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Water NZ - Resource Consent Consistency Workshop
23 August 2013

Problems with consent limits for small wastewater treatment plants

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The Sanitary Works Subsidy Scheme (SWSS) and resource consent issues

- The SWSS ran from 1 July 2003 to 30 June 2013
- As at 20 August 2013, 53 projects have been completed, 13 are still under construction and three projects (Kerikeri, Rotoma and Matata) are at the Provisional Approval stage.
- The SWSS has been administered by the Ministry of Health's Subsidy Desk. The total subsidy commitment is just under $155M
- Many of the schemes have involved resource consents and there has often been dialogue with applicants over consent conditions
- In some cases regional council officers have prescribed the effluent quality **and** the treatment method. For the Dannevirke upgrade the consent requires microfiltration.
- For the Hihi project in the Far North the consent prescribed a membrane bio reactor. But ….. Hihi has a very high wet weather flow peaking factor
- Prescription of the method of treatment transfers risk from the consent holder to the regulator - it is potentially ultra vires.

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The Dannevirke treatment plant upgrade

- Existing 3 stage pond system worked well
- New add-on microfiltration plant has been commissioned to meet revised consent conditions. Consent required microfiltration
- Alum dosing into maturation pond is used to reduce DRP to less than 1 gm/m3 when flow in the Mangatera Stream is < half median (ie approx 25% of the time).
- The original intention was to dose alum ahead of the microfiltration plant.
- DRP concentrations in the Mangatera Stream upstream of the discharge are significantly higher than the 15 mg/m3 limit in the Manawatu Catchment Management Plan. Can ask, why dose alum 5 years early?
- Even if the alum dosing did work (it doesn't) the receiving environment is unlikely to notice the difference (ie there will be minimal benefit) until other point sources are reduced
- The consent says that after 1 November 2004 all wastewater discharged to the Mangatera Stream must pass through the microfiltration treatment system.
- Why all of the flow?

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How much treatment is needed? (from annual training session with health protection officers)

- How do we decide how much treatment is needed?
- What is in wastewater?
- What effluent standards exist and how are they derived?
- Should we have the same effluent standard whenever we discharge to the sea? Or to a river?
- What about non-point source pollution? (rural run-off, septic tanks and urban stormwater)
- Aim of the training session is to give some understanding of what is in wastewater (aka sewage) and what the potential harmful effects are when discharging treated effluent to the environment

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Objectives of Wastewater Treatment

- Wastewater collected from cities and towns must ultimately be returned to receiving waters or to the land
- Complex question of which contaminants must be removed to protect the environment - and to what extent - must be answered specifically in each case
- There is no “one size fits all”
- Based on a combination of science and engineering judgement, within the framework of the RMA (public is involved)
- Before discharge to surface water, sewage needs to be treated such that public health is protected, aesthetic conditions are maintained, oxygen depletion is limited, the discharge of toxics is kept within acceptable limits and the release of nutrients will not lower water clarity or promote unacceptable weed growth (eg slime on rocks)

Effects Driven - 1

- Treatment should be effects driven - start with the effects on the receiving environment.
- Need a holistic approach No point having a brilliant plant on the end of a knackered reticulation system which overflows during wet weather
- The aim of the HPO training is to provide some understanding of the factors involved in establishing a cost effective and consentable effluent standard

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Effects Driven - 2

- Two types of standards are used around the world for discharge to surface water – receiving water standards and effluent standards
- Uniform effluent standards would be easy to administer, but would need to be conservative to cover worst case discharge situations with minimal dilution, and would result in high cost treatment as well as high operating costs
- Through the RMA, NZ has adopted a system of effects based receiving water standards.
- This has the advantage that the quality of effluent can be related to the amount of dilution available, the sensitivity of the receiving water and to the way the public want to use the water
- The cumulative effects of other discharges should also be taken into account

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Treatment Considerations

- Anything is possible, given sufficient resources to build and operate a wastewater treatment plant.
- The potential effects on the environment need to be assessed by experienced water quality scientists
- High tech plants are available - but they are typically expensive, complicated to run and energy intensive (for example Membrane Bioreactors)
- Also need to consider what happens during wet weather when flows increase. Can the process handle the peaking factor?
- As a rule, the smaller (ie the more compact) the wastewater treatment plant the higher the cost to build and operate
- Oxidation ponds offer the lowest cost treatment method, where there is sufficient land

What is in wastewater?

- Raw wastewater is a very dilute mixture of suspended and dissolved solids
- Around 200 to 250 litres per head per day dry weather flow, peak wet weather 3 to 6 times this flow (sometimes much more)
- In dry weather it is more than 99.9% water, with less than 0.1 % of the wastewater comprising dissolved and suspended material.
- The concentration of suspended solids is typically around 0.025%, or 250 g/m3 (ie 250 parts per million)
- This amounts to 15 tonnes of solids in the daily flow of 60,000m3
- The challenge is to remove an appropriate amount of the contaminants and pathogens to allow safe return of treated effluent to the environment without adverse effects on the ecology

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Significant Receiving Water Quality Parameters

- Faecal coliforms
- Enterococci
- Floatables
- Grease
- Colour
- Suspended solids
- Odour

- Nutrients
- Dissolved oxygen
- pH
- Temperature
- Toxic substances

History of 5-day Biochemical Oxygen Demand (BOD5)

- Why 5-day BOD? Comes from the 1904 UK Royal Commission.
- The longest river in the UK takes 5 days to reach the sea, therefore organic waste could exert an oxygen demand for up to 5 days
- Secondary treated effluent as determined by the Royal Commission had a 20:30   BOD:SS (Biochemical Oxygen Demand/Suspended Solids).
- So raw wastewater starts at a BOD:SS of around 240:240g/m3, and this is reduced to 20:30g/m3 after secondary treatment
- BOD and suspended solids were the first constituents of wastewater that were targeted. Other constituents came much later.
- g/m3 = mg/l = ppm, so 20 g/m3 = 20 parts per million
- The saturated concentration of oxygen in water is around 9g/m3 at 20 degrees centigrade

Options for effluent disposal

1. To Land, or -

2. To Water

   - the open sea
   - an estuary
   - stream
   - river
   - lake

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Moa Point Outfall Example

- Outfall is 1800 metres long, diffuser depth is 22 metres
- Minimum dilution at slack water is 100 times (plume buoyancy effect from fresh water discharged into salt water)
- Shellfish quality at the surface (14 faecals/100ml) would be achieved with an effluent standard of 1400 faecals/100ml
- Allowing for subsequent dilution and die-off, we could have 10,000 faecals/100ml in the effluent, and would still achieve shellfish water quality at the shoreline
- However, the consent requires 200 faecals/100ml, which is 50 times more stringent than logic would suggest
- This consent is more about politics than science
- Closest filter feeder (ie bi-valve mollusc) are more than 2km away. Mussels at Point Dorset.
- The UV disinfection dose rate could be reduced to save power

Outfall Diffuser

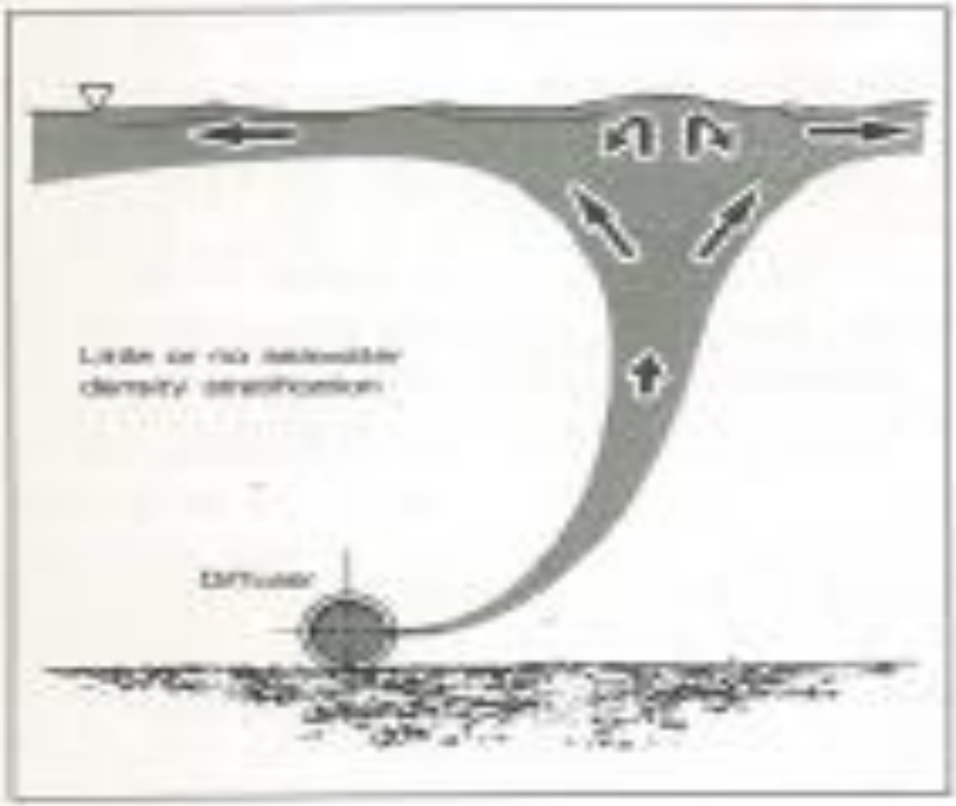

Fig. 2-2 Schematic Representation of Surface Effluent Field.

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Nutrients

- Sewage contains the primary nutrients phosphorous and nitrogen in small concentrations, either in organic forms (ie, as living or dead micro-organisms and plants) or inorganic forms (orthophosphate, ammonia and nitrate).
- Typical nitrogen concentrations are around 30 grams per cubic metre (approx two thirds of this is ammonia, with most of the residual being organic nitrogen) and there are typically 6 to 10 grams per cubic metre of phosphorous

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Nutrients (cont'd)

- Because secondary treatment plants remove only a relatively small proportion of the nutrients (around 20%), most of the nutrients are discharged in the effluent
- Discharges of secondary effluent can cause eutrophication problems in rivers, lakes and enclosed harbours/estuaries (sea lettuce in the Heathcote/Avon Estuary prior to the construction of the long sea outfall is a good example)
- Generally no problem with nutrients in the open ocean. The ocean around NZ is often short of nutrients and large scale mixing rapidly reduces nutrient concentrations to background levels.
- Nutrients contribute to marine life - some of the world's most productive fishing grounds are fertilised by large rivers.

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Pathogens

Pathogens are disease causing organisms that are excreted by infected human beings. The range of pathogens present in wastewater at any time reflects the level of public health prevailing in the contributing population. Main categories are:

- Bacteria (eg typhoid, salmonella, cholera, shigella)
- Viruses (eg hepatitis, norovirus, adenovirus, and enterovirus (eg polio) and
- Protozoa (eg amoebic dysentery, giardia, cryptospiridium)

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Pathogens (Cont'd)

- Because the incidence of pathogens in sewage is generally small and uncertain, it is not practical to test for them.
- Other more common micro-organisms present in large numbers in the guts of warm blooded animals are used as “indicator” micro-organisms, which indirectly tell us about the potential levels of pathogens.
- Faecal coliforms, *E.coli* and enterococci are used as indicators of pollution

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Health Risk

- For bathing waters, a line cannot be drawn between risk and no risk
- Numerical value placed on the health risk indicator organism limits vary considerably both by country and historically, as does the indicator used
- Earliest limits were set in the 1940's by USA agencies. These were copied by some countries and ignored by others
- NZ closely followed the USA trends in the use of such a standard, hence the 1967 Water and Soil Conservation Act with SA (shellfish beds) and SB (bathing) classes for saline waters
- 200 faecal coliform/100mls SB came from work carried out on the Ohio River in 1953
- When total coliforms exceeded 2,400 per 100mls, risk of gastro-intestinal and ear/nose/throat infections was higher than normal, so allowing safety factor many agencies adopted 1000 totals
- For Ohio River total/faecal ratio was 5:1 --- hence the 200 faecals/100mls

Implications for effluent standards

- Virus are a concern for shellfish quality (eg Norovirus, hepatitis, enterovirus)
- Does a faecal coliform limit on a WWTP provide adequate protection? Good question.
- Should virus be monitored, or perhaps bacteriophage?
- Kawakawa is believed to be currently monitoring bacteriophage

4-log removal of F-specific bacteriophage

- This is a condition for several recent Far North discharge consents, aimed at protecting shellfish quality. The condition became standard for new Northland Regional Council (NRC) consents
- It is expensive to achieve because with ponds we cannot guarantee this quality, so it is a threat to the ongoing use of ponds, in spite of their numerous benefits for deprived small communities
- The condition has been transplanted from the Mangere (Auckland) discharge consent, ie from a wastewater treatment plant serving around 1 million people
- Subsidy Desk was concerned about the potential cost implications for the SWSS
- Meeting was held late 2008 with NRC, NDHB, FNDC, Whangarei DC, MoH and Iwi. Chaired by Jim Bradley of MWH
- NRC confirmed that 4-log removal was not a generic NRC requirement
- It was generally agreed that there was a need for microbiological risk assessments, taking into account subsequent dilution, die-off and non-point sources of pollution

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Why strip nutrients?

- Not a problem with an ocean outfall - the sea around New Zealand is generally nutrient deficient
- Palmerston North and Masterton need to meet an in-river dissolved reactive phosphorus (DRP) standard (phosphorus is the limiting nutrient for these rivers)
- The concern is periphyton growth (slime) on the stoney river bed. (Not a problem for a river with a silty bottom, eg Manawatu River downstream of Opiki).
- For PN and Masterton nutrients are an issue at low river flows, in summer, when the river is warm and clear. Both an aesthetic concern (slime) and DO fluctuation (ecology – fish can be stressed at night)
- Palmerston North solution is to strip DRP at low flows (< half median).
- For Masterton discharge to the Ruamahanga will stop at summer flows < median (half median in winter).
- At high flows, no problem. Periphyton is scoured away, lower temperature, the river becomes turbid, less light transmitted, less weed growth).

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Rongotea (SWSS scheme)

- Rongotea is a small Manawatu community of around 600 pop’n.
- Effluent is discharged to an already polluted farm drain. 2 stage pond system, with sub-surface wetlands.
- The consent states that DRP shall not exceed 1.5 g/m3 and includes a requirement to install chemical dosing. Dosing takes place 365 days per annum, with no environmental benefit.
- Discharge is into man made Campbell’s Drain which flows into Sluggish Creek then the Oroua River.
- When visited, $8,000 per annum for alum was achieving only 4.5 grams/m3
- Dosing has apparently been stopped
- It is not clear what Horizons think about the matter
- Upstream DRP 6.4 g/m3

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Turangi

- Turangi had an oxidation pond/wetland treatment system which has been replaced by a high energy - high operating cost $6M MBR plant (membrane bioreactor)
- The driver was the consent which required a reduction in total phosphorus and total nitrogen
- 10 m3 per day of sludge is being trucked to Taupo for treatment/disposal.
- Nutrients from the oxidation pond appear to have been absorbed and transformed in the very large South Taupo Wetland (STW)
- At the consent hearing, one scientist stated that the oxidation pond discharge was not affecting the trophic status of Lake Taupo
- Operating costs (energy, chemicals, sludge transport) for the new MBR plant all exceed the budget
- To some extent, the upgrade can be seen as a wetland protection project (minor effects on the wetland have been reported, but not quantified)
- If approved, the subsidy value would have been > $2.5M. Benefit for residents??

Opoutama

- This is a Dep 9 community of 49 households in Wairoa District Council near Mahia.
- The original consent required 49 separate on-site packaged treatment plants which had to be a Hynds Lifestyle ‘Advanced” SAF or an Oasis Series 2000 or Innoflow AX20. Talk about prescriptive!!
- Subsidy was approved but only with the condition that the Council owned and operated the packaged treatment plants. This caused a re-think by Council.
- The resource consent is extremely detailed. It runs to 21 pages with 59 conditions, including quarterly coastal monitoring within 750 metres offshore at an approximate depth of 2.5 metres below sea level.
- This is for a subsurface effluent disposal system more than 200 metres from the shoreline.
- The discharge consent provides a good example of officer inexperience and poor judgement. The monitoring costs are reported to be $450 per annum per household
- The discharge consent for a similar scheme for Tauwhare Pa in the Waikato runs to just 29 conditions.

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SWSS - Conclusions

- The bar is being lifted in terms of treatment standards – particularly nutrient removal
- Wastewater treatment can be very expensive. The SWSS was seen as a potential source of funding
- There was strong demand for SWSS funds, with a maximum rate of 90%. Public health risk has been the prime criterion to prioritise subsidies. Deprivation index was also given a high weighting.
- Environmental upgrades, where implemented, should be effects driven and based on sound science
- A number of the environmental upgrade applications received did not stand up to close scrutiny. Monitoring data was inadequate and effects were not properly understood
- Prescriptive consent conditions can share risk

Summary

- The 10 year SWSS programme has interfaced with almost all of the regional and unitary councils
- Various competencies in the setting of discharge consent conditions have been noted
- It should be understood that deprived small communities have small budgets. It is always a challenge to provide affordable treatment/disposal solutions for these communities
- During the life of the SWSS the Ministry of Health's Subsidy Desk always encouraged fit for purpose, cost effective and sustainable solutions
- Consent conditions should be effects based, sensible and supported by good science
- Regional council consent officers would often benefit from a better understanding of wastewater treatment methods and costs, including the management of wet weather flows
- Consent officers should never go 'up the pipe' and prescribe treatment methods
- Good consent officers need to have tertiary level water quality science training and understand the relative importance of non-point source pollution (ie the 'big picture')