key point sources of contamination. While almost all sites sampled had high nutrient concentrations, waters draining the Vogeltown area (P6) had relatively high suspended solids and ammoniacal nitrogen with little apparent mitigation of these as the combined flow passed through Goodwin Dell area (P10)."

4.3.2 Sediment Sampling Results

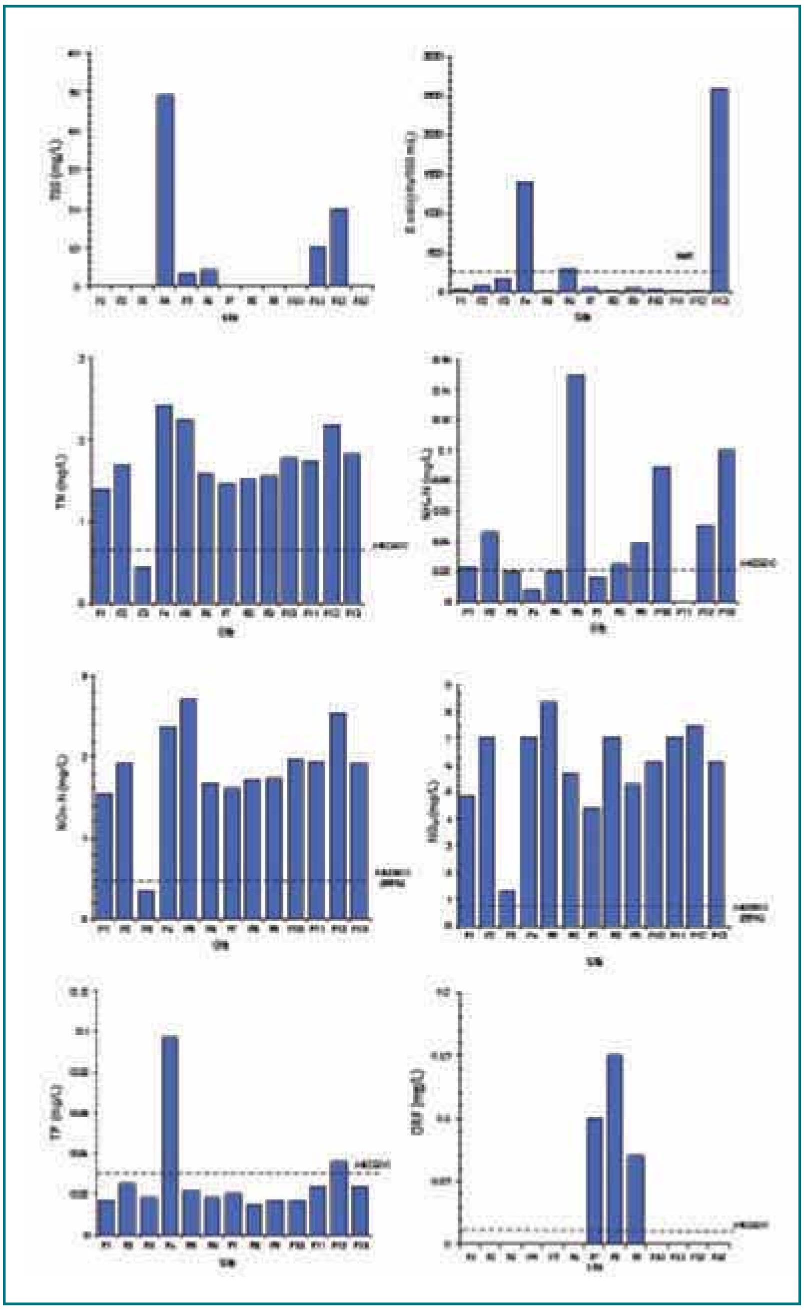
The metal concentrations in the sediment samples collected from sites in Pukekura Park are given in Table 3 together with the corresponding ANZECC ISQG-low and high range trigger values. The copper concentrations in the sediment samples collected from the watercourses of the Park ranged between 101 and 171mg/kg, while the lead concentrations in the sediment samples ranged between 67 and 144mg/kg. For both copper and lead, all concentrations were between the ISQG-low and high guideline value. Zinc concentrations ranged between 220 and 1000mg/kg with the highest concentrations measured in the sediment collected from the bed of the lakes (S4 to S6). These concentrations exceeded the ISQG-high trigger value. The nickel concentrations in the sediment samples were < 10mg/kg at all sites sampled.

Table 3 – Sediment Sample Results

	ANZECC (2000)	Goodwin Dell (S1)	Brooklands Arm (S2)	Main Tributary Weir (S3)	Main Lake North (S4)	Fountain Lake (S5)	Main Lake North East (S6)
Copper (mg/kg)	65 – 270	**171**	**129**	**131**	**146**	**125**	**101**
Nickel (mg/kg)	21 – 52	4.5	3.9	3.5	6.8	3.8	6.8
Zinc (mg/kg)	200 – 410	**460**	**330**	**220**	**1000**	**530**	**500**
Lead (mg/kg)	50 – 220	**116**	**67**	**90**	**144**	**70**	**122**

Notes: ANZECC guideline values presented as low and high ISQG which corresponds to effects range-low and median.
Values in exceedance of the ANZECC (2000) ISQG effects range low in bold.

Figure 2 – Nutrient and E. Coli Concentrations in Water Samples Collected from the Pukekura Park with the Corresponding ANZECC Guideline Trigger Value



4.3.3 Water Quality Monitoring

Water quality monitoring of Pukekura Park provides data from which the general trend in contaminant concentrations can be assessed under elevated flows in addition to determination of temporal variability, loads and nutrient budgets. The results (data not given) showed a general increase in contaminant concentrations during high flow conditions. In particular, the concentration of total suspended solids, E. coli, total phosphorus and total copper at all sites increased in the waters sampled during high flow conditions. Conversely, the nitrogen-based nutrients (e.g. nitrate, ammoniacal-nitrogen) concentrations decreased with flow, suggesting that the predominant source of nitrogen was from sub-surface and groundwater sources. The results of the flow monitoring showed the following:

- The TSB stadium area (P14) is a potential source of both bacteria and zinc with E coli counts between 240 – 7000cfu/100mL and total zinc concentrations between 0.013 to 0.068mg/L.
- In general, bacteriological counts, and the concentration of metals, total phosphorus and suspended solids measured at Goodwin Dell (P10) increased proportionally with flow as is typical of urban catchments with a relatively high proportion of impervious surface and quick runoff response.
- In the Brooklands Arm tributary (P2) the relationship between contaminant concentrations and flow was less obvious as is typical of sub-catchments with point sources of contamination.
- The contaminant concentrations at the outlet of Fountain Lake (P1) showed only a minor relative increase with increasing flow compared to the Goodwin Dell and Brooklands Arm tributary. It is likely that the water quality at the outlet of Fountain Lake is a greater reflection of the chemical and physical processes occurring in the lakes rather than the river and stream watercourses feeding the lakes.

5. Discussion

5.1 The Effects of Contaminants on the Lakes

Water quality monitoring was undertaken from August, when surface waters are generally cool (~11°C), through to the beginning of December when waters are warmer (18°C). However, with a gradual increase in water temperature, nitrate concentrations decreased and turbidity and dissolved oxygen levels increased. These findings are consistent with those for lakes undergoing increased biological activity due to seasonal changes with the potential for poorer water quality.

Both an increase in weed growth and a pungent odour emanating from Main Lake occur during summer. The important factors for weed growth include nutrients, light, water clarity, temperature, suitable substrate and water chemistry. Main Lake is both shallow and maintains a relatively stable substrate. In addition, an odour emanating from Main Lake would suggest increasingly anoxic conditions as summer approaches. Oxygen is consumed when organic matter and bacteria decompose at the bottom of lakes. These conditions remobilise bio-available sediment-bound phosphorus which is then available for algal and plant growth. As nitrate is in ready supply in the waters throughout the Pukekura Park, this new source of phosphorus increases the potential for algal, plant growth and eutrophication.

In addition to the effects of eutrophication, anoxic conditions during summer may also result in remobilisation of metals from benthic sediment to overlying waters. Elevated metal concentrations in the bed sediment of the Pukekura Park lakes represent a source of bio-available metals. Subsequently, increased toxicity and the risk for uptake into the food chain may occur in the overlying water column during summer.

5.2 Limiting Nutrients

Dissolved inorganic forms of N and P are immediately available for uptake by algae, while particulate nutrients are transported downstream. It has been proposed that a cost effective management approach to minimise the proliferation of algae and weeds is to mitigate the inputs of the limiting nutrient.

The Redfield ratio is commonly used to determine whether nitrogen or phosphorus is the limiting nutrient in terms of algal growth in waters. Algae normally contain nitrogen to phosphorus in ratios of between 7:1 (below which algal growth is N-limited) and 15:1 (above which algal growth is P-limited) (Edgar, 1999). In this study, total N and P concentrations have been used to calculate the Redfield ratio in the lake waters and the dissolved reactive phosphorus and dissolved inorganic N (DIN: nitrate-N and ammoniacal-N) in the waters of the tributaries. This equates to a molar ratio of N:P of < 16:1 for N-limited systems and N:P > 16:1 for P-limited systems. A more conservative approach and one that has been adopted in this study is to use the N:P ratio only as an indicator of extreme N or P limitation. In this case, N:P ratios > 30:1 indicate P-limitation while ratios < 16:1 indicate N-limitation (method from McDowell and Larned, 2008).

> "Both an increase in weed growth and a pungent odour emanating from Main Lake occur during summer. The important factors for weed growth include nutrients, light, water clarity, temperature, suitable substrate and water chemistry. Main Lake is both shallow and maintains a relatively stable substrate. In addition, an odour emanating from Main Lake would suggest increasingly anoxic conditions as summer approaches."

For each site and sample, DIN:DRP and TN:TP ratios were calculated after converting the data from the preliminary investigation to molarity from the measured weight concentrations. For the tributaries, the ratio of DIN:DRP was calculated while the TN:TP was used to calculate the Redfield ratio for waters in the lakes. The calculated N:P ratios ranged between 13 and 244 with a median ratio of 71. These results show that the Park is generally phosphorus limited, which is generally the case in New Zealand (White, 1983).

5.3 Contaminant Mass Loads and Budgets

The total nutrient load was calculated from the total nitrogen and phosphorus concentrations and the monitored flow data at each of the sampling sites over the monitoring period. Appropriate management of nutrients inputs can then be achieved based on the hydrological and nutrient inputs to the system.

The phosphorus and nitrogen loads per unit time (g/s) were calculated from the total phosphorus (g/m^3) and nitrogen (g/m^3) results, and monitored flows (m^3/s). These calculations were then used to estimate the nutrient load accumulating in the Park's lakes as shown in Table 4.

Table 4 – Total Phosphorus and Nitrogen Mass Loads for the Lakes

	Phosphorus (kg/yr)	Nitrogen (kg/yr)
Vogeltown	18	1910
Brooklands Arm	36	1487
Fountain Lake Outlet	41	3016

Table 5 – Contribution of Total Phosphorus and Nitrogen from Waterfowl

	Phosphorus (kg/yr)	Nitrogen (kg/yr)
Waterfowl – High Season	14	46
Waterfowl – Low Season	4	12

Based on the three month monitored average total phosphorus and nitrogen loads, approximately 381 kg of nitrogen and 13 kg of phosphorus accumulate in the Lakes each year.

It has been documented that waterfowl are a significant source of nutrients in water bodies internationally. Shaver (2008) estimated daily loads of 79.4kg/yr of nitrogen and 24.5kg/yr of phosphorus for a population of 300 ducks and 20 geese respectively. The nutrient load to Bowl Lake from the resident waterfowl population was estimated from approximate daily nutrient loading rates from bird droppings of 0.628g of nitrogen and 0.196g of phosphorus. Based on a resident duck population of 200 ducks in summer and 50 during winter, the waterfowl contribution to Bowl Lake is shown in Table 5. The results show the following:

- During the high season, the nitrogen load due to the waterfowl population varied between 1.5% to 3% of the total lake mass load and for the mass load of phosphorus, 35% – 80% of the total lake mass load. Consequently, waterfowl are large contributors in terms of the phosphorus load to the Park's lakes
- The Brooklands Arm sampling site (P2) is downstream of Bowl Lake which has a significant population of ducks (Photograph 3). Consequently the contribution due to the waterfowl in terms of phosphorus (compared to nitrogen) in this stream is significant relative to the Vogeltown tributary (respectively 0.4kg/ha/yr and 0.2kg/ha/yr)

Photograph 4 – Edge of Brooklands Lake

5.4 Contaminant Sources and Treatment Options

Both point and nonpoint nutrient and bacteriological loads are the biggest issues facing the Park's lakes in terms of water quality. However, with an appropriate water management plan, it is likely that there may be some improvement in long-term lake water quality. In this section, both the main point and nonpoint sources of contamination to the Park's lakes are discussed as well as appropriate treatment options to mitigate these.

5.4.1 Nonpoint Sources

The results of this study show that nitrate concentrations are elevated throughout much of the Park's water bodies. As such, it is likely that much of the groundwater and sub-surface water in the catchment contains high nitrate concentrations due to activities and practices that have occurred in the catchment over a long period of time. It is therefore reasonable to expect, in terms of nitrate, that any future control to mitigate such sources will not see any significant reduction in water bodies of the catchment for some time. As such, mitigation of the nitrate load in the Park's lakes would therefore need to rely on management solutions that reduce the load in each of the major inlets.

5.4.2 Point Sources

Waterfowl: There is a large waterfowl population resident in the Park. The biggest population is in the Bowl of Brooklands with an estimated 200 ducks during the summer season, dropping to about 50 in winter (Photograph 4). The resident waterfowl population of Main Lake and Fountain Lake is much lower relative to land area with the population spread around the lakes. Waterfowl in the Bowl of Brooklands are a significant source of phosphorus, which is the limiting nutrient in terms of aquatic plant and algal growth in waters of the Park. As such, waterfowl in the Park is a direct factor in promoting aquatic plant and algae growth whereas nitrogen would have less effect. In addition, while both nitrogen and phosphorus exist in dissolved and particulate forms, the results of this study show that in the tributaries of the catchment, particulate forms predominate. Therefore, appropriate sediment control measures as well as source reduction (i.e. waterfowl management) would have a direct beneficial effect in terms of overall improvement in water quality.

Stables: In general, the water quality of Bowl Lake is significantly poorer than waters upstream of the Bowl. A significant source of contamination to Bowl Lake is likely to be stormwater runoff from the stables area above the Bowl. The results of the preliminary survey showed elevated total suspended solids, bacteriological counts, nitrate and total phosphorus concentrations in the run-off drain from the stables. In this case, the most appropriate treatment option is likely to be the complete removal of this contaminant source.

Urban: Land Use As a preliminary assessment, urban and residential areas in the south and southeast of the Pukekura Park catchment contribute the most in terms of sediment to the Park's lakes. The Vogeltown tributary conveys sediment from these areas as well as other urban contaminants such as particulate forms of zinc and phosphorus during high flows. The transport of these contaminants to the Park's Lakes can be mitigated by use of appropriate sediment control devices (e.g. swales, rain gardens).

TSB Stadium and Car Park: The largely impervious TSB stadium and car park area discharges roof and road runoff contaminants to Main Lake. The primary contaminants discharged from the site are bacteria and zinc. It is likely that the major source of zinc in run-off from this area is road surfaces (vehicular tyres). These contaminants can be mitigated through use of filtration/infiltration devices at locations where stormwater passes.

Lakes: Sedimentation is a significant process in the Park's lakes as indicated by low fluctuations in mass loads at the outlet of the Fountain Lake. Accumulated sediment in the bed of lakes can be periodically removed through dredging to create healthier and more aesthetically desirable lakes.

6. Catchment Management Plan

Degradation of the Park's lake water quality has occurred progressively overtime, resulting from long-term changes in activities and development in the wider catchment. As such, any improvement of the Park's lake water quality must also be a long-term objective and, to be cost effective, will comprise a staged treatment train approach with a number of solutions rather than a one-treatment solution. Appropriate methods and management practices for remedying and/or enhancing the water assets of the Park are given under each of the following:

- Major sub-catchments
- Park Lakes
- Catchment-wide
- Community
- Lakes

To complement the natural environment of the Park, low impact design (LID) practices, which utilise vegetation and the natural environment to manage stormwater quality and quantity, should be utilised where feasible. Solutions need to be selected that best suit the contaminants of most concern in each sub-catchment, and that are both practical to construct and maintain.

> "Waterfowl in the Bowl of Brooklands are a significant source of phosphorus, which is the limiting nutrient in terms of aquatic plant and algal growth in waters of the Park. As such, waterfowl in the Park is a direct factor in promoting aquatic plant and algae growth whereas nitrogen would have less effect."

6.1 Vogeltown Sub-catchment

The following proposed control mechanisms will lead to a reduction in the load of sediment and sediment-associated contaminants entering the Park's lakes from the Vogeltown and Kaimata Street sub-catchments:

- Construction of a forebay on the Goodwin Dell tributary, downstream of the confluence of the Vogeltown and Kaimata Street tributaries. A sediment forebay would provide stormwater treatment by slowing the velocity of stormwater flow and allowing sediment to drop out of suspension prior to discharge to the lakes. A forebay would require frequent maintenance in order to minimise sediment accumulation. Therefore site selection for vehicle access while minimising disruption for usage to the Park is important.
- Remove existing levels of sediment accumulated in the Truby King Dell pond, which is heavily silted. It is recommended that this area be reinstated as a preliminary treatment area for sediment removal.
- Construction of a wetland system either upstream of Truby King Dell pond or in the Goodwin Dell area. A wetland located in the Goodwin Dell area would have the advantage that it would treat the combined flow from Vogeltown and Kaimata Street tributaries. The feasibility of a wetland system in each of these locations requires further investigation as these treatment devices require reasonably large, flat areas in order for them to provide adequate treatment and flow attenuation.

6.2 Brooklands Arm

Management solutions for the Brooklands Arm tributary in order to improve water quality in the tributary and lakes prior to discharge to the lake system include:

- A constructed wetland system in the area of the existing Brooklands Arm sediment trap to reduce nutrient and bacteriological counts discharged to the lakes. This requires further investigation due to site constraints.
- Accumulated existing sediment levels in the vicinity of Brooklands Arm sediment trap requires removal and the area redeveloped into a sediment forebay.
- Removal of all lawn clippings from the mown grassed area of the Bowl.
- Removal of the stables wash-down area as a potential contaminant point source would improve the water quality of Bowl Lake. This could be achieved by either roofing the stables wash-down area and/or directing all wastewater from the wash-down area to the sewer.
- Waterfowl management within Brooklands Bowl is imperative in order to improve of nutrient and bacteriological loads and water quality in Bowl and Lily Lakes. However, waterfowl management presents one of the greatest challenges in terms of overall successful management solutions. Nevertheless, there are a number of approaches that could assist in reducing the waterfowl population. One of these may be to reduce the desirability of the Bowl area as a habitat for waterfowl. This could be achieved by undertaking a public education programme to limit the number of people feeding the waterfowl combined with a relocation programme (culling is not recommended), particularly during warmer summer months when waters are more susceptible to poor conditions. Another option is to reduce the desirability of the Bowl area as a habitat for waterfowl by minimising access to Bowl and Lily Lakes. This could be achieved by placement of a barrier along the lake front margins thereby restricting waterfowl access.

6.3 TSB Stadium and Car Park

Improvement to the water quality and quantity of runoff from the existing TSB stadium roof and car park area could be achieved by utilising methods that direct runoff to soakage. These practices need to be sized for frequent 'first flush' low flow events rather than high flow events. The following are proposed treatment options for this area, each requiring further investigation:

- Placement of swales along the edge of the existing car park pavement would provide a more natural flow path and will also provide a small contaminant load reduction. Limitations with this option are the available space and grading of the existing car parks.
- Rain gardens (bio-retention systems) could be constructed at existing catchpit locations and/or along the kerb. Runoff directed to the rain garden would pond at the surface and then slowly infiltrate through the soil medium, where it would then discharge either by infiltration to the ground below and/or collected in an underdrain pipe. Overflow provisions back into the existing reticulation system are required to cater for runoff volumes exceeding the design treatment.
- Permeable paving could be installed within the existing car parking bays which allow stormwater runoff to infiltrate to ground.
- A larger scale option than that of permeable paving is the use of infiltration trenches. This practice is better suited where runoff is less likely to contain sediment, or has been pre-treated to remove sediment, that will over time clog up infiltration processes. In this instance, runoff from the stadium roof could be directed straight to an infiltration trench.
- Catchpit filters (Enviropods etc). These devices will remove coarser sediment and organic matter such as leaf detritus.
- The large grassed area to the east of the TSB complex, Totara Dell, could be utilised as a single filtration/infiltration treatment area for runoff from the stadium and car parks.

> "The primary sources of water and sediment contamination in the lakes were the TSB stadium, stables, waterfowl, urban land use in the south and southwest of the catchment, and accumulated sediment in the Park's lakes."

6.4 Park Lakes

The lakes are a source of contaminants to both sediment and overlying waters through internal cycling. Degradation of the water quality of the lakes, particularly during summer, is partly attributed to the accumulation of sediment and contaminants. The following were recommended:

- Dredging of the lakes where fine sediment has accumulated is a priority in terms of improving the water quality of the Park's lakes. If the bed sediment is not periodically removed (dredged), high contaminant concentrations in the lakes may remain for some time due to internal nutrient cycling despite any future controls in the greater catchment. Installation of sediment forebays at the inlets to the lakes will assist in minimising the frequency and volume of future dredging.
- In addition to standard wetland design, a recent proprietary product, a Floating Treatment Wetland developed by Floating Island Pacific, could be installed in the Park's lakes. The floating island consists of a non-woven matrix of fibres which provide a platform for the growth of plant roots buoyed by bonded foam. The floating wetland would assist in water quality improvements by removing dissolved contaminants from the lakes.
- Alternative flow paths between Main Lake and Fountain Lake may provide some key benefits to the water quality of Fountain Lakes. In particular, the flowpath that connects Main Lake and Fountain Lake could be rerouted to the southwest corner of Fountain to improve flushing.
- The use of an alternative water source may be used as a restoration tool for the Park's water quality. In this case, water of better quality, potentially from a groundwater source, may be pumped or flushed through the Park's lakes in order to reduce the nutrient and contaminant concentrations to limiting concentrations.

6.5 Catchment-Wide Control

- Land use controls within the catchment could be implemented. In particular, the capturing of gross pollutants and coarse sediments from urban streets and residential areas before they enter the waterways. Options include catchpit filters (Enviropods etc), porous pavement and regular street cleaning. These may necessitate a review of the District Plan to assess whether any tools or rules could be changed.

6.6 Community Education

Education of both the community living within the Park catchment area and Park visitors is essential to promote greater understanding and responsibility of the Park's values and management issues. Topics include:

- The importance of water quality for a maintaining the Park and its waterways and the treatment processes available and that are implemented in the Park.
- Labelling catchpits that collect runoff that discharges to the Park e.g. "Drains to Lake".

- The impact of feeding waterfowl both in terms of impacts to the health and well-being of the resident bird population and the impact of associated contaminants on water quality of the Park's water resources.
- Potential effects of home maintenance and associated activities in the catchment on the Park's water resources e.g. fertiliser usage, car washing wastewater, grass cutting disposal.

Methods include pamphlet distribution, interpretative signage in the park, and information stalls/ workshops held at community events in the Park.

7. Conclusions

The results of this study show that in general, the water quality of Pukekura Park's water bodies were nutrient enriched with some high bacteriological counts and zinc concentrations. The primary sources of water and sediment contamination in the lakes were the TSB stadium, stables, waterfowl, urban land use in the south and southwest of the catchment, and accumulated sediment in the Park's lakes.

The water quality of the Park's lakes has been degraded incrementally through a range of changes to the hydrology and water quality within the catchment. To reverse this trend in a cost effective manner, will require incremental changes and adoption of a "treatment train" approach. A catchment management plan with options for improving the water quality of the lakes has been undertaken. The plan includes both installation of stormwater treatment devices on each of the major contributing tributaries and point source control. The construction of forebays and wetlands on the Vogeltown and Brooklands Arm tributaries is likely to lead to an overall reduction in the total load of sediment and sediment-associated contaminants entering the Park's lakes. Appropriate source control methods include management of the waterfowl population in the Bowl, redirection of stable wash water discharge and installation of infiltration/filtration treatment of surface runoff from the TSB stadium complex. Degradation of the water quality in Main Lake, particularly in summer, is partly attributed to accumulated sediment and, as such, dredging of the lakes where fine sediment has accumulated is a priority in terms of improving the water quality of the Park's waters. ■

References

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000). Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy, Australian and New Zealand Environment and Conservation Council. http://www.mfe.govt.nz/publications/water/anzecc-water-quality-guide-02/anzecc-water-quality-guide-02-pdfs.html

Edgar, NB (1999). Land Use in the Taupo Catchment, New Zealand. New Zealand Journal of Marine and Freshwater Research 33: 375–383.

McDowell RW, Larned ST (2008). Surface Water Quality and Nutrients: What Should the Focus Be? Proceedings of the Workshop Carbon and Nutrient Management in Agriculture, Massey University, Palmerston North February 2008.

Ministry for the Environment (MfE) (2003). Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Ministry for the Environment. http://www.mfe.govt.nz/publications/water/microbiological-quality-jun03/html/index.html

Shaver E (2008). Auckland Botanic Gardens Lake Management and Low Impact Design Discussion and Recommendations. Prepared for Auckland Regional Council.

White E (1983). Chemicals and Their Importance to the Lake. In Lake Taupo: Ecology of a New Zealand Lake. Editors Forsyth DJ and Howard-Williams C. NZ Department of Scientific and Industrial Research Information Series No. 158, Wellington.

Development of Auckland's Demand Management Plan

Roseline Klein – Watercare Services Ltd; Charlotte Reed, Tonkin & Taylor Ltd and Jonathan Reed – CH2M Beca Ltd

Introduction

Each day, Watercare Services Limited supplies around 330 million litres of water to Auckland, and treats around 408 million litres of wastewater to a high standard. Watercare's vision is to provide the people of Auckland with outstanding and affordable water services, now and into the future. Its legal obligation is to do so in a way that minimises the overall costs to its customers. Encouraging efficient water use is therefore crucial to Watercare achieving its business objectives. It also fits the company's philosophy of kaitiakitanga, or environmental stewardship; a recognition that water is more than a commodity, it is a precious resource and a necessity of life.

Demand Management

The Auckland Council came into being on 1 November 2010, following the amalgamation of seven territorial authorities and the Auckland Regional Council. As part of that process, Watercare's bulk supply business joined with the water retail businesses operated by the legacy councils to create an integrated water and wastewater service provider.

In 2011, Watercare published its first Demand Management Plan, in which it established a demand management target of 15% reduction in gross per capita consumption (gross PCC) by 2025. This equates to a gross PCC of 253 litres per person per day, compared to the 2004 figure of 294 litres per person per day – an ambitious target, given Auckland already has a lower gross PCC than other New Zealand cities. In October this year, Watercare published an updated version of the 2011 document, the 2013-2016 Auckland Regional Water Demand Management Plan. The gross PCC target remains the same; however, the 2013 plan provides new data analysis, assesses the programmes that have been implemented to date, identifies additional actions to be developed and areas where effort should be directed, and provides actions and timeframes for implementation.

Gross v Residential Per Capita Consumption

Per Capita Consumption is measured by two different indicators:

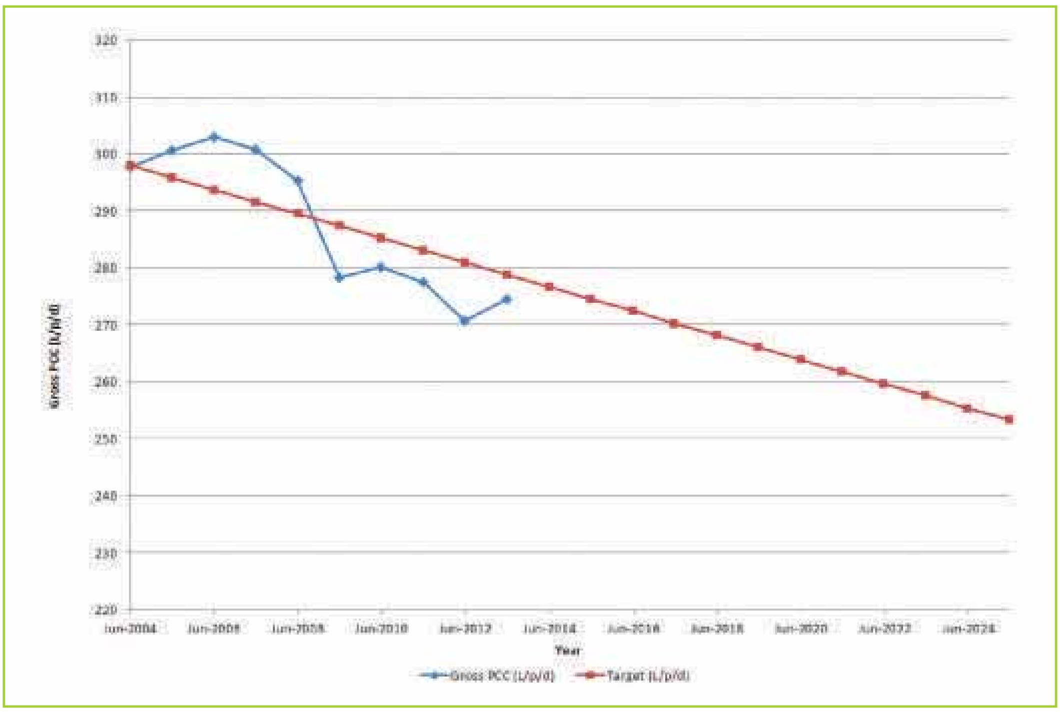
Gross Per Capita Consumption is total water put into supply, divided by the number of people connected to the water supply system. Gross PCC is the main indicator used to track demand management in New Zealand. In Auckland, it is currently 274 litres per person per day, which is the lowest amongst comparable New Zealand local authorities[1]

Residential Per Capita Consumption is total water supplied to residential customers only, divided by the number of people connected to the water supply system. Residential PCC is used to track how much water households use. It is harder to measure than gross PCC and as a result is not published as often as gross PCC. In Auckland, the residential PCC is 2012 was 157 litres per person per day. Other cities in New Zealand have been assessed to have a residential PCC of between 180 litres per day and 198 litres per day.[2]

One of the improvements brought by the 2013 plan is to quantify what the gross PCC target means in terms of the overall water use of Auckland in 2025. Reaching the gross PCC target means that in 2025, we can avoid the need for an additional 35 megalitres a day of water to be supplied to Auckland.

Currently, Auckland is five litres per person per day ahead of the intermediary 2013 target, as shown in Figure 1. Figure 1 also shows the year-on-year variability in gross PCC. This can partly be explained by weather characteristics; for example, the long, hot dry summer of 2013 resulted in higher demand than the cooler, wetter summer of 2012.

Figure 1 – Auckland's demand management savings pathway



Planning Framework

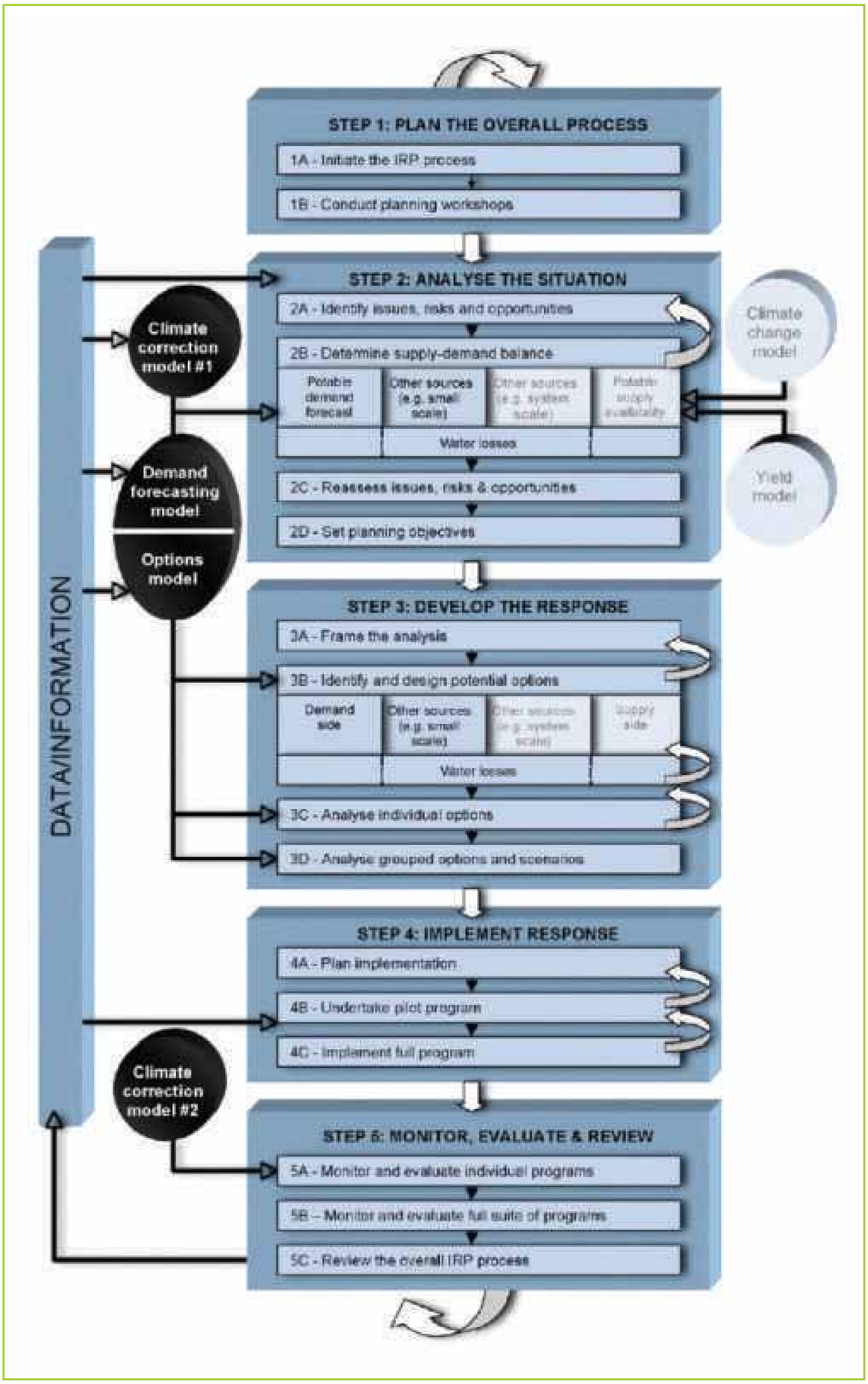
Watercare has elected to base the Plan on the Guide to Demand Management (2008), developed by the Water Services Association of Australia (WSAA). This framework is freely available and represents one of the available best practice methods for water resource planning, including demand management.

The framework is shown in Figure 2. The advantages of using this planning framework include:

- Confidence that a robust methodology underpins the Plan

"Each day, Watercare Services Limited supplies around 330 million litres of water to Auckland, and treats around 408 million litres of wastewater to a high standard. Watercare's vision is to provide the people of Auckland with outstanding and affordable water services, now and into the future. Its legal obligation is to do so in a way that minimises the overall costs to its customers."

Figure 2 – the WSAA framework



- Ability to ensure the Plan fits with the overall water resources planning process
- Incorporation of existing best practice. Watercare has not had to 're-invent the demand management wheel' and the Plan covers all aspects of demand management

Analysis of Demand

Watercare has a fully metered customer base, which has enabled the company to build a comprehensive understanding of how the water it supplies is used. This understanding allows Watercare to tailor its demand management measures appropriately, and measure their success effectively. Water meters also encourage consumers to consider their water usage – demonstrated by the drop in gross PCC that followed their introduction to the Auckland market.

Approximately 60% of the water supplied by Watercare is used by residential customers. Non-residential customers consume around 27%, with the remainder comprising unmetered uses and unaccounted for water, including leakage.

Figure 3 shows the breakdown of water supplied over the three financial years from 2010 to 2012, separated between residential and non-residential users, the Papakura bulk supply and non-revenue water. The Papakura bulk supply is separated out as no breakdown is available for residential and non-residential demand in this area. For the same reason, the Papakura population was excluded from the residential PCC figures[3].

Over this period of three years:

- Gross PCC reduced by approximately 10 litres per day (as shown in Figure 1); but
- Residential PCC has remained broadly constant

These data, while somewhat limited, seem to indicate that change in gross PCC does not necessarily entail a corresponding change in residential consumption.

"Overall, the highest indoor water end use was the shower, followed by the washing machine and the toilet."

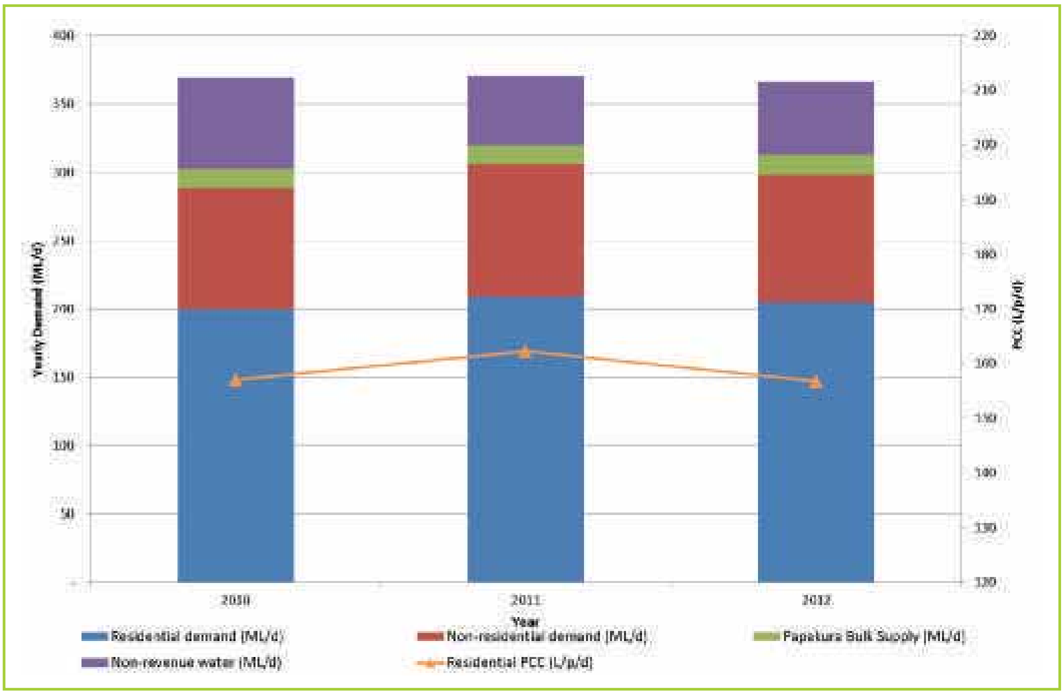


Figure 3 – Consumption classification for 2010–2012

To understand how water demand management measures could reduce residential water use, it is important to first look at how water is used by households and by non-residential users. Between February and September 2008, the Building Research Association of New Zealand (BRANZ) monitored the water use of 51 randomly selected households across the Auckland region. The results of this study were used to assess which water efficiency options could best be used to reduce water use in Auckland.

Overall, the highest indoor water end use was the shower, followed by the washing machine and the toilet. Figure 4 shows this and how water use changes between summer and winter.

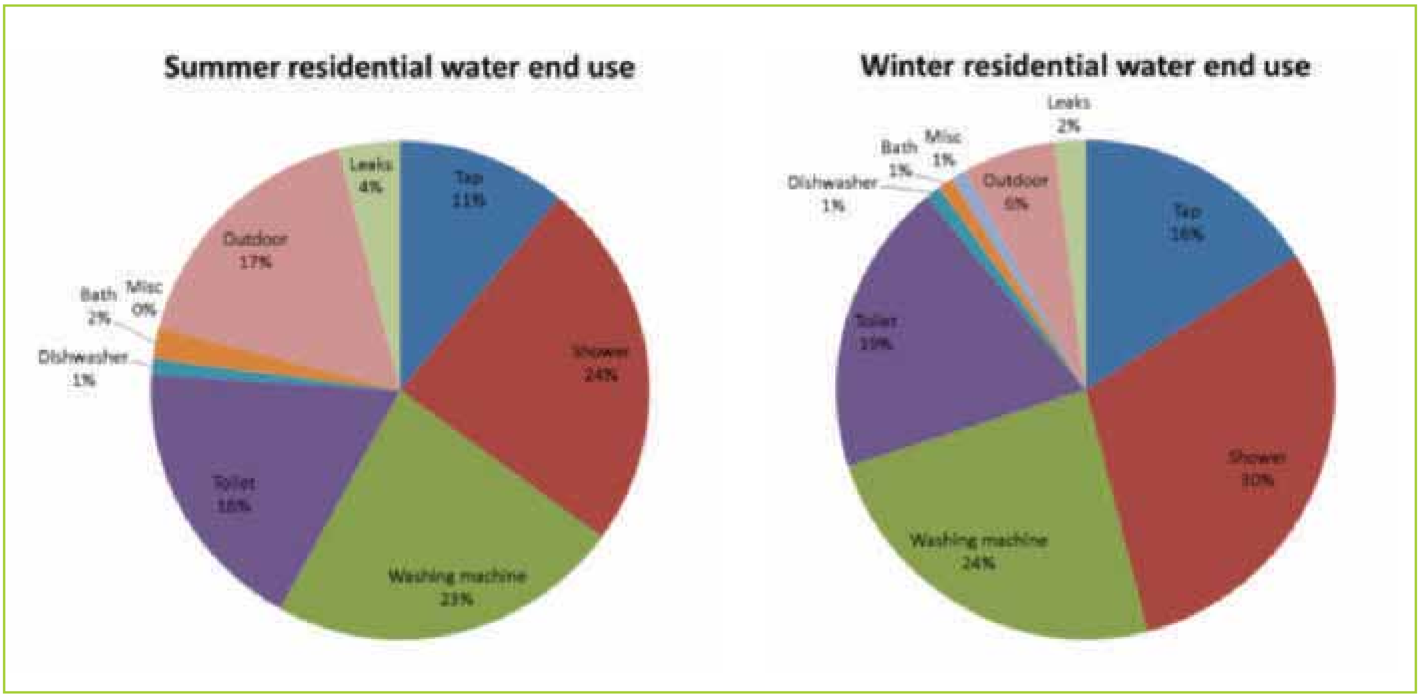


Figure 4 – Residential water end use

"To understand how water demand management measures could reduce residential water use, it is important to first look at how water is used by households and by non-residential users."

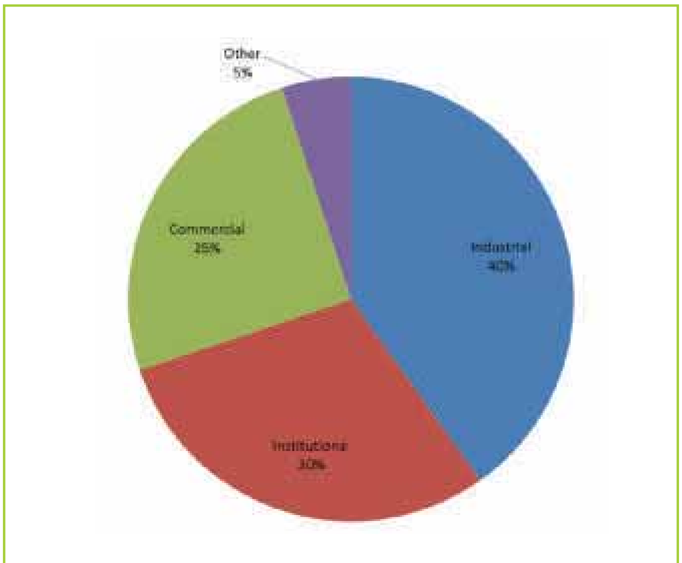
"Growth and peak demand are two of the most important factors affecting the future demand for water in Auckland. Auckland's population is forecast to increase by 57% by 2051 and Watercare needs to invest in sufficient additional infrastructure to meet anticipated peak demand, while continuing to meet its obligations as a minimum cost provider."

In 2012 Watercare sponsored a Masters of Engineering research project that investigated how non-residential users consume water and their contribution to peak summer water demand. The research project reviewed non-residential water use between November 2007 and February 2012 for monthly metered accounts. One of the project's primary goals was to establish how non-residential water consumption was divided between the major sectors (commercial, industrial, institutional), and the corresponding subsectors (e.g. manufacturing, agriculture, schools). The results of this analysis were used to determine where savings could most easily be made by non-residential users.

Figure 5 shows the distribution of non-residential water use between the major sectors. Industrial users account for the largest portion of non-residential water demand (40%) and institutional and commercial demands are fairly similar, at 30% and 25% respectively[4]. The 5% 'other' section represents those accounts which could not be satisfactorily classified.

The study investigated each of these sectors in more detail. It showed that a small number of large users are responsible for much of the industrial and institutional demand, whilst commercial demand is more evenly spread.

Figure 5 – Distribution of non-residential water use



"The study investigated each of these sectors in more detail. It showed that a small number of large users are responsible for much of the industrial and institutional demand, whilst commercial demand is more evenly spread."

A Clear Pathway to Meeting the Target

Step 3 of the WSAA framework is to develop the response. Watercare's Plan first considers the scale of the savings required to meet the target, described below. It also reviews existing demand management practices, examples of which are given below.

Examples of Watercare's Current Demand Management Programmes

The Water Advice Line

Watercare has launched a 'Water Advice Line' programme alongside EcoMatters Environment Trust. This programme targets residential customers with high water use across the region. High water users who contact Watercare for assistance in reducing their consumption are offered the opportunity to participate. A water audit is conducted over the telephone and the findings are used to develop customised water saving recommendations. Regular reports on the customer's water usage over a 12 month period are provided to monitor progress and assess the benefits of the programme. Between November 2012 and October 2013, nearly 200 households entered the Water Advice Line programme.

Housing New Zealand Programme – Working With a Large User

Watercare is working with Housing NZ on a regional water efficiency programme which aims to detect leaks and reduce the number of high water users in their Auckland properties. Every month, Housing NZ properties' meter readings are compared and those with the greatest change in consumption are selected for audit. A project team analyses the meter reading data for these properties in order to detect high water users and any significant changes in water usage. Housing NZ contractors then examine whether this is due to leakage. Over the 2012–13 financial year, 351 houses were examined. Of those, 255 houses were identified as having leaks requiring repairs. Through this, Housing NZ achieved water savings of 132 megalitres over one year, or approximately 360 litres a day. As the number of properties with leaks declines, properties with high water use are now being encouraged to identify ways to reduce consumption.

Growth and peak demand are two of the most important factors affecting the future demand for water in Auckland. Auckland's population is forecast to increase by 57% by 2051[5] and Watercare needs to invest in sufficient additional infrastructure to meet anticipated peak demand, while continuing to meet its obligations as a minimum cost provider.

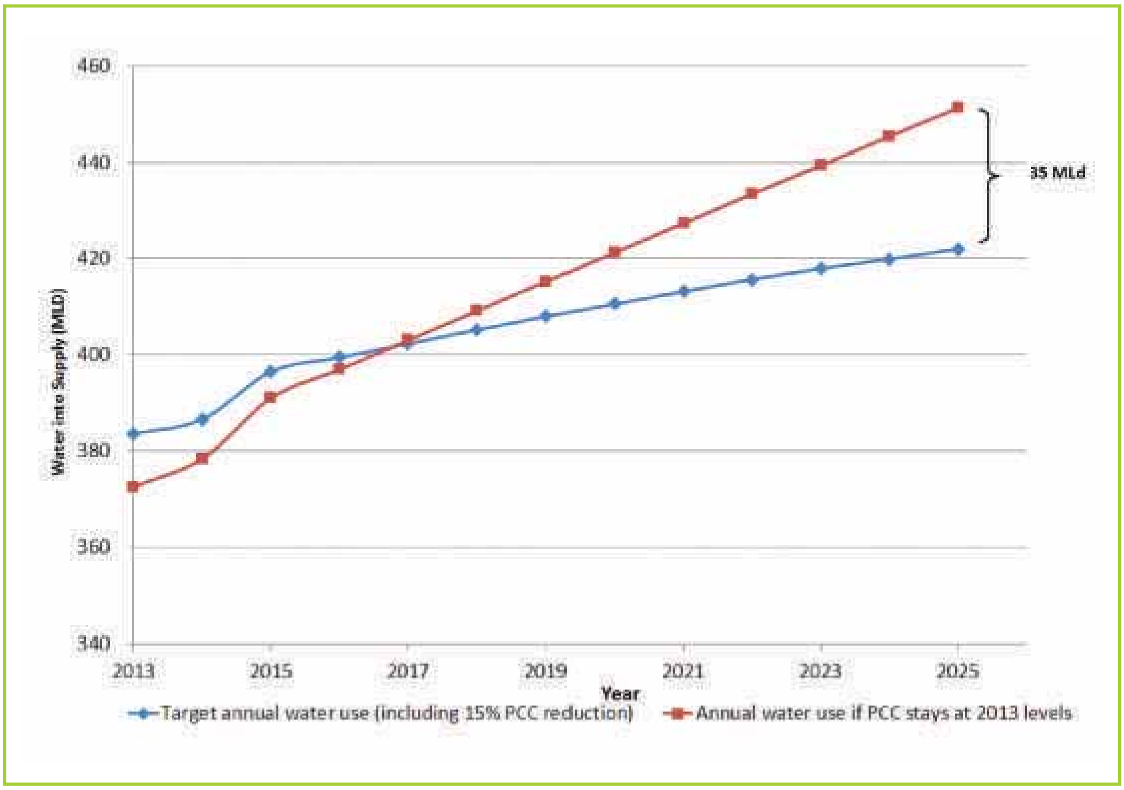


Figure 6 – Projected annual water demand based on current and target gross per capita consumption

The blue line in Figure 6 shows the average annual volume of water Auckland will use if the demand management target is met. The step increase in 2014 reflects the scheduled addition to the metropolitan supply of rural communities including Pukekohe and Kumeu. The red line shows the volume that will be used if gross PCC does not change. Again, we see that current gross PCC is lower than the intermediary target.

However, if consumption remains at the present level, total water supply needed for Auckland in 2025 would be 35 megalitres a day more than Watercare has planned to cater for.

"This highlights the need for a strong demand management plan. It also illustrates Watercare's ongoing challenge to accurately match future supply with peak demand; to secure sufficient funding to develop the necessary infrastructure while meeting its obligation to deliver high-quality water and wastewater services at a minimum cost."

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Outcomes

The Plan sets out how Watercare can work with its customers to save 35 megalitres per day by 2025 in order to achieve its overall target. This represents steps 4 and 5 of the WSAA framework, which includes implementation, monitoring and review.

A long list of demand management options was developed and reviewed against criteria including potential savings, ease of development, suitability for target sectors and sub-sectors, and Watercare's ability to either implement or influence the implementation of each option.

The selection process then categorised the options as:

- For immediate action
- For further assessment by way of a pilot programme
- Further investigation required
- For future consideration

The Plan also develops a number of key performance indicators which will be monitored and published by Watercare on an annual basis, allowing accurate measurement of the progress towards the demand management target. The Plan recommends that specific measures for individual options or projects should also be developed, such as the key actions, costs incurred and the savings (either measured or estimated).

A cost-benefit tool has been developed by Watercare to assess the benefits of different water efficiency measures. Over time, this will be populated with data specific to Watercare and this demand management programme to enable decisions to be made about the cost effectiveness of various demand management activities in the future.

Conclusions

Watercare's 2013 Demand Management Plan provides a solid foundation for future demand management activities in the Auckland region. It assesses the programmes that have been implemented to date, suggests additional initiatives for development and identifies areas where effort should be directed. It uses robust analytical techniques to provide actions, key performance indicators and timeframes for implementation, and enables demand management options to be targeted at the different sub-sectors that together make up the total demand for water in Auckland.

Footnotes:

[1]Water New Zealand 2011-2012 National Performance review. Comparable Local Authorities are those with over 80% of their properties considered to be urban properties.

[2]Auditor General of New Zealand: Local authorities: Planning to meet the forecast demand for drinking water

[3]Papakura is an Auckland suburb serviced by Veolia. Watercare supplies Veolia with bulk water and does not have access to the end-use data,

[4]A limitation of this data is that many smaller accounts were excluded from this assessment as they were not metered on a monthly basis. This is likely to have excluded many Commercial users such as retail stores or supermarkets; consequently, commercial demand may be greater than suggested by these results.

[5]Auckland Residential Futures Model, Medium Projection, issued by Auckland Council, February 2012

"A cost-benefit tool has been developed by Watercare to assess the benefits of different water efficiency measures. Over time, this will be populated with data specific to Watercare and this demand management programme to enable decisions to be made about the cost effectiveness of various demand management activities in the future."

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Annual Report on Drinking Water Standards

In July this year the Ministry of Health released its Annual Report on Drinking Water Standards for the July 2011 to June 2012 year. The report describes the microbiological and chemical quality of water in New Zealand drinking-water supplies serving populations of more than 100 people as well as progress towards meeting the requirements of the Health Act 1956 (as amended in 2007).

The report carries a comprehensive listing of compliance to drinking water standards for all local authority 'zones', categorised under the relevant regulations. Each zone within each local authority jurisdiction is rated against a number of factors including chemical and microbiological contamination.

Water is pleased to provide a summary of the Annual Report here. A full copy can be found on the Ministry's website at www.health.govt.nz/publication/annual-report-drinking-water-quality-2011-2012.

Report Summary

Overall, 76.7 percent of New Zealanders (2,920,000 people) received drinking-water that met all requirements of the Standards in the reporting period. This represents an increase of 250,000 people compared with the previous 1 July 2010 to 30 June 2011 reporting period.

The rise in numbers is not due to an increase in overall compliance rates, but reflects the inclusion of 10 Christchurch zones in the current period that were excluded from the previous reporting period. In terms of supply population, there was a 1.8 percent point drop in overall compliance rate compared with 78.5 percent meeting requirements in the previous period.

The decrease in the overall compliance rate is driven by 18 distribution zones, which serve 143,000 people. These zones met all the requirements of the Standards in the previous period, but failed to do so this time. This decline in compliance was offset by 24 zones serving 71,000 people, which failed previously, but met all requirements for the current reporting period.

To comply with the overall requirements of the Standards, a zone must comply with the bacteriological, protozoal and chemical standards. Compared with the previous period, bacteriological compliance decreased by 1.5 percentage points, chemical compliance decreased by 1.4 percentage points, but the protozoal compliance rate rose by 0.7 percentage points.

Three factors contributed to this 1.5 percentage point decrease in bacteriological compliance:

- a 0.8 percentage point increase in the proportion of the reported population that received water with excessive transgressions[1]
- a 0.1 percentage point increase in the proportion of the reported population that received water for which there was inadequate corrective action following a transgression
- a 0.6 percentage point increase in the proportion of the reported population that received water from inadequately monitored supplies.

The first two of these reasons for non-compliance, 'excessive transgressions' and 'inadequate corrective action,' potentially put public health at risk. 'Inadequate monitoring,' where sampling is not carried out in accordance with the Standards, is a technical non-compliance and not a direct public health concern.

Bacteriologically-compliant drinking-water was received by 95.8 percent of New Zealanders (3,648,000 people) on reported

"The rate of development and implementation decreased as population size decreased. Twenty nine percent of the smaller drinking-water suppliers had not started preparing their public health risk management plans, but smaller suppliers have longer to comply with the provisions of the Act."

supplies during the period, compared with 97.3 percent previously. Protozoal compliance increased to 79.8 percent from 79.1 percent, while chemical compliance decreased to 95.7 percent, from 97.1 percent. As expected, compliance with the Standards was generally highest in the large supplies and lowest in the small supplies.

The exception to this was the rate of chemical compliance. This was highest in small supplies because they are not required to be assessed for chemical contamination and so comply by default.

The provisions of the Health Act 1956 take effect progressively over the next few years, starting on 1 July 2012 for large suppliers. As part of these provisions, water suppliers will be required to prepare public health risk management plans. Overall, 37 percent of the supply population (36 percent of zones) have had plans implemented by 1 July 2012.

Drinking-water suppliers serving a further 60 percent of the population (44 percent of zones) were preparing plans prior to implementation. Public health risk management plans for all large zones have either been implemented or were at various stages of plan preparation.

The rate of development and implementation decreased as population size decreased. Twenty nine percent of the smaller drinking-water suppliers had not started preparing their public health risk management plans, but smaller suppliers have longer to comply with the provisions of the Act. Small supplies are generally not required to have a public health risk management plan.

During the 1 July 2011 to 30 June 2012 reporting period, a number of other actions were carried out by water suppliers to meet the requirements of the Act.

- Monitoring: Overall, distribution zones serving 96 percent of the population (83 percent of zones) met the monitoring requirements of the Standards. Compliance with the Escherichia coli and chemical monitoring requirements of the Standards generally increased with the size of the zone population, with 95 percent of large supplies and 78 percent of small supplies meeting the monitoring requirements.

- Adequacy of supply: Overall, distribution zones serving 99.9 percent of the population (98 percent of zones) met the requirement for adequacy of supply during the reporting period, including all large, medium and minor supplies.
- Source protection: Overall, distribution zones serving 99.9 percent of the population (97 percent of zones) met this requirement, including all large, medium and minor supplies.
- Records: Adequate records were maintained for distribution zones supplying 99.9 percent of the population (97 percent of zones). All large, medium and minor supplies met the records requirement. Small supplies are not required by the Act to keep records.
- Complaints: Water suppliers investigated almost all of the complaints they received about the drinking-water they supplied to the population (99 percent of zones).
- Remedial action: Almost all suppliers undertook immediate remedial action in response to transgressions. Water suppliers did not take remedial action, when necessary, in supplies serving 2 percent of the population (6 percent of distribution zones).

By the end of the reporting period, all size categories of drinking-water supply had reported good progress towards meeting the legislative requirements of the Act with the exception of monitoring and remedial actions. Water suppliers are moving towards a more proactive approach to protect health. In general, the larger suppliers have a greater level of compliance with their current requirements than smaller categories of supplies.

While drinking-water suppliers were not yet expected to meet the requirements of sections 69S to 69ZC of the Act within the reporting period, including the requirements regarding monitoring, public health risk management plans, adequacy of supply and source protection, most drinking-water suppliers met these requirements. There is a tendency for fewer smaller water suppliers to have met their current requirements under the Act than the larger water suppliers. Many water suppliers already meet the requirements of the aspects of the Act that are being phased in, and many others are making progress towards that.

Christchurch Water Supplies

The current reporting period included the 10 Christchurch supplies, serving 400,000 people, that had been exempted from the previous (1 July 2010 to 30 June 2011) reporting period due to the Canterbury earthquake sequence. Although it will be several years before repairs to the infrastructure supporting these drinking-water supplies return it to its pre-earthquake status, progress is being made.

While the risk profile for the water supplies in Christchurch was higher during the current reporting period than it was before the earthquakes, this risk is being managed.

During this current period, all 10 Christchurch drinking-water supplies met the bacteriological and chemical requirements of the Standards, while protozoal compliance was met by nine supplies, serving 317,000 people.

Footnote

[1]An excessive transgression is when the number of samples in which Escherichia coli is found during the reporting period is greater than that allowed by the Standards.

March Construction crew block and test a 50 metre line to locate a leak

The job was made easier by using Sava Pipe Sealing Bags

Christchurch Rebuild Brings Daily Challenges

It doesn't matter what part of the rebuild of Christchurch you're involved in, from project managers and engineers to crane operators and drain layers, the job we do is rarely straightforward and usually requires a decent application of problem solving as well as hard work. Every day brings new challenges and no one has taken the time to give us a step by step, 'slot A into slot B' set of instructions on how to rebuild a city.

Instead we spend our long days figuring out how to join things together, pull things apart, dig things out, weld things on, lift things up, tear things down, fit things in, keep ourselves safe and still get the job finished on time and within budget. It's a challenge, but it pays well and we love it.

> "It doesn't matter what part of the rebuild of Christchurch you're involved in, from project managers and engineers to crane operators and drain layers, the job we do is rarely straight forward and usually requires a decent application of problem solving as well as hard work. Every day brings new challenges and no one has taken the time to give us a step by step 'slot A into slot B' set of instructions on how to rebuild a city."

HTC Specialised Tooling has been providing solutions to these challenges for over 30 years. We have a huge range of gear to help, as we like to say "make the hard jobs easy" and one of our newest and most popular items is our Sava range of inflatable drainage plugs. Simple by design, you inflate the appropriate size in a pipe to safely and easily create an air and water tight seal. Once the pipe is repaired, place a testing bag at the other end to fill the space between with pressurised air or water. If it holds pressure you know you have a good section of pipe.

Here in Christchurch, March Construction have been among those leading the charge with the infrastructure rebuild and use Sava plugs on all their sites across the city. Jamie Ross, one of their experienced site managers, is committed to creating efficient worksites to ensure March Construction continues to set the standard for delivering on time and within budget. Jamie is a strong believer in using the right tools for the job and knows the savings this can bring.

"When you employ hundreds of people and the city continues to be hamstrung by delays, the decision to give my teams the tools they need to get the job done is a no-brainer. If there's a tool that helps do something faster, better and safer it will probably pay for itself pretty quickly". Tommy, one of Jamie's hard working foremen, reckons the Sava plugs have saved them many hours fiddling around with wind-up plugs and while his day still presents many unexpected challenges, Sava has at least made the hard job a little bit easier.

The Sava range is available for hire or purchase from HTC. ■

"Makin' the Hard Jobs Easy"

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With or without flow-through by-pass. Sava pillow shaped pipe plugs are economical, lightweight and fit in through tight access points such as standard 24" manholes.

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The construction of these plugs ensures the flow of larger amounts of sewage through the plug. Testing tightness with air or water is possible. All plugs are equipped with quick action couplings for inflation.

MULTI-SIZE LONG PLUGS TESTING HOUSE CONNECTIONS

These plugs are used for testing tightness of pipes with air or water and can be inserted at an angle through connections into a main pipe, efficient sealing of both connections and a main pipe is guaranteed.

PLUGS FOR TESTING HOUSE CONNECTIONS

These plugs are suitable for testing tightness of plumbing and sewers sith air or water. Their use is simple and all the work can be done from one inlet opening gully only. Handling and inflating these plugs runs independently. Distance between plugs can be adaptable

MULTI-SIZE PLUGS

These all-purpose plugs have a superior surface pattern for sealing and are used for sealing and testing pipeline tightness with air or water. Multi-size plugs are stretchable so only a few plugs are required to cover pipelines of different diameters.

FLEXIBLE PACKERS

Suitable for repair of damaged pipeline sections and joints. In combination with resins and reinforcement materials they assure tightness and proper static strength of a pipeline.

SINGLE & MULTI-SIZE PLUGS

These can be used in all types of pipelines. The range comprises of single-size plugs used for sealing pipes of one diameter and multi-size plugs where one plug size can be used for sealing pipelines of different diameters.

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SmartRaft – a Solution for Waterway Restoration

How a local company turned to nature to develop a water treatment system that costs nothing to run, uses no energy and works continuously with minimal maintenance.

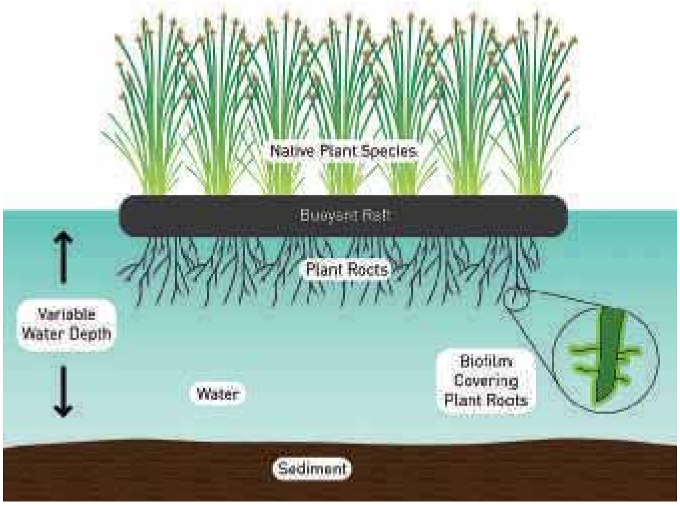
With increasing interest in water and water quality, and resulting pressure on farmers and local government to protect the health of waterways, attention is turning to development of effective waterway restoration strategies and on-site water treatment systems. To make new development attractive, solutions need to be economical, easily maintainable, have low energy input and be compact.

For Johanna Güttler, Robert Fryer and the rest of Nelmac's Conservation & Ecology team, finding a solution that met these requirements was an irresistible challenge. They were looking for an answer that helps restore water quality and nature without using valuable land and further impacting on the environment. After much research and trialing, SmartRaft was created.

> "SmartRaft is a floating treatment wetland technology. It is a buoyant raft made from recycled plastic bottles embedded with plants."

SmartRaft is a floating treatment wetland technology. It is a buoyant raft made from recycled plastic bottles embedded with plants. The plants growing on a SmartRaft suspend their roots into the water (as seen in Figure 1) and source all their nutrient requirements directly from the water.

Figure 1 – SmartRaft illustration



SmartRafts can serve multiple purposes. SmartRaft plants clean the water they are on by removing the nutrients, heavy metals, suspended solids and pathogens from the water and by converting nitrate into nitrogen gas. Nutrients (incl. phosphorus and nitrogen) and some heavy metals are taken up by the plants via the roots to meet their own requirements.

Suspended solids, heavy metals and pathogens as well as more nutrients and heavy metals accumulate in a biofilm that forms around the roots naturally. Once the biofilm and associated particles becomes too heavy, it falls off the roots and deposits the particles in the sediment, where they remain bound in the sediment.

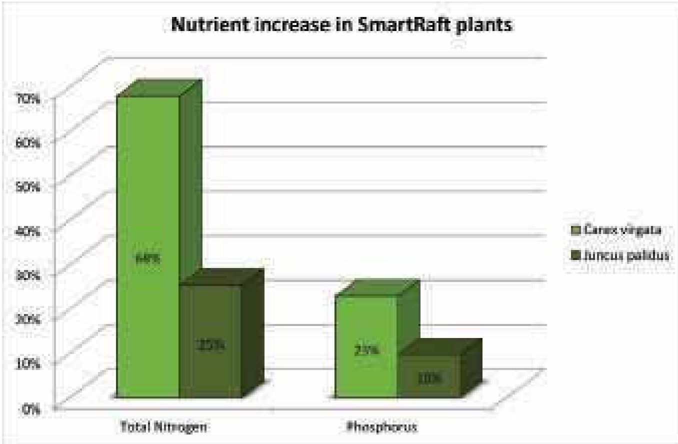


Figure 2 – Increase of nutrient (phosphorus and nitrogen) content in SmartRaft plants in 10 months compared to nursery plants before planting

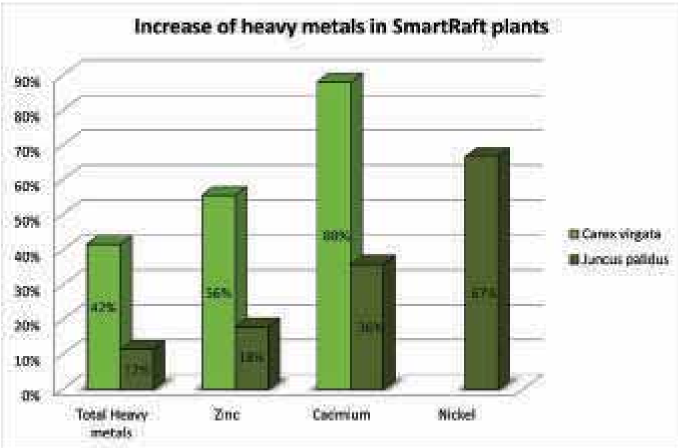


Figure 3 – Increase of total heavy metal content, zinc, cadmium and nickel in SmartRaft plants in 10 months compared to nursery plants before planting

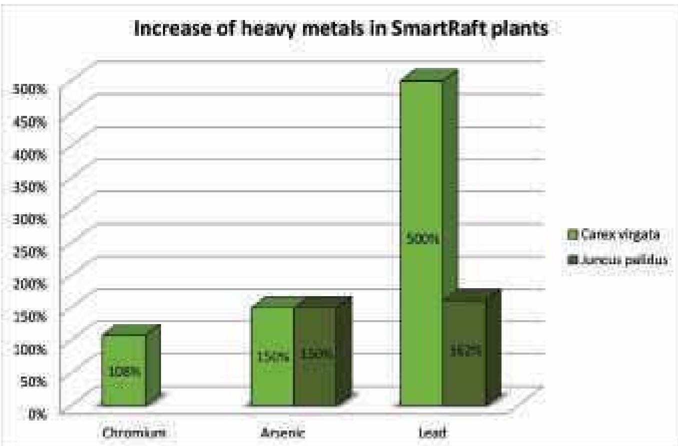


Figure 4 – Increase of chromium, arsenic and lead in SmartRaft plants in 10 months compared to nursery plants before planting

Figures 2 – 4 show the uptake of nutrients and selected heavy metals by SmartRaft plants on a run-off pond of a fertilizer company in 10 month after installation. The increase of nutrients and heavy metals is compared to the amount contained in the same plant species in the nursery prior to installation.

Only a small fraction of the nutrients and heavy metals in the water is accumulated in the above-ground plant material of SmartRaft. Depending on the plant species used for SmartRaft, nutrients and heavy metals are also accumulated in the roots.

However, far more of the nutrients and heavy metals are removed from the water through accumulation in the biofilm around the roots of SmartRaft plants and settling out in the sediment after sloughing of the roots.

SmartRafts are ideal for fixing ponds and waterways with an algae problem. SmartRafts cover the water surface and shade it plus lowering the nutrient availability in the water. This excludes algae from the waterbody, prevents algal bloom and eutrophication of ponds and waterways.

The shade provided through the SmartRafts and the overhanging foliage can minimize evaporation from a waterbody as well as regulating the temperature, therefore avoiding water loss.

For waters lacking clarity, SmartRaft is an ideal solution too. SmartRafts not only settle out those suspended solids that impede on clarity but they also make the conditions for settling of particles better because there are less water turbulences (wind, waves and thermal mixing) when SmartRafts are floating on the pond.

Figure 5 – Plant roots are the key to the SmartRaft treatment

SmartRafts are a great solution to improve water quality of ponds and waterways. They also create a unique environment and ecosystem. Biodiversity is increased through the SmartRaft plant habitat on the water, which encourages waterfowl, fish and insects onto the raft and into the water. Additional to the above benefits, SmartRafts look great and are an aesthetically pleasing feature for any pond.

Figure 6 – SmartRaft two month after installation

SmartRafts also cope with the main reason for failure of conventional wetlands – water fluctuations and resulting overtopping. In most ponds the water level can fluctuate greatly. Plants grown around the edges of a pond, however, do not tolerate long periods of low or high water levels. They either dry out or drown. SmartRaft plants overcome this issue through remaining floating on the water surface raising and falling with the water levels.

SmartRafts are ideal for any kind of pond holding water and slow flowing streams with a depth of more than 600mm. SmartRafts can easily be retrofitted onto any existing pond. No earthworks or inundation of the surrounding land is required.

Figure 7 – SmartRaft 14 month after installation


The team at Fluent Infrastructure Solutions

Fluent Solutions: A Tight Team with a Proud Tradition

Within half an hour of being told of an impending major company restructure, Derrick Railton, Gary Dent, Anthony Steel and Melanie Stevenson decided to start a new consulting engineering company. After working together for over 25 years, it was not a difficult decision to make.

So began the life of Fluent Infrastructure Solutions Limited (trading as Fluent Solutions). The four directors realised they needed to move quickly to provide the same high quality level of service and timely delivery, to maintain their relationships with their clients.

Within two weeks, the company had hit the ground running, taking up residence in Burns House, looking out over the Octagon, right in the heart of Dunedin.

> "Fluent have enjoyed the strong support of clients within Otago and around the country. There are new projects, such as the Shotover Wastewater Treatment Plant for Queenstown, and a fresh approach to work."

All four directors are highly experienced three-waters infrastructure engineers, well-regarded in the New Zealand water industry. They have been joined by Tommy Chan, another three-waters infrastructure engineer, and Dr Mona Wells, an environmental scientist specialising in contaminated land evaluation and remediation.

Six months on, Derrick reflects on an exciting and satisfying experience, "getting back to our Otago roots, and re-starting as a smaller yet more reactive team". Fluent have enjoyed the strong support of clients within Otago and around the country. There are new projects, such as the Shotover Wastewater Treatment Plant for Queenstown, and a fresh approach to work: "Never before have we entertained so many clients and colleagues over coffee than we do now …of course the fancy coffee machine helps!"

Getting back to their roots has also meant re-connecting with the network of professionals that Fluent's directors have worked with in the past. Anthony says he is "enjoying resourcing projects through a number of new contacts and partner firms in the urban infrastructure development industry" and believes "Fluent's new position in the consulting industry bodes well for future opportunities". ■

Water New Zealand Conferences & Events

Water New Zealand Stormwater Conference 2014
14 – 16 May 2014
Christchurch, New Zealand
For more information on *Water New Zealand* conferences visit www.waternz.org.nz

Other Conferences

Ozwater'14 – 2014 Australian Water Association Conference
29 April – 1 May 2014
Brisbane, Australia
For more information visit www.awa.asn.au

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