THE WESTERN BAY WAY, BENEFICIAL BIOSOLIDS USE

G Hall, K.J Beecroft, CPG New Zealand Ltd
U.W Glasner, Western Bay of Plenty District Council

ABSTRACT

Western Bay of Plenty District Council (WBOPDC) has taken up the challenge of producing stabilised biosolids from its diverse range of wastewater sludges so they can all be safely and beneficially applied to land. It is anticipated that other Local Authorities with similar situations could benefit from the WBOPDC experience. Te Puke WWTP biosolids reuse is contracted out for vermicomposting in Kawerau. The Council is however investigating vermicomposting of biosolids in the future at a centralized facility servicing the whole District. Details of these ventures are provided.

The main issues with land application of biosolids are contaminants such as heavy metals, obtaining adequate land, costs especially transport, and resource consenting. WBOPDC and CPG undertook a study which examined these issues with respect to possible solutions for biosolids produced from the Katikati and Waihi Beach WWTPs. This paper summarises the analysis and presents the selected option, application to Council owned pastoral land. Management of the biosolids application rate and method has been designed to ensure that potential risks to human, animal and environmental health are mitigated. Public perception and the effect of Fonterra's policy with respect to acceptance of biosolids on dairy farm land are also examined.

KEYWORDS

Biosolids, vermicomposting, stabilisation, contaminant, land application, beneficial use, Fonterra.

1 INTRODUCTION

The Western Bay of Plenty District Council own and operate wastewater treatment plants (WWTPs) servicing the communities of Te Puke, Katikati and Waihi Beach. The WWTPs produce sludges of differing consistency and constituents.

The Te Puke WWTP consists of an activated sludge extended aeration process, with sludge wasted from clarifiers on a daily basis. The waste activate sludge (WAS) is dewatered through a centrifuge, with the resulting sludge cake requiring removal from site every five days. Traditionally Te Puke's sludge has been transported to landfill outside of the District.

Wastewater from Katikati is treated through two oxidation ponds followed by surface flow wetlands. The WWTP has been in operation for 10 years, resulting in accumulation of sludge in the oxidation ponds to the extent that hydraulic retention time has significantly reduced and treatment performance compromised. WBOPDC therefore had the need to desludge these ponds and source a destination for the final product.

Waihi Beach has a sequential activated sludge lagoon, which wastes sludge to one of two sludge storage ponds each day. The sludge ponds are becoming full with limited storage capacity now available for diversion of sludge and wastewater if an emergency occurred at the treatment plant. Similar to Katikati, the Waihi Beach ponds require desludging and removal of the material off site.

Over the past two years the WBOPDC has set about investigating and implementing options to beneficially use the sludges as biosolids, defined by the Guidelines for the Safe Application of Biosolids to Land in New Zealand (NZWWA, 2003). Following discussion on these beneficial biosolids use initiatives, this paper describes WBOPDC's long term vision for processing and use of biosolids in the District.

2 TE PUKE BIOSOLIDS

Te Puke is a rural township in the Western Bay of Plenty District with approximately 7,000 residents and medium size industries such as food and timber processing. The Te Puke WWTP generates 900 tonnes per annum of centrifuge dewatered WAS. Since 2009 the sludge has been sent to an industrial vermicomposting operation near Kawerau, 70km from Te Puke.

2.1 CHARACTERISATION AND GRADING

Table 1 shows the Te Puke sludge trace element analysis compared to NZWWA (2003) contaminant guideline values. Also included in the table is nutrient and trace element analysis for pulp mill solids and a final vermicompost product. The relevance of the pulp mill solids data is that the Bay of Plenty pulp mills generate between 80,000 and 100,000 tonnes of solids per year, which also requires disposal or preferably beneficial reuse. The vermicompost results shown are those from a trial undertaken by vermicomposting a blend of Te Puke WAS and pulp mill solids. Values in Table 1 that are underlined in bold indicate parameters that exceed the 'a' grade contaminant guideline value (Refer to Section 3.2 for grade definitions). Nutrient analysis has yet to be undertaken for the Te Puke WAS.

Table 1: Te Puke WWTP Sludge, Pulp mill Solids and Vermicompost Analysis

Parameter	Te Puke WAS	Pulp Mill Solids	Vermicompost	Guideline 'a' value after 31/12/12	Guideline 'b' value
Nutrients [%w/w]					
Carbon	-	43.03	14.9	No value	No value
Nitrogen	-	0.22	0.98	No value	No value
C/N ratio	-	198	15.2	No value	No value
Phosphorus	-	0.09	0.33	No value	No value
Trace elements [mg/kg]					
Arsenic	3.67	<0.1	7.5	20	30
Cadmium	0.68	0.13	0.82	1	10
Chromium	9.8	23.75	42.2	600	1500
Copper	**<u>125</u>**	11.24	33	100	1250
Lead	18.8	4.23	6.63	300	300
Mercury	**<u>1.5</u>**	<0.1	0.28	1	7.5
Nickel	8.9	5.09	13.2	60	135
Zinc	289	41.23	88	300	1500

Te Puke WAS can be considered to have low level of contamination with trace elements (heavy metals). Only copper and mercury concentrations in the WAS are above the grade 'a' limits, and only slightly. Whereas the pulp mill solids are well below all limits for an 'a' grade biosolid. This makes the pulp mill solids from Bay of Plenty pulp and paper industry a potential blending agent for municipal biosolids such as Te Puke WAS. Potentially mixing both organic wastes at a ratio of 1 to 1 would provide a product meeting all 'a' grade trace element contaminant limits.

2.2 VERMICOMPOSTING PROCESS

WAS from Te Puke and pulp mill solids have been processed for almost a year at an industrial vermicomposting plant near the Tasman Pulp mill at Kawerau in the Bay of Plenty. The current 900 tonnes per annum of Te Puke WAS, plus 1,000 to 4,000 tonnes of pulp mill solids requires a processing area of less than two hectares. The vermicomposting operation in Kawerau is conducted by windrow technology where the physical and chemical qualities of the pulp mill solids are used to avoid nutrient leaching into the ground and to minimise odour emission. Further information relevant to the Kawerau vermicomposting process is provided below.

During vermicomposting, compost worms feed on bacteria, organic matter such as cellulose, fungi, and small mineral particles. During the approximately 5 cm long pass through the gut of the worm the feedstock is screened and ground in the worm's gizzard, which increases the surface area of the feedstock so bacteria can decompose the waste much faster. Further on, the intestine of the worm acts as a bio-reactor for bacteria to rapidly decompose the organic matter to provide energy and nutrients to the worm. The grinding and antibiotic substances in the mucus of the worm's gut destroy pathogens effectively (Eastman, 1999). At the end of the 5 cm pass through the worm's gut decomposed and stabilised waste is finally capsulated in mucus and released as casting.

Some biosolids are not a suitable feedstock for vermicomposting when fed as a single source. High concentrations of ammonia, high electrical conductivity (dissolved salts) and a demand for carbon can become harmful to compost worms. As a result, municipal biosolids are often combined with bulking agents for vermicomposting, such as pulp mill solids used at Kawerau.

Vermicomposting is an aerobic process and strictly requires avoidance of anaerobic conditions at any time. As a result decomposition of the organic matter in the feedstock produces carbon dioxide and avoids emission of methane and nitrogen dioxide, which are highly relevant green house gases (GHG). The GHG emissions of vermicomposting are lower than conventional composting where these processes are not able to avoid pockets of anaerobic conditions.

Over a period of three to six months the vermicompost matures. The introduced and increased number of bacteria in the casting decomposes the remaining organic matter slowly. The joint action of compost worms, bacteria, and fungi produces several products which stimulate and regulate plant growth. Trials have demonstrated consistently that vermicomposted organic wastes have beneficial effects on plant growth independent of nutrient transformations and availability (Atiyeh et al, 2002).

3 KATIKATI AND WAIHI BEACH BIOSOLIDS

Sludge level and volume surveys were undertaken for both the Katikati and Waihi Beach ponds. Five samples from each pond were taken to estimate their average percentage solids content using a tube sampling device of sufficient length to collect samples through the entire depth of the sludge column. The results are summarised in Table 2.

Table 2: Katikati and Waihi Beach Ponds Sludge Survey Results

	Ave Depth (mm)	**Volume (m^3)**	**% Solids**	**Dry Mass (tonnes)**
Katikati Pond 1	650	1,410	3.50	49
Katikati Pond 2	490	1,290	3.80	49
Waihi Beach Pond 1	1,100	1,480	4.70	70
Waihi Beach Pond 2	1,300	2,050	4.95	101
Total Dry Mass		6,230		398

3.1 KATIKATI POND DESLUDGING AND DEWATERING

In order to maximise the hydraulic retention time and treatment efficiency WBOPDC made the decision to desludge the Katikati oxidation ponds early in 2009. Dredging and pumping the sludge to geotextile bags was chosen as the desludging and dewatering methodology. The geotextile bags were installed within a 0.5m deep basin constructed on site with a 0.5mm thick polyethylene liner. The sludge dewatering occurs passively through the geotextile material, with dewatering taking place relatively rapidly over the first two weeks, but slowing down after this period.

The advantages of the methodology used were:

- Only minor variations were required to the Katikati WWTP effluent and air discharge consents to authorise the activity;
- The ponds, including aerators, could remain operational, with individual aerators turned off for a period before and during desludging in their vicinity;
- No power costs for dewatering, except for a small pump to transfer rainwater and dewatered liquid from the geotextile bag basin back to the oxidation ponds;
- The sludge can remain in the geotextile bags for a year or longer so meet the stabilisation requirements of a biosolid (NZWWA, 2003); and
- With the biosolids stored in geotextile bags, treatment capacity is restored in the oxidation ponds, while investigations and consenting can take place for final beneficial use of the product.

The main requirement for use of geotextile dewatering bags is sufficient area for the bag storage basin, which is often available at wastewater treatment pond sites. For the Katikati oxidation ponds a basin with floor area of 42m x 21m was required to house five geotextile bags. Photographs 1 and 2 illustrate the use of geotextile dewatering bags at the Katikati WWTP.

Photograph 1: Early Stages of Dewatering

Photograph 2: Pumped Return to Oxidation Ponds

Part of the Contractor payment for desludging the oxidation ponds was based on the dry tonnes of sludge transferred to the geotextile bags. As shown in Table 3 this was calculated from the measurement of each bag and the average dry solids content of samples taken approximately two weeks following completion of pond desludging.

Table 3:   Katikati Geotextile Bags Dry Tonnage Calculations

Parameter	Bag 1	Bag 2	Bag 3	Bag 4	Bag 5
Bag Circumference (m)	13.5	13.5	13.5	18	18
Filled height (m)	**1.30**	**1.25**	**1.35**	**1.45**	**1.55**
% Solids	**11.45%**	**11.15%**	**10.60%**	**11.00%**	**11.50%**
Bag Length (m)	**20**	**20**	**20**	**18**	**18**
Short Axis Radius (m)	0.65	0.625	0.675	0.725	0.775
Long Axis Radius (m)	3.65	3.67	3.62	5.00	4.95
End Area (m2)	7.4	7.2	7.7	11.4	12.1
Sludge Volume (m^3)	149.0	144.2	153.6	205.2	217.1

Sludge Quantity (t DS)	17.06	16.08	16.28	22.57	24.97

The final sludge quantity calculated from the five bags was 97 tonnes of dry solids, which represents a good yield based on 98 t DS calculated from the oxidation pond sludge level and volume survey.

3.2 CHARACTERISATION AND GRADING

The five samples taken from each of the Waihi Beach ponds were mixed to provide a composite sample from each pond for chemical composition analysis. Prior to sampling for chemical composition the sludge from the Katikati oxidation ponds had been transferred to the geotextile dewatering bags as described in Section 3.1. One composite sample was collected from each bag and mixed to provide an overall composite sample for analysis.

The Katikati and Waihi Beach sludges are predominantly domestic in origin, with no significant industrial inputs to the WWTPs at both locations. To be described as biosolids a product must meet criteria as outlined in NZWWA (2003). Concentrations of nutrients, trace elements and persistent organic compounds from analysis undertaken for the Katikati and Waihi Beach sludges are given in Table 4, which also includes the NZWWA (2003) biosolids contaminant guideline values.

Results underlined in bold indicate parameters that exceed the 'b' contaminant guideline value. Persistent organic compounds for Waihi Beach Pond 1 were not analysed.

Table 4: Katikati and Waihi Beach Biosolids Composition versus NZWWA (2003) Values

Parameter	Katikati	Waihi Beach Pond 1	Waihi Beach Pond 2	Guideline 'a' value after 31/12/12	Guideline 'b' value
Nutrients (% w/w)					
Nitrogen	5.2	3.9	2.2	No value	No value
Phosphorus	0.6	1.6	1.8	No value	No value
Trace elements (mg/kg)					
Arsenic	6.36	14.4	9.79	20	30
Cadmium	3.76	2.02	1.68	1	10
Chromium	47.3	30.3	20.0	600	1,500
Copper	550	411	304	100	1,250
Mercury	<u>**9.8**</u>	1.3	1.3	1	7.5
Nickel	23.7	34.1	19.6	60	135
Lead	72.2	51.3	33.5	300	300
Zinc	1260	1230	828	300	1,500
Persistent Organic Compounds (mg/kg)					
DDT/DDD/DDE	<0.004	-	<0.004	0.5	0.5
Aldrin	<0.004	-	<0.004	0.02	0.2
Dieldrin	<0.004	-	<0.004	0.02	0.2
Chlordane	<0.004	-	<0.004	0.02	0.2
Heptachlor	<0.004	-	<0.004	0.02	0.2
Hexachlorobenzene	<0.004	-	<0.004	0.02	0.2
Hexachlorocyclohexane	< 0.004	-	< 0.004	0.02	0.2
Benzene hexachloride	< 0.004	-	< 0.004	0.02	0.2

Total PCBs	NA	-	-	0.2	0.2
Total dioxin TEQ	NA	-	-	0.00003	0.00005

The Katikati sludge has undergone dewatering, and maturation in the geotextile dewatering bags since June 2009. Pond 2 at the Waihi Beach has not been used for three years, so its sludge has effectively been maturing for that time. Due to the resultant stabilisation, under NZWWA (2003) guidelines both products can be considered biosolids rather than sludges. The guidelines are used to grade biosolids according to the potential for adverse effects on the receiving environment, by designating an upper case stabilisation grade and lower case contamination grade.

The upper case term refers to the level of pathogen attenuation and vector attraction reduction that the biosolids obtain through the stabilisation process. 'A' indicates that the product has met rigorous standards for pathogen and vector-attraction reduction, and is regularly tested. 'A' grade biosolids are generally considered to be safe for use in areas with public access. 'B' indicates that the processing of the product has verified quality assurance and includes a recognised vector-attraction reduction procedure, but may not have significant or regularly tested pathogen reduction process controls. 'B' grade biosolids are deemed safe to use with controls as proposed by the guidelines (Table 6.2, NZWWA, 2003).

The lower case term refers to the concentration of trace element and organic constituents in the biosolids. "a" indicates that the product achieves a very high level of constituent control, and is considered safe to use in public areas without significant additional controls. "b" indicates that the product is safe to use with appropriate controls managed through a resource consent on its application, to ensure mass loading of contaminants does not exceed soil limits. The guidelines use a basic contaminant equation system with the assumption that biosolids beneficial use should not cause soil constituents of concern to approach soil ceiling limits within a 20 year application period of annual applications (NZWWA, 2003).

Based on the guidelines, if a single parameter is above the 'b' grade contaminant concentration then the sludge is not considered a biosolids product that can be beneficially reused. From Table 4, only mercury in the Katikati biosolids does not meet the 'b' grade criteria. To enable the application of Katikati biosolids to land, a reduction in the mercury concentration is required to remain consistent with the basis for land application as described in NZWWA (2003). This reduction may be achieved by dilution with another product such as green waste, saw dust or blending with the Waihi Beach biosolids to achieve a 'b' grade. Alternatively, cases can be put forward for the beneficial use as follows:

- Reduce the amount applied to land from the agronomic application (200 Kg N/ha/yr) to the equivalent application of the "b" heavy metal standard on a mass basis; and
- The application of the Katikati product, which is a batch application with minimum five year return period, will not have a significant effect on the environment, and can be calculated (Appendix III, NZWWA 2003) to have an acceptable effect on the total soil concentration of mercury.

To demonstrate the second bullet point for mercury, the soil background concentration (0.01 mg Hg/kg), bulk density (0.8 dry tonnes/m^3) and mixing depth (200mm) are required. Based on the NZWWA (2003) soil limit for mercury of 1 mg/kg, the biosolids mercury concentration from Table 4 of 9.8 mg/kg, and a 20 year application period an average of 8.0 t DS/ha/yr could be applied before the heavy metal soil ceiling is reached.

However, based on the nitrogen concentration of the Katikati biosolids of 5.2 %w/w (Table 4), and an application rate of 200 kg N/ha/yr (which is the Environment Bay of Plenty permitted activity loading), an average of only 3.8 t DS/ha/yr could be applied. Therefore the biosolids application rate to be applied would be limited by nitrogen as opposed to Mercury.

The resource consent process (refer to Section 3.4) is flexible enough to consider the above basis when establishing likely effects on the environment.

3.3 BENEFICIAL USE OPTIONS

Options identified for beneficial use of Katikati and Waihi Beach biosolids in 2009 were:

- Application to WBOPDC forest;
- Application to WBOPDC pasture;
- Vermicomposting; and
- Application to third party land.

Evaluation of all beneficial use options was made on the basis of a 'Bb' grade biosolid. The scale of the Katikati and Waihi Beach rating base makes producing an 'Aa' grade product as per NZWWA (2003) cost prohibitive. Basic criteria were used as the basis upon which to assess the biosolids use options. These were:

- Fuel and Transport Costs;
- Other Operational and Capital Costs;
- Potential for Beneficial use; and
- Resource Consent Issues.

All options are briefly summarised below with comment related to the assessment criteria. Environment Bay of Plenty requires resource consent for application of all 'Bb' grade biosolids to land as a discretionary activity. As such consent issues are expected to be similar for all options so are not expanded on individually. Section 3.4 covers the resource consent strategy for the selected option.

3.3.1 APPLICATION TO WBOPDC FOREST

Biosolids have been successfully used as a soil conditioner at a number of forest sites in New Zealand, including the Christchurch City Council forest application program. WBOPDC jointly own the 1,255 hectare TECT (Tauranga Energy Consumer Trust) forest park with Tauranga City Council. The TECT park is located approximately 70km from Katikati and 90km from Waihi Beach.

This option involves the transport of the dewatered biosolids to a temporary storage and management depot located within the TECT park. The Waihi Beach biosolids would require dewatering in a similar fashion to the biosolids contained in the geotextile bags at the Katikati WWTP, to allow for efficient transport and application. At present the forestry site available is not set up to enable vehicle passage for spreading. If this option were to be pursued WBOPDC would need to undertake strategic felling and track preparation. A suitable method of achieving an even application of biosolids would be the use of a compost spreader or muck wagon.

3.3.2 APPLICATION TO WBOPDC PASTURE

The application of biosolids to productive land has been practiced widely around the world (UN-HABITAT, 2008). In New Zealand the concept has not been widely adopted, but the use of biosolids as a fertiliser and soil conditioner should increase as a greater understanding of the fate of biosolids applied nutrients and contaminants in the environment is reached. WBOPDC own approximately 110 hectares of land adjacent to the Waihi Beach WWTP, which is currently leased and operated as a dairy farm. The farm site is 20km from the Katikati WWTP. Fonterra's position in 2009 stated that provided the biosolids application is performed to their requirements, such a process can be undertaken on farms that supply them with milk. Refer to Section 4 for further details.

The close proximity of the land to the Waihi Beach sludge ponds is highly advantageous as there would be minimal costs associated with transport of the biosolids. Therefore there is no need for dewatering the Waihi Beach biosolids as they may be discharged directly to the farm as a slurry using tankers, which provides a further significant cost saving. With Council owning the land and the farm manager whose pasture would benefit from the biosolids fertiliser value, being very supportive there are no issues in terms of securing the land for use. Application of Katikati biosolids would be by compost spreader or muck wagon, or by blending them with the product in the Waihi Beach sludge ponds as suggested in Section 3.2, and spraying the mixture as a slurry.

3.3.3 VERMICOMPOSTING

The process of vermicomposting is explained in Section 2.2. The Kawarau vermicomposting venture which takes the Te Puke sludge, could also process the biosolids from Katikati and Waihi Beach. Vermicomposting alone is not a beneficial use system. The composting reduces the mass of the biosolids through digestion, and produces end-products that may be used as soil conditioners and fertilisers. For the purposes of this option, some form of beneficial use is implied after the vermicomposting process, and it is considered that the responsibility for end use including resource consents rests with the vermicomposter.

Kawerau is located approximately 130 km and 150 km from Katikati and Waihi Beach respectively, so use of the existing vermicomposting facility is not viable due to transport costs. In addition all of these sludges would require dewatering further which would add to the overall operating costs.

3.3.4 APPLICATION TO THIRD PARTY LAND

This option involves the application of biosolids to land, other than that owned by WBOPDC and is dependent on securing suitable end users for the product. The application process and land use options are similar to those described for WBOPDC pasture and forestry. The Waihi Beach biosolids would require dewatering as there is no private land in the vicinity of the WWTP that is suitable or available. Transport distances of biosolids to private landowners will be subject to the location of that land, and therefore costs will vary accordingly. Potential end user groups are foresters, pastoral users and horticulturists. Presently there is no third party market available from these groups and obtaining one could take considerable time and be costly, if Council employed a consultant to undertake the market research.

3.3.5 SELECTED BENEFICIAL USE OPTION

The biosolids beneficial use options described above were assessed against the criteria listed at the beginning of Section 3.3. A scale of 0 to 5 was used as a qualitative measure of the relative cost or reliance of the option for each criteria, where 0 represents a low cost/reliance and 5 a high cost/reliance. These ratings for transport costs, operational and capital costs, potential for beneficial reuse and resource consent issues were combined in a simple non-weighted arithmetic matrix (Table 5) to develop a ranking for each option. The lowest total value of the matrix is the best potential option.

Table 5: Katikati and Waihi Beach Biosolid Beneficial Use Options Matrix

Option	Transport Costs	Operating Costs	Reuse Potential	Consent Issues	Total
WBOPDC Forest	3	4	1	3	**11**
WBOPDC Pasture	1	3	1	3	**8**
Vermicomposting	5	4	2	1	**12**
Third Party User	3	4	3	3	**13**

Application of biosolids to WBOPDC pasture at the farm located adjacent to the Waihi Beach WWTP is clearly the preferred option due to low transport costs, and with no need to dewater the Waihi Beach biosolids, relatively low operational costs. Importantly there is a clear beneficial use and a very willing recipient in the farm manager. The distance to Kawerau precludes the existing vermicomposting operation, despite the direct costs and responsibility for obtaining resource consent for final use being removed from WBOPDC. The third party user option is also discounted as it lacks an established market and cannot match the benefits of utilising land over which Council has control.

It is important to note that the above assessment is a summary only and specific to the circumstances at, and locations of the Katikati and Waihi Beach WWTPs. Although the same principles can be applied to biosolids from other WWTPs, the outputs and preferred option may be quite different.

3.4 RESOURCE CONSENT STRATEGY

Following the above assessment a resource consent application to apply the Katikati and Waihi Beach biosolids to 34 hectares of the Council owned farm was prepared. The basis of the application was:

- All biosolids to be applied under the proposed activity shall meet a minimum ‘Bb’ grade;

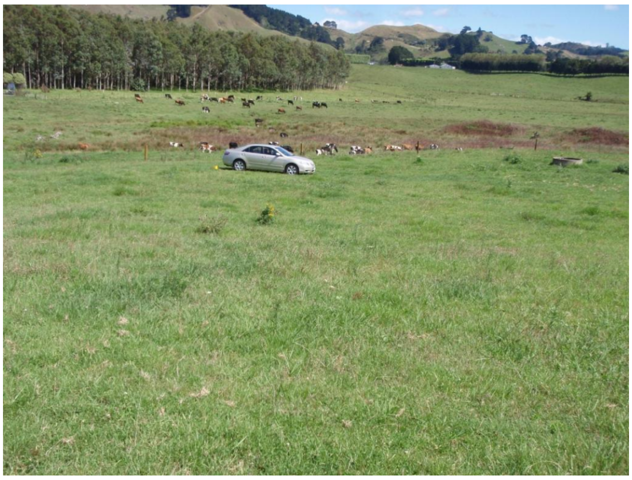
- Where biosolids analysis results identify a heavy metal or organic contaminant as the most limiting parameter, then the contaminant will determine the biosolids loading rate which will be the lower loading corresponding to 200 kg N/ha/y, or the soil guideline limit for that parameter not being exceeded for the period of the consent; and
- Where nitrogen is the most limiting parameter the application rate proposed would be a one off application of the equivalent of 600 kg N/ha with a return time not less than three years, i.e. equivalent to 200 kg N/ha/yr but in a single application.

Detailed laboratory analysis of the biosolids constituents as per Table 4 was not included with the consent application. Verification testing of the biosolids in their final form to confirm the 'Bb' grading, as well as soil test analysis was recommended as a condition of the resource consent and associated management plan to determine the maximum permitted application loading rates.

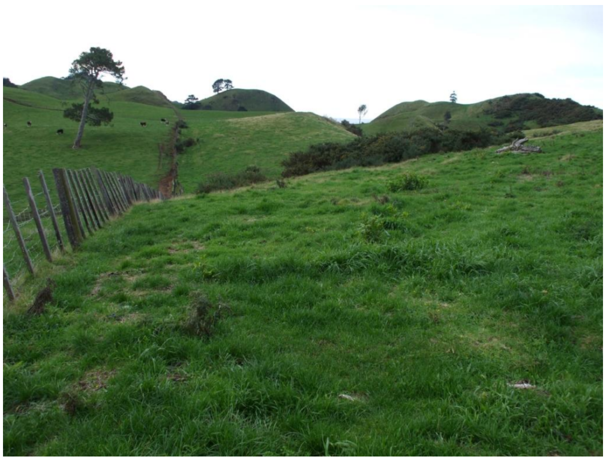
Prior to submitting the consent application, Fonterra advised their biosolids policy was under review and as such products from human origin would no longer be accepted on dairy farm land. Refer to Section 4 for more details. For WBOPDC this meant that 34 hectares of easy access and flat dairy land with sufficient capacity to assimilate all of the Katikati and Waihi Beach WWTPs biosolids plus similar quantities of 'Bb' grade biosolids from other sources was no longer available, unless the land use changed from lactating dairy.

Fortunately the Council had 12 hectares of the farm runoff block which only dry cows graze available for biosolids application, as well as two blocks totaling 7ha at the top end of the farm which stock do not access. Both these sites come with increased costs compared to the original dairy farm site being approximately one km away from the WWTP, with the runoff block in particular having more resource consent issues to overcome. Photographs 3, 4 and 5 illustrate why there was a preference for the dairy farm site compared to the other sites.

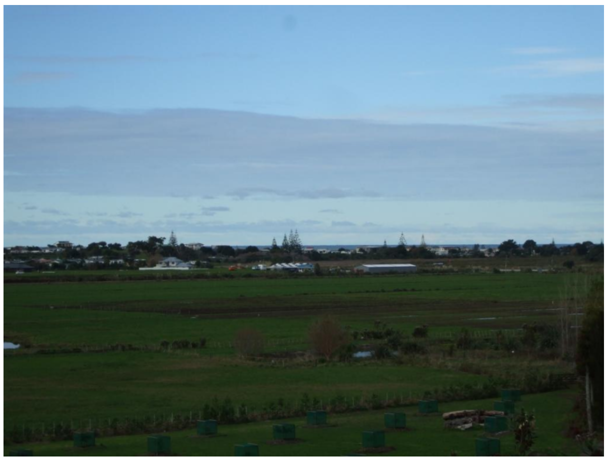
Photograph 3: Dairy Farm Site



Photograph 4: Top End of Farm



Photograph 5: Runoff Block



The dairy farm site has easy access being directly adjacent to the Waihi Beach WWTP and is flat to gently rolling pasture. The top end of the farm where biosolids can be applied is sloped and undulating. The runoff block is low lying with a high water table and is closer to the coast, so more detailed analysis of the potential transport of contaminants to ground and surface waters was required. Being adjacent to the existing residential zone, under the Waihi Beach structure plan the area of the runoff block is planned for future residential development post 2021. Despite these obstacles securing consent for biosolids application at the top of the farm and runoff block was still preferable to alternative options, at least for short term use.

Demonstrating mitigation of risk to the environment and public health is critical for obtaining resource consent for the biosolids application to land at these sites. Mitigation measures were proposed in the consent application and a Biosolids Management Plan has been prepared to monitor compliance with these measures. The mitigation requirements include biosolids and constituent loading rate verification testing (NZWWA, 2003), appropriate application methodology, buffer distances to water bodies, property boundaries and dwellings. Record keeping forms to demonstrate compliance with consent conditions including the specific mitigation measures are included in the Management Plan.

At the time of writing this paper, a resource consent application and assessment of environmental effects for both sites has been lodged and consultation is continuing with local Iwi, the Department of Conservation and Toi Te Ora Public Health. All concerns expressed by these parties relate to the runoff site. Because of this, and to avoid consent notification, a small scale biosolids application trial on site at the run off block is proposed. Waihi Beach biosolids will be applied over a small area (< 1 hectare) at the maximum allowable nitrogen loading rate, and groundwater around the site monitored before, during and after application for nitrogen, phosphorus, heavy metals and faecal coliforms. It is anticipated that results from the trial will be used to substantiate consent conditions for full use of the runoff block.

4 FONTERRA'S BIOSOLIDS POLICY

As covered in Section 3.4 the ability to apply biosolids to pasture is restricted by what Fonterra is willing to accept on dairy farm land. This has significant implications for the WBOPDC, and requires further comment in relation to the wastewater industry as a whole.

At the time of the biosolids beneficial use options study in 2009, Fonterra's biosolids policy was it is acceptable to spread treated waste from human origin to pasture grazed by dairy animals provided that:

- The material has been secondary treated and disinfected;
- The secondary treatment process produces an oxidized effluent;
- The median concentration of total coliforms must not exceed 23 cfu/100ml (based on a seven day period) and the maximum number of one sample over a 30 day period must not exceed 240 cfu/100ml.
- Material not treated to the above standards will be acceptable provided that subsequent to application, crops are grown and harvested prior to re-sowing the pasture for grazing.

Considering Fonterra's policy at that time, the Council owned dairy farm at Waihi Beach was ideally suited to receive biosolids from Katikati and Waihi Beach as a fertiliser and soil conditioner. Maize or sorghum could be grown, harvested and new pasture sown during the six month stand down period (NZWWA, 2003) before stock can be re-introduced.

However Fonterra advised early in 2010 that their policy on acceptance of biosolids was under review and would be changing to:

- Any application of biosolids to soil renders it unsuitable for growing any feed to be fed to lactating dairy cows; and

- The same considerations do not apply to dry cows but a 30 day with holding period where pregnant animals could not be fed that feed before calving would come into effect.

Not part of the proposed policy but key to Fonterra's basis for it, is that one of the risks identified, market perception, means it is impossible to offer suitable mitigation following application. Even 'Aa' grade biosolids will not be acceptable under the revised policy, even with growing and harvesting of a crop after application and any length of stand down period before dairy stock are re-introduced to the pasture.

Fonterra has not presented any scientific, health or environmental evidence to substantiate it's rejection of biosolids applied to dairy land. Market perception is just an extension of negative public perception which was evident, although not wide spread during the resource consent process for the Waihi Beach biosolids application sites. Negative perception comes about through the general public's lack of knowledge and their inability to understand that our biosolids can be applied safely to land based on NZWWA (2003) and other control measures.

The wider implication of Fonterra's stance is that not only are vast areas of dairy farm land no longer available for application of biosolids, but any other land on which biosolids had been used as a fertiliser could not be converted to dairy in the future. This potentially restricts the application of biosolids to further large areas of land throughout the country including forestry and orchards where dairy conversion is possible.

5 FUTURE VISION

Prior to Fonterra's biosolids policy review reducing available land area, WBOPDC was already investigating an alternative beneficial use venture to vermicomposting Te Puke's biosolids in Kawerau and land application at Waihi Beach. Council's vision for managing biosolids, septic tank sludges, and other organic wastes currently not recycled is a quadruple bottom line approach on economic development while maximising the social, cultural, and environmental benefits.

WBOPDC is seeking to combine the benefits of a highly productive horticultural area (kiwifruit and avocado production) surrounded by large forest plantation, and the proximity to Tauranga City. Figure 1 presents a diagram of inputs and outputs as well as service opportunities for a proposed centralized vermicomposting operation in the WBOPD. The diversity of land use in the District allows for wide ranging marketing and utilisation of the end products.

Figure 1: Western Bay of Plenty Centralized Worm Farm Concept

Currently WBOPDC are exploring a centralized vermicomposting operation that would recycle regional biosolids and septic tank sludge with the option of adding organic wastes from food processing industries and private households.

5.1 QUADRUPLE BOTTOM LINE BENEFITS

The following summarises the quadruple bottom line benefits of a centrally located vermicomposting plant servicing the whole District.

Economic

- Scope for cost reduction if average transport distances are reduced.
- Biosolids monitoring requirements and costs reduced due to a more consistent end product.
- Greater opportunity to monitor (via GIS) biosolids applied to land from a single source.
- Economies of scale for a single large operation.

Environmental

- Environmentally safe technology as described in Section 6.2.
- Reduced spore, odour and GHG emissions.
- Increase in soil organic content when applied to land in place of mineral fertilisers.

Social

- Education on organic waste management, recycling, biological and environmental fields.
- Employment opportunities and training for a wide range of skill levels.
- Research and product development opportunities with BOP Polytechnic located nearby.

Cultural

- Vermicomposting is an extremely natural process.
- Land application of vermicompost is expected to be more culturally acceptable to Iwi.
- Closer working relationships developed with local Iwi.

6 CONCLUSIONS

Vermicomposting is an efficient way to process wastewater sludges derived from human origin and reduce the associated potential health and environmental risks. This conclusion is supported by extensive research on the topic. A final beneficial use for the end biosolid product is however still required.

For beneficial use of biosolids adequate land area and a willing recipient are essential. Council owned land should be utilised if possible to reduce the risk and potentially costs associated with obtaining third party agreements, resource consent and maintaining long term access. For most local authorities, suitable land located close to the source of biosolids to minimise transport costs is important in order for beneficial use schemes to be affordable. Unless suitable land is available within the vicinity of the WWTP, as was the case for Waihi Beach, dewatering of pond produced biosolids will be necessary in order to transport a solid product of much smaller volume.

WBOPDC found dewatering of the Katikati oxidation pond sludge by geotextile bags to be extremely advantageous for investigating beneficial use options. Once the ponds are desludged to the geotextile bags, there is no need to do anything else with the sludge until a final destination and use for the end product is secured. During this time the sludge continues to stabilise and so meets the requirements of a biosolid that can be safely applied to land as per NZWWA (2003).

The total volume of biosolids produced in New Zealand is likely to increase as treatment plants are improved in the future (MfE, 2006). As well as this, older pond systems, which are still providing sufficient treatment for their effluent receiving environment, will require more frequent desludging in order to continue doing so. If at the same time the land options available for beneficial use of biosolids are decreasing due to decisions such as those made by Fonterra, the New Zealand wastewater industry will face an even greater challenge in the future to make economic and environmentally acceptable use of biosolids.

Breaking down barriers to make use of an excellent fertiliser and soil conditioner, which otherwise becomes a waste product sent to landfill must be an objective for the wastewater industry as a whole. Overcoming negative public perception on the use of biosolids from human origin through education is imperative. Case studies presented on successful biosolids land application schemes would be a good start in this regard.

MfE (2006) reports that from available data 79,440 tonnes, or 67.5% biosolids produced in New Zealand (excluding Mangere biosolids used for land reclamation) are land filled each year. So there is some way to go before New Zealand's use of biosolids can be considered environmentally sustainable. Territorial Authorities have a major role to play to achieve this objective. The WBOPDC is beginning the process for its District with the current land application initiative at Waihi Beach. Implementing Council's future vision of a centralized vermicomposting facility servicing the whole District, represents a significant challenge, but one that should be strived for.

ACKNOWLEDGEMENTS

The authors wish to thank Dr Michael Quintern for the information provided on Vermicomposting.

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NOMENCLATURE

% w/v	percentage weight by volume
% w/w	percentage weight by weight
cfu	colony forming units
GHG	green house gas
Hg	mercury
kg N/ha/yr	kilograms of nitrogen per hectare per year
mg/kg	milligrams per kilogram
t DS	tones of dry solids
TECT	Tauranga Energy Consumer Trust

WAS	waste activated sludge
WBOPDC	Western Bay of Plenty District Council
WWTP	wastewater treatment plant