PROJECT NEWSLETTER STRENGTHENING THE RESILIENCE OF MARAE AND COMMUNITY WATER AND WASTEWATER INFRASTRUCTURE

Issue 3, June/July 2015

BEVAN TURNPENNY, ONE OF THE KEEN TAIRAWHITI/GISBORNE WTAG MEMBERS, WATERING THE ESTABLISHING WETLAND PLANTS FOR THE UPCOMING GISBORNE SLUDGE TREATMENT TRIALS

AUE TE PIRO

Te Waipara kia kaua e Paatu ki te Wai Maori

STRENGTHENING THE RESILIENCE OF MARAE AND COMMUNITY WATER AND WASTEWATER INFRASTRUCTURE

KIA ORA KOUTOU

We have had a very busy first half of 2015. With water use and occupancy records now coming in regularly from ten marae in the upper North Island we have been analysing the data to identify any sign of leaks or instances of extreme water usage. We are now starting to report back preliminary results to participating marae. This work will provide an accurate assessment of water and wastewater flows in relation to usage across a range of marae. Please keep those marae occupancy records coming in!

In March the team made a splash at the Annual Conference of the New Zealand Land Treatment Collective (NZLTC) held in Wanaka, with four members of the NIWA team presenting work from this project. Jackie Colliar was awarded *Best Overall Paper* at the conference for her paper entitled “A marae water use monitoring network: Preliminary assessment of water use”. Rebecca Stott was jointly awarded *Best Technical Paper* for her paper entitled “Influence of shock loading on microbial disinfection resilience of wetland and denitrifying bioreactor ecotechnologies”, and Femke Rambags (PhD student linked to the programme) was awarded *Best Presentation by a Junior Professional* for her paper entitled “Nitrate and faecal microbe removal in a denitrifying bioreactor”.

In May I was invited to present information on wastewater management options for Papakaainga developments at an excellent workshop run by Aubrey Te Kanawa for the Waikato Agencies Papakaainga Forum. The workshop provided information to support the design, consenting, project management and construction of Papakaainga on Maori land. The wetland-based ecotechnologies being developed in our research programme appear to be particularly relevant to these types of communal housing developments, providing cost-effective, low-maintenance wastewater treatment options that are not reliant on complex mechanical devices or an external power supply.

I hope that you enjoy this winter newsletter. Please let us know of other projects you are involved in related to this mahi – we would be very interested to learn about and share your experiences.

Ka kite ano, Chris

NIWA Taihoro Nukurangi

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IN THIS ISSUE

Pukete Wastewater Pilot Trials

NIWA has installed a number of constructed wetland modules (‘bioreactors’) at the Pukete Wastewater Treatment Plant to test their performance at treating wastewater and to look at their resilience to shock loading.

In this issue, basic wetland systems and their general water treatment capabilities are described, along with some background on the conditions that wetlands provide to enhance nitrogen removal from wastewater.

Passive Grease Traps

Basic information on ***Passive Grease Traps,*** what they are, how they work and how they should be maintained is described in this issue’s “Tech Corner”.

Pukete Wastewater Treatment Pilot Trials

When asked for advice on almost any subject, as scientists and engineers, we try to base our answers on the results of scientific research. So when we embarked on this project to advise marae and communities on appropriate wastewater treatment strategies, we considered the types of challenges typically faced - where there are intermittent peaks in wastewater flows - and what solutions may be available that could deliver good wastewater treatment. We also focussed on options that are simple to construct, operate and maintain, and are cost effective. Based on our experience, and with these objectives in mind, we identified constructed wetlands and passive woodchip filters or bioreactors as potential components of onsite wastewater treatment systems. Here we provide a short summary of what we have been researching and the kinds of results we have been seeing so far.

Figure 1: Experimental gravel bed wetlands planted with mokuautoto and kapungawha. Note: actual systems would be set into the ground and lined with thick polythene or similar product.

Some Background

Firstly, what is a wetland?

Natural wetlands are areas of land which are wet enough, often enough that the plants (and animals) in them have adapted to survive and thrive despite being in permanent or semi-permanent water, e.g., plants such as raupo, bulrushes, reeds etc. Wetlands are normally found at the interface between dry land and permanently flowing water like springs, streams, lakes, and estuaries. Water flowing from the land often passes through these wetland areas where it is cleansed of many of its contaminants – wetlands are sometimes referred to as the ‘kidneys’ of the landscape.

A constructed wetland is an engineered wetland, designed to serve some water treatment or management purpose. The simplest constructed wetlands are most similar to shallow swamps. They slow water flows and allow them to spread out, dropping any sediments they may be carrying, and removing nutrients by plant uptake and bacterial removal. People often think of plant uptake as the major way that nutrients are removed because the plants are highly visible, however after 6-12 months, bacteria generally become the major removal mechanism for nutrients such as nitrogen.

Nitrogen comes in a number of forms e.g. organic nitrogen (such as nitrogen in the food we eat), various dissolvable forms such as ammonium and nitrate (which are plant nutrients), and some gaseous forms such as nitrous oxide and N_2. N_2 gas makes up around 80% of the air we breathe, and is inert (stable and non-reactive). In a wetland we want to convert the organic and dissolvable forms of nitrogen into N_2 gas. This normally involves first converting ammonium into nitrate ($NH_4 \rightarrow NO_3$, or nitrification, basically adding oxygen), and then converting it to N_2 gas (via denitrification, or removing the oxygen again under low oxygen conditions).

This is really the key to our trials – giving the wastewater aerobic (high oxygen) conditions, and then anaerobic (low oxygen) conditions to provide the right conditions to remove nitrogen from the water.

So now onto our trials. These were run at the Pukete Wastewater Treatment Plant which treats wastewater from Hamilton City. If you want to run a trial on wastewater, you need a steady supply, and they certainly have that. Our systems started with the simplest types of constructed wetlands, and then moved to more sophisticated set-ups.

The Basic Wetland System

The most basic system consisted of a gravel bed planted with wetland plants. Wastewater was added into one end and ran out the other. The water level was kept just below the surface. This is known as a horizontal flow gravel bed wetland.

With this system there is no ‘active’ addition of aeration (for nitrification), nor active way of creating low oxygen conditions (for denitrification). Even so, the system was pretty good, removing about half the nitrogen and more than 95% of solids and BOD (biochemical oxygen demand, a key measure of wastewater strength).

Advanced Wetland Systems

If you need to remove greater amounts of nitrogen, a more advanced system is required. By intermittently spraying incoming water over the surface of a sand or gravel bed wetland, and then allowing

Figure 2: Vertical flow wetlands in experimental containers. These are planted with rautahi which shades the surface and prevents algae growing and clogging up the sand/gravel surface. Unfortunately they do such a great job that in this photo they stop us seeing the spray units.

it to passively drain between applications, the wastewater is spread as a thin film over the gravel surface, allowing exposure to lots of oxygen. These types of wetlands are called Vertical Flow Wetlands (or VFW). Ammonium nitrogen (NH_4) is readily nitrified to nitrate (converted into NO_3) as they pass through the media - this step is typically called nitrification (Figure 2).

The next step following nitrification is denitrification where nitrate is converted to nitrogen gas ($NO_3 \rightarrow N_2$ gas). This step requires extra energy, which the bacteria get from organic carbon. However, the VFW generally filters most of this out, so we have to provide an additional source of it, or catch it before we add the water to the VFW (and use it later). The easiest way is to provide an additional organic carbon source such as wood chips. We put these in a tank and run the nitrified wastewater through it. Because it is permanently filled with water less oxygen gets in and forces the bacteria to scavenge for oxygen off the nitrate (NO_3).

We call these woodchip filters 'Denitrifying Bioreactors'. We have a couple of different types we are trialling, but, in short, they now remove between 60% and 75% of the incoming nitrogen and also reduce faecal microbes.

We have also been testing these systems to see how well they cope with big jumps in the amount of waste they have to cope with (not uncommon for marae, camping grounds and beachside communities). We'll give you an update on this in our next newsletter.

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Gisborne City Sludge Treatment Wetland Trials

NIWA, in close collaboration with the Centre for Integrated Biowastes Research (CIBR), has recently embarked on an exciting new project with the Gisborne/Tairawhiti Wastewater Technical Advisory Group (WTAG) and Gisborne District Council to develop alternative uses and disposal options for the treated effluent and biosolids from Gisborne City. Implementation of appropriate treatment and discharge options for Gisborne's wastewater has been a long-standing issue with a high level of Tangata Whenua and wider community involvement. Gradual understanding and co-operation between and within the community and the council has evolved to the stage that a collective solution based around wetland treatment has emerged.

NIWA and CIBR are working together with the community and council to explore the establishment of wetland systems to treat and beneficially re-use wastewater and biosolids from Gisborne's new Biological Trickling Filter (BTF). Although commonly used in other areas of the world, wetlands constructed for the dewatering and treatment of sludge have not previously been applied in New Zealand. Their efficacy treating BTF sludge is being assessed under local conditions using native plant species, rather than the invasive common reed employed elsewhere in the world. Additionally, the removal efficiency and, the fate and effects of a range of key contaminants of concern in New Zealand (including emerging organic contaminants, pathogens and heavy metals) will be investigated. The initial phases of the work have involved all parties turning out to build some pilot-scale wetlands to evaluate which plant species grow best in Gisborne BTF sludge. NIWA has been investigating the settling and dewatering characteristics of the sludge and developing preliminary wetland treatment options, whilst the community and council in association with CIBR are exploring alternative uses and dispersal options for the treated biosolids and effluent.

This project includes an unprecedented level of community involvement and interest. We are enjoying the close interaction, and the tough and insightful questions being asked.

For more information contact Chris Tanner - (07) 856 1792

Tech Corner – Passive Grease Traps

TECH CORNER IS A REGULAR FEATURE OF THE PROJECT NEWSLETTER AIMED AT PROVIDING BASIC 101 INFORMATION ON ASPECTS OF ONSITE WASTEWATER SYSTEMS.

WHAT ARE THEY?

Grease traps intercept and collect fats, oils and grease (FOG) discharged from kitchen wastes. They can protect your wastewater system from blockages by eliminating or reducing FOG discharged into pipework and the downstream systems.

There are two main types of grease traps or interceptors: Passive grease traps/interceptors (located outside of buildings) and mechanical grease separators/interceptors. Most marae have passive grease traps although some marae may be better suited to mechanical separators or hydro mechanical grease interceptors which are smaller and require less space. This issue's Tech Corner describes passive grease traps (e.g., Figure 3).

HOW DO THEY WORK?

Passive grease traps are made up of a series of compartments which wastewater from the kitchen flows through. Their typical configuration is shown in Figure 4.

They work by cooling down the wastewater so that FOG floats to the surface and other solid material, such as food scraps, sink to the bottom.

To be effective, grease traps must retain the fluid long enough for it to cool and for the FOG to float to the surface.

Figure 3: Lifting the lid – Inside a passive grease trap chamber.

They should have tight-fitting lids, be raised above surrounding ground, or have raised lips around the top to stop rainwater from getting in.

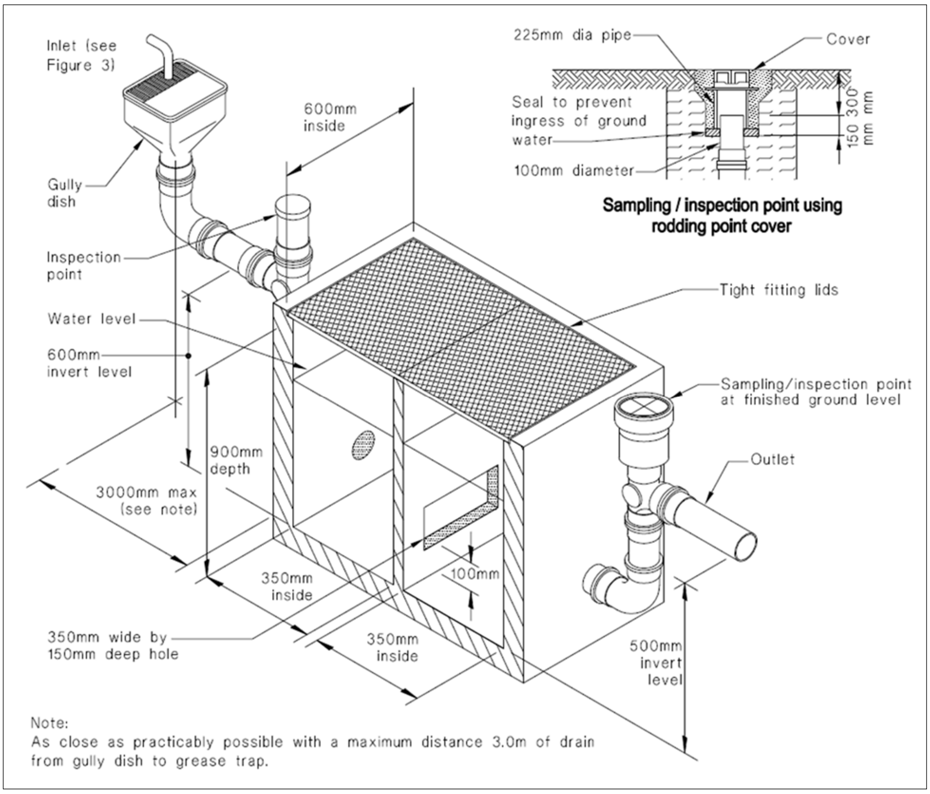

Figure 4: Minimum requirements for grease traps up to 150 litre capacity (Sourced from Figure 4 – NZ Building Code Acceptable Solutions and Verification Methods for NZ Building Code Clause G13 – Foul Water).

HOW BIG SHOULD THEY BE?

To be effective, grease traps must retain drainage water for at least 30 minutes at peak flow (Crites & Tchobanoglous 1998). The peak instantaneous flow will depend on your kitchen (e.g., how many sinks it has, the number and types of appliances).

The NZ Building Code Acceptable Solutions and Verification Methods for Foul Water (G13 – Foul Water) requires grease traps to have at least twice the capacity of all sanitary fixtures and sanitary appliances discharging to it, and in no case less than 100 litres.

Two common methods of determining minimum grease trap size are the peak flow method (i.e., based on the estimated peak hourly flow) and the fixture unit method. If you are upgrading or building a new kitchen, seek guidance on system requirements from your local authority and design engineers.

WHAT MAINTENANCE DO THEY NEED?

Regular cleaning helps maintain performance of the grease trap and avoid or minimise odours.

Maintenance of the grease trap involves removing grease from the top and sludge/solids from the bottom, and scraping and hosing down the sides and removing all of the contents.

The level and frequency of cleaning and maintenance required can only be determined through regular usage and experience following installation, as it depends on the size and capacity of the installed unit, how often the kitchen facilities are used, and how much FOG is going into It.

GOOD HOUSEKEEPING

You can reduce the amount of cleaning and maintenance on your grease trap by following some good housekeeping practices, including:

- scraping plates, dishes and cooking utensils into recycling or rubbish bins before washing
- disposing of waste fats and oils (such as from the deep fryer) separately. NEVER put fat and oils down the drain
- using minimal fat and oil for cooking
- recycling fats and oils.

REFERENCES:

Auckland Regional Council Technical Publication 58 (2004) On-site Wastewater Systems: Design and Management Manual; Third Edition ARC Technical Publication 2004.

Crites, R., Tchobanoglous, G. (1998) Small and decentralised wastewater management systems. Boston: WCB/McGraw-Hill.

BS EN-1825-1:2004 Grease separator-Part I: Principles and design, performance and testing, marking and quality control

Ministry of Business, Inovation and Employment (2014) Acceptable Solutions and Verification Methods For New Zealand Building Code Clause G13 Foul Water (2014), Second Edition, Amendment 5.

Wellington City Council Fats, oils and your food business pamplet and Passive Grease Trap Factsheet.http://wellington.govt.nz/~/media/services/environment-and-waste/trade-waste/files/greasetraps.pdf

MARAE WATER USAGE MONITORING UPDATE

NIWA has partnered with ten marae around the North Island to monitor water (as a surrogate for wastewater production) and marae usage. The project seeks to refine design assumptions for water and wastewater system designers, and enable the potential benefits of a range of innovations to be assessed (e.g., installation of water-efficient showers, toilets, taps and appliances, and separate treatment of blackwater and greywater).

Monitoring at some marae has been underway for over 12 months while at others it has only recently started. Interim monitoring results from three marae show a good correlation between water use and marae occupancy (Figure 5). The monitoring results illustrate the extreme variability in marae usage, with little to no usage occurring for extended periods of time coupled with short periods of high use.

Typical wastewater system design guidelines suggest per capita wastewater generation of 40 litres per person per day (l/p/d) for day-only marae users and 150 (l/p/d) for day and overnight marae users. While limited conclusions can be drawn at this early stage, it appears that actual per capita water usage, and therefore wastewater generation, is lower than typically assumed in marae water and wastewater system design.

The initial monitoring results suggest that existing design guidelines need to be reviewed and confirms the benefits of recording marae occupancy and measuring water use to inform better water system management and design. The findings of the monitoring programme will be published following analysis of all data from the monitoring project.

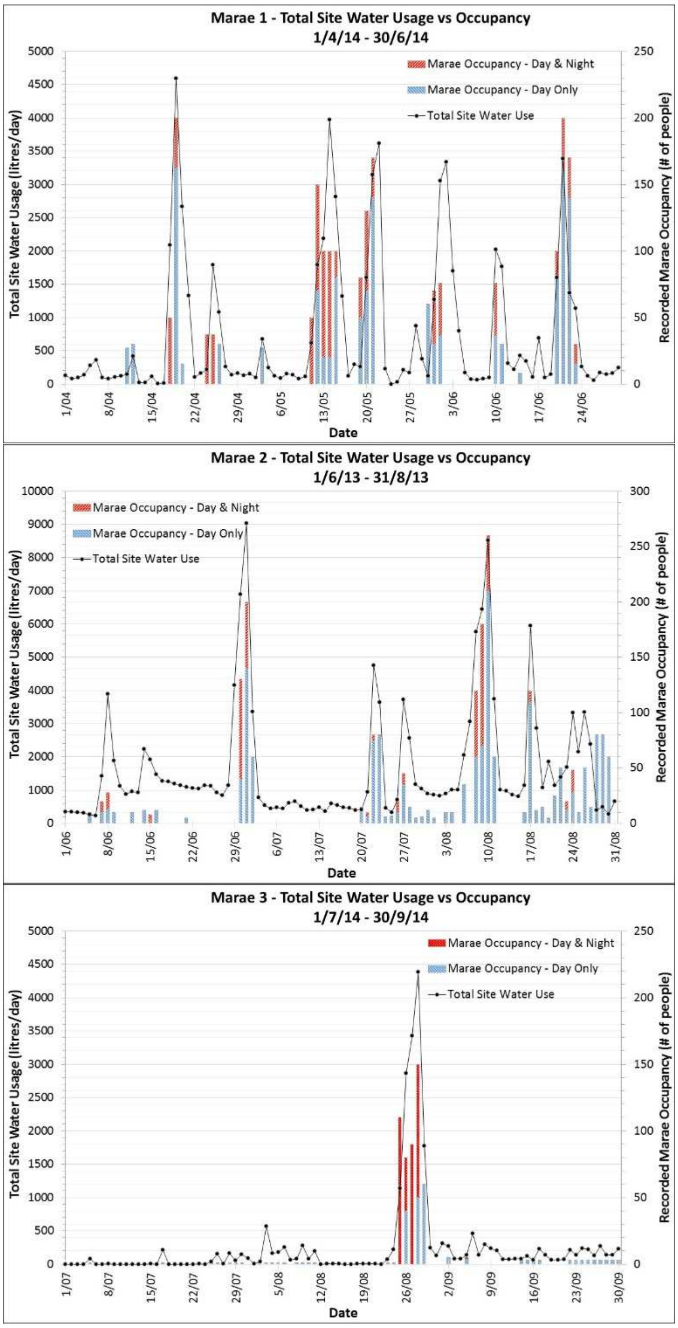

Figure 5: Three months of occupancy (day-only and day and overnight) and total site water usage data from 3 partner marae

REFERENCE:

Colliar, J.M., Sukias, J.P., Tanner, C. Stott, R. Bellingham, M. (2015) A marae water use monitoring network: Preliminary assessment of water use. *New Zealand Land Treatment Collective Conference 2015*, Wanaka, New Zealand 25 – 27 March

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NEWS IN BRIEF

Femke Rambags: NIWA/University of Waikato funded PhD project

MICROBIAL CONTAMINANT REMOVAL IN DENITRIFYING BIOREACTORS

Land application is often the final step for treating wastewater from septic tanks. With relatively low costs and limited operation and maintenance requirements, the septic tank and land disposal treatment system is relatively inexpensive, however it is not particularly effective for nitrogen removal. As a result, large land areas are often required for wastewater disposal following septic tank treatment. Additionally, care must be taken to prevent the transmission of infectious diseases through leaching of waterborne pathogenic microorganisms, present in septic tank effluent, to surface and ground waters.

Inclusion of a secondary treatment step between the septic tank and land disposal areas offers opportunities for reducing land area required and preventing the transmission of infectious diseases, by removing nitrogen and by reducing pathogens from septic tank effluent. Numerous studies have identified denitrifying bioreactors (woodchip filters) as a robust alternative for improving nitrogen removal in onsite wastewater treatment systems. In addition, there are indications that these systems are also capable of removing faecal microbes.

Working with NIWA and the University of Waikato, the objective of my PhD project is to determine how well denitrifying bioreactors remove faecal bacteria and virus loads from septic tank effluent. The findings from my research will contribute to the design of robust, low-cost, cost-effective, low-energy usage, high-rate onsite wastewater treatment systems.

Introducing Femke Rambags

I graduated with a BSc in Earth Sciences from the University of Utrecht in the Netherlands.

My interest in water management and curiosity for tackling water management related problems led me to pursue an MSc in Hydrology (University of Utrecht) and, later, an MSc in International Land and Water Management (Wageningen University, the Netherlands). I was able to further explore my interests at KWR Watercycle Research Institute (the Netherlands), where I had the chance to work on a broad range of hydrological issues as a junior researcher.

I moved to New Zealand in June of 2014 and am currently doing a PhD through the University of Waikato where, together with NIWA, I will be investigating the ability of woodchip and coconut filters to remove faecal bacteria and viruses.

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FEEDBACK

If you have any feedback on our newsletter, suggestions on content you would like to see included in future issues, or would like to share your wastewater experiences with us, please get in touch with a member of the project team.

ACKNOWLEDGEMENTS

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