CAN REGULATION PROVIDE A BETTER ENVIRONMENTAL OUTCOME? NPDC'S DRIVE TO LOWER METAL LEVELS IN BIOSOLIDS

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ABSTRACT

New Plymouth commissioned a Thermal Drying Facility in 2000 from which a high quality pelletised biosolid is manufactured.

To produce biosolids which comply with the New Zealand Biosolids Guidelines (NZWWA, 2003) the New Plymouth District Council implemented a metals reduction programme at source utilising regulation and charging regimes.

The paper presents the results of this campaign and demonstrates how the bylaw and economic incentives have driven change in industry management of metals in trade waste discharges.

The implications of the imminent reduction in the guideline metal limits are discussed and the ongoing challenge of achieving these limits. Will this reduction in metal limits continue to promote sustainable use of biosolids?

INTRODUCTION

In an effort to improve the management of biosolids, the New Plymouth District Council (NPDC) commissioned a gas-fired rotating drum thermal drying facility (TDF) in 2000 to treat biosolids from the New Plymouth Wastewater Treatment Plant (WWTP). The dryer was designed, built and commissioned by Flo-Dry Engineering.

The New Plymouth WWTP uses a biological activated sludge treatment process to produce a high quality effluent. The clean, disinfected effluent is discharged to the Tasman Sea via a 480m ocean outfall. Surplus sludge from the aeration process is diverted to the sludge de-watering plant and undergoes thickening prior to entering the TDF.

The rotary dryer, with direct gas firing, evaporates the water from the plant sludge to produce a thermally dried biosolid. The product is sterilised through maintaining the end temperature above 85°C. The final product has less than 10% moisture content. At this temperature and with a contact time of 20 to 25 minutes a sterile, desiccated biosolid is produced.

The rotary drum causes the biosolid to form into pellets which are screened to between 2 and 4mm in diameter. The end result is a pelletised (rilled) dry fertiliser that is safe, stable and has excellent application characteristics (Figure 1).

Figure 1: Final Bioboost® product from the TDF

New Plymouth District Council sells this pelletised product to a local company, Bioboost Limited that has expertise in fertiliser applications, spreading and distribution. Having developed the market over the last 10 years, this fertiliser is distributed and sold throughout New Zealand, both in bulk to businesses such as golf courses, maize cropping, and in 25kg bags for horticultural use and the home market at many retail outlets.

Bioboost® is manufactured to agreed specifications. As defined by the *Guidelines for the safe application of Biosolids to land in New Zealand* (NZWWA, 2003), Bioboost® meets the highest quality grade 'A' for stabilisation (pathogens essentially removed), and complies with the 'a' contaminant grade (although zinc only recently complied with the limit).

The challenge to comply with the 'a' contaminant grade of the guidelines has focused the Council on a programme of continual metals reduction in influent entering the WWTP. This paper outlines the mechanisms used, discussing whether regulation is a successful tool to drive change. Coupled with this, the copper, zinc, cadmium and mercury contaminant limits in the current guidelines are due to reduce from 1 January 2013 providing a challenging environment for the continued beneficial reuse of biosolids in the New Plymouth district.

REDUCING METALS AT SOURCE

The beginning

Leading up to the construction of the TDF, it was acknowledged that metal levels in the biosolids were severely limiting the possibilities for disposal of dewatered sludge to land.

To produce biosolids which would comply with the 1992 Public Health Guidelines (later replaced by the *Guidelines for the safe use of Biosolids to land in New Zealand, 2003)* NPDC implemented a metals reduction programme at source utilising regulation and cost incentives.

This manifested in the update of the Trade Waste Bylaw in 1997. Fees and charges were defined more clearly, with charges for metals increasing. Trade waste consents were required for more industries, including septage collectors, who also became part of the charging system. The resulting bylaw contributed to the model bylaw for New Zealand.

Increased monitoring of high risk industries was also undertaken with an associated trade waste monitoring/charging regime which effectively penalised industries with significant contaminant loads or non-compliance with bylaw limits.

The improved regulatory measures initiated through this period has achieved a marked reduction in metal contaminants (Figure 2) and ensured the metal levels set in the guidelines for an Aa grade biosolid would be achieved consistently for all contaminants except Zinc.

Nickel has recently increased due to an industry exceeding their daily mass limit. After investigation a small leak at the industrial site was identified and repaired. The bylaw and trade waste consent for this site allowed this to be picked up, however it resulted in a non compliance with nickel biosolid limits for a short time.

This initial drive to reduce metal levels has proved very successful and achieved 100% beneficial reuse of the produced biosolids year after year. However as can be seen below metal concentrations arising from domestic sources now pose a significant challenge.

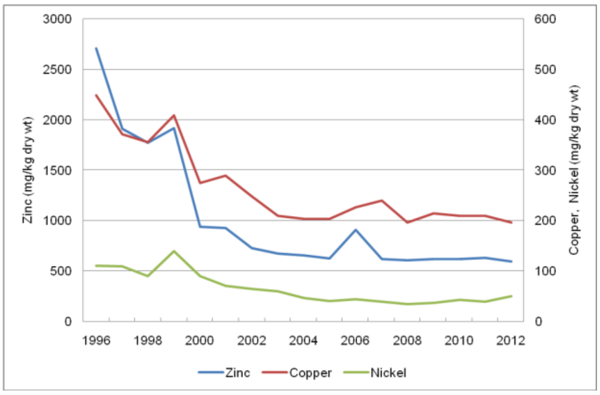

Figure 2: Average annual metal levels in biosolids 1996 to 2012

Dealing with non-industrial sources

From 1 January 2013 the guideline metal limits are set to reduce for copper, zinc, cadmium and mercury (Table 1). Of particular concern to the Council are copper (dropping from 300 to 100mg/kg dry wt) and zinc (reducing from 600 to 300mg/dry wt).

Table 1: 2011 metal concentrations in NPDC biosolids compared to guideline limits

Metal	Grade 'a' max. (mg/kg dry wt)		NPDC biosolid (mg/kg dry wt)
	Current	2013	
Copper	300	100	210
Zinc	600	300	625
Cadmium	3	1	0.8
Mercury	2	1	0.8

To further improve metal limits, an investigation into the contribution of other streams outside industry that may have an influence was initiated in 2007 which in turn could identify targets for further metals reduction.

Septic tank waste was suspected as an additional source of metal contamination, and there has been an increasing volume of septage being discharged to the WWTP in recent years (Table 2).

Table 2: Annual septage volumes discharged to NP WWTP

Year	Annual septage volume (m^3)
2006	1982
2007	2207
2008	2196
2009	2155
2010	3202
2011	1395*

* some offsite dewatering of septage resulted in reduced volumes discharged in 2011

Coupled with this, the Oakura township was being reticulated (completed in 2010), with expected increased volumes through the decommissioning of 500 septic tanks (Figure 3). The impacts of this on metal levels in biosolids was not appreciated at the time.

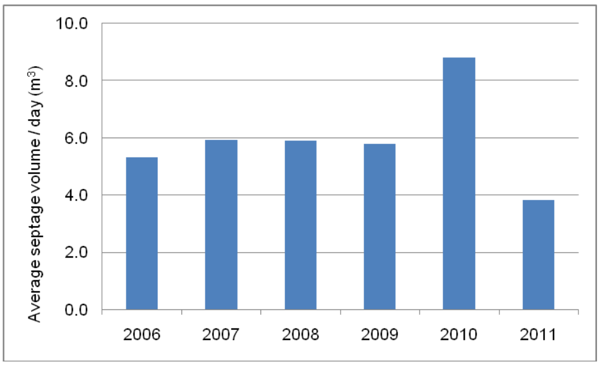

Figure 3: Average daily volume of septage discharged to the New Plymouth WWTP per year

With limited past analytical information, monitoring was undertaken to determine impacts on biosolid metal levels. From random sampling of septic tanker waste it quickly became apparent that five truck loads per day discharged at the WWTP would elevate the metal level concentrations in biosolids. Results were far higher than suggested in literature e.g. Tchobanoglous & Burton (1991).

Table 3: Summary of septic tanker monitoring results for 2007-2011

	Metal	**Ave**	**Min**	**Max**
Concentration per load (g/m^3)	Copper	18.4	0.0	105.3
	Nickel	0.7	0.0	4.0
	Zinc	44.7	1.4	344.0
Mass / load (grams)	Copper	90	0	527
	Nickel	3	0	20
	Zinc	219	7	1720

Metal levels, particularly copper and zinc, were high (Table 3). Suspected sources are:

- Collected roof water
- Commonly used household products e.g. shampoos
- Internal plumbing and taps
- Tanker trucks contaminated with residues from industrial waste
- Length of time between septic tank cleaning.

What effect does this have on biosolids? The most problematic metal for complying with the biosolids guidelines is zinc - in recent times we have been just outside the limit. Based on these results it was predicted that one load of septage on average would increase the zinc mass levels in biosolids by 9% (Figure 4). The worst result could increase zinc in the biosolids by 33%.

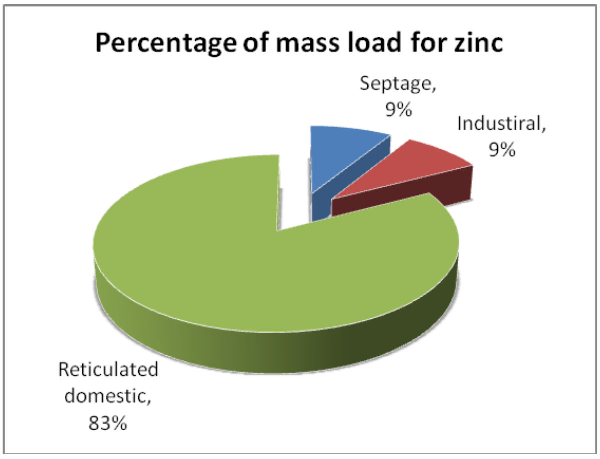

Figure 4: Contribution of source wastewater to the zinc mass load at NP WWTP

Copper contribution was similar with a 12% increase on average (Figure 5) and in the worst case, a 37% increase could result.

Septage is buffered in the aeration basin which reduces the impact of a single load in a week with high levels.

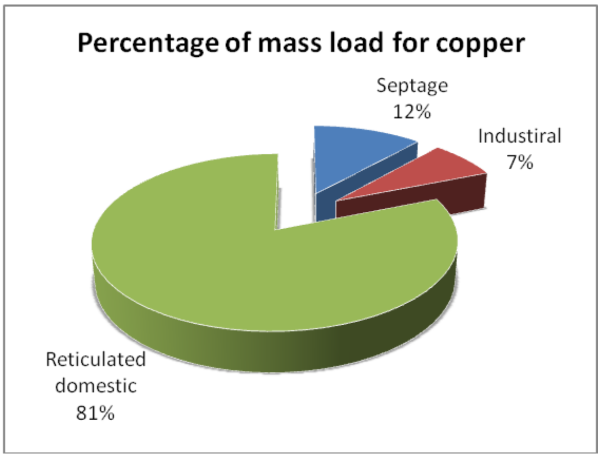

Figure 5: Contribution of source wastewater to the copper mass load at NP WWTP

As a mechanism to reduce these discharges, between 2008 and 2011 septage fees and charges were adjusted to include a charge based on metal concentrations (Figure 6). This better reflected the true cost of processing septage and it could encourage a local contractor to set up a dewatering unit, thus removing concentrated metals from the septic tank waste stream.

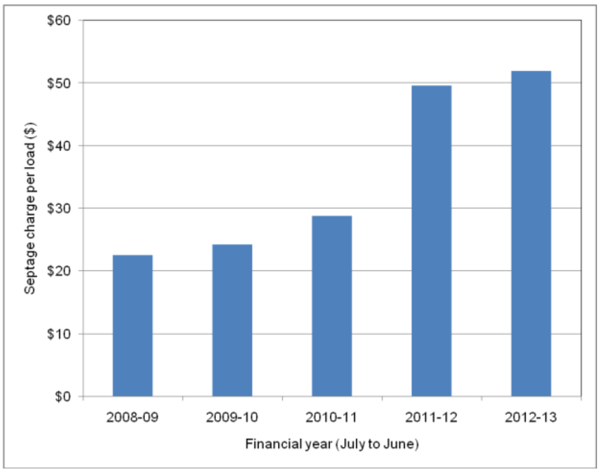

Figure 6: Trend in septage charges (per load discharged directly to the WWTP) since 2008

In 2011 one local contractor – Gas and Plumbing Ltd – built a dewatering unit similar to the Simon Moos system. That same contractor has recently imported a rotary fan press which began operating in early 2012. Performance of the dewatering facility is summarised in Table 4. Leachate from the process is discharged to the sewer as trade waste with significantly lower metals than any direct discharge of septage to the WWTP. The small volumes of dewatered sludge are disposed to landfill. Gas and Plumbing Ltd receive approximately 450m^3 per month of which equates to approximately 14 tonne of dry solid disposed of to landfill.

Table 4: Characteristics of septage from the dewatering plant at Gas and Plumbing Ltd

Leachate		Dewatered sludge	
Copper (g/m^3)	0.03	Copper (mg/kg dry Wt)	516
Nickel (g/m^3)	<0.03	Nickel (mg/kg dry Wt)	16
Zinc (g/m^3)	<0.1	Zinc (mg/kg dry Wt)	1280
BOD_5 (g/m^3)	480	Solids (% wt/wt)	35.4
SS (g/m^3)	44	Moisture (% wt/wt)	64.6

Since late January 2012, 98% of all septage truck waste has been diverted to this dewatering facility. The result has shown a gradual decrease in metal levels in the sludge at the New Plymouth WWTP (Figure 7), which will eventually be mirrored in the biosolids (due to the composite sampling monitoring regime this will not be reflected for another 3-6 months).

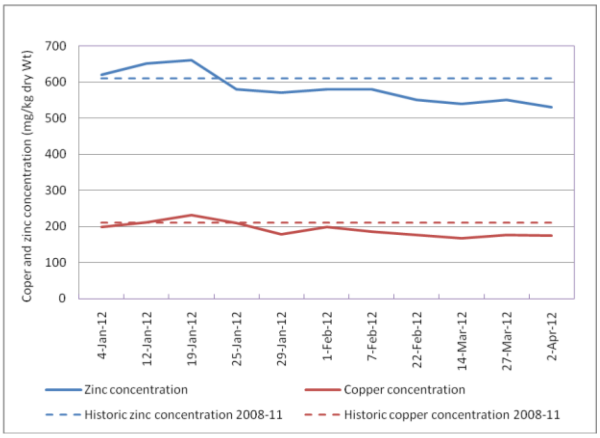

Figure 7: WWTP sludge metal concentrations following separation of septage truck waste

Using the most recent data, the metal reduction in dewatered sludge at the WWTP as a result of dewatering septage at an alternative facility has actually resulted in:

- 17% reduction in copper
- 13% reduction in zinc.

This has reduced the average concentration for zinc from 625 to 560 mg/kg, and copper from 210 to 184 mg/kg. As a result the biosolids are now consistently achieving compliance the full 'Aa' grade.

The reduction is likely to be higher than stated above as only half of the waste separated out is septage. Other sources are grease trap waste and black water from oil well sites which have characteristics typical of reticulated domestic waste. Combining all these wastes reduces the overall concentrations per cubic metre processed.

The operation of a dewatering unit in North Taranaki has given the Council a better mandate to completely eliminate septic tanker discharges within the next 2 years to coincide with the requirement to achieve lower metal levels. However, despite these significant improvements in the source metal levels, achieving the 2013 limits for metals will continue to be a difficult challenge.

What next? - tackling the 'diffuse' portion

Being the largest contributor of metals such as zinc and copper, the domestic reticulated wastewater is the next issue to tackle, but is also the hardest due to its 'diffuse' nature. This will now involve a drive to change consumer behaviour and encourage households to change products used, possibly by raising awareness of what is in household cleaning products and cosmetics, and how this affects biosolids.

Another option is to apply for a resource consent for region wide use of Bioboost® which will still allow unrestricted use of the product in the region, based on existing soil metal levels and recommended application rates.

IS THERE AN ENVIRONMENTAL BENEFIT?

Having reduced metal levels in the biosolids considerably over the last 10 years through regulation, significant environmental benefits have been achieved through the substantial reduction in metal levels and resulting beneficial reuse of the biosolids.

Further reductions are likely to be small, gradual and as a result of change in consumer awareness and behaviour. Whether further work in this area going to achieve enough reduction to achieve the 2013 'Aa' biosolid limits is debatable. For New Plymouth, at the reduced guideline limits from 2013, it is unlikely that 'Aa' grade will be achieved without dilution (i.e. by mixing with a compost). Further regulation at the local authority level is unlikely to have an impact on the domestic levels and alternative approaches must now be explored.

If biosolids are used as a fertiliser (with lower application rates), the impact on soil metal concentrations are significantly reduced compared to total soil replacement. For example average concentrations of zinc in Taranaki soils range from 40 to 140 mg/kg dry weight (Percival & Sutherland, 2002). Copper concentrations range from 50 to 120 mg/kg dry weight around Mt Taranaki and the ring plain, but are 10 to 50 mg/kg dry weight in the eastern hill country.

At recommended application rates of 200kg N/ha/year, this equates to 1 mg/kg of zinc and 0.5 mg/kg of copper in addition to background levels; well below soil limits (300 and 100 mg/kg respectively) in the guidelines.

Based on this is there much additional environmental benefit to be gained from reducing the limits where the biosolid is used more as a fertiliser than a complete soil replacement? Does this discourage WWTP operators to strive for high quality 'unrestricted use' biosolids? In this respect, while a conservative approach is warranted in the development or review of any guideline, biosolid limits which are the same as soil limits appear in this case to be too conservative.

While 2013 guidelines are consistent with Australian guideline limits for these metals, the current 'a' grade for these metals (pre 2013) are still significantly lower than the highest quality EU and USA contaminant levels and the second tier contaminant grade in New Zealand.

Guidelines should encourage sustainable biosolids use, while ensuring protection of soils, plants and animals (including human health). However, these limits should also be practicably achievable – i.e. should be enabling to encourage ongoing sustainable reuse. While the guidelines have certainly achieved this to date for New Plymouth, the 'Aa' grade has been less achievable elsewhere in New Zealand (for undiluted biosolids). Reducing the levels is unlikely to improve this situation and therefore may not encourage further improvement in biosolid reuse in New Zealand without assistance from other legislation e.g. the Waste Minimisation Act 2008.

A review of the guidelines has been recommended by various stakeholders including the NPDC and supported by Water NZ. In 2011 a working group was formed with further research to be undertaken in 2012-2013.

The impact of having an 'Ab' grade product on marketing and public perception of the Bioboost® product is unknown, and will be a key consideration in the future management of NPDC biosolids particularly when considering upgrade options for the TDF within the next 10 years.

CONCLUSION

The New Plymouth District Council's quest to reduce metals in biosolids has been largely successful through the implementation of an effective bylaw and charging regime applied to industrial trade wastes; ensuring the true cost of treating metals is recouped, and there is 100% reuse of biosolids. However further regulation to reduce metals in the domestic waste stream is difficult and requires a different approach e.g. through education or national lead regulation.

In general we believe the New Zealand Guidelines offer flexibility for biosolids management while ensuring the environment and public health are protected. However the practicality and therefore the encouragement of sustainable reuse options is potentially limiting if the high grade metal limits are largely unachievable – NPDC is one of the only councils in New Zealand with grade 'Aa' biosolids sold in an established market for 100% beneficial reuse of the product. Disposal to landfill is currently the most common route of biosolid disposal in New Zealand.

The key to any successful guideline will be maintaining a robust guideline document based on good science which will improve public perception, while still allowing it to be applied in a practical, achievable way considering application methods and end landuse.

The Council is participating in the review of the biosolids guidelines being undertaken by Water NZ (formerly NZWWA). In our view, the environmental impact of otherwise landfilling biosolids does not outweigh the good practice management of reused biosolids currently being produced and recycled into the community at large.

ACKNOWLEDGEMENT

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Gas and Plumbing Ltd have provided a service which is likely to improve the quality of our biosolids by implementing an alternative disposal option for septage and have allowed us to present this information.

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