MEMORANDUM **Job 10416 Y3M1:3A**

To: Biosolids Partner Councils

From: Hamish Lowe, LEI

Date: 29 January 2020

Subject: A cost analysis summary for end-use options in the Lower North Island.

PROJECT BACKGROUND

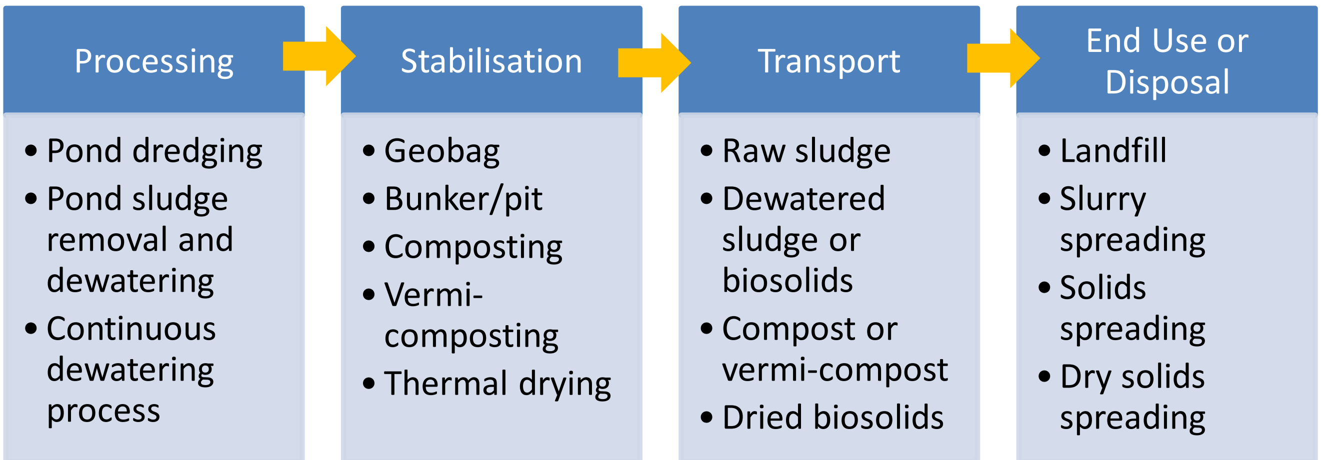
Lowe Environmental Impact (LEI), The Centre for Integrated Biowaste Research (led by ESR), and 10 lower North Island Councils are working together to develop a biosolids strategy that includes the potential collective management of sludge, with a focus on beneficial use. The MfE funded project has been running for three years and aims to identify and test options for discharge and beneficial use of biosolids, in particular for smaller councils who may not have been able to achieve such solutions individually. The resulting toolbox of scenarios may reduce the cost of sludge management and increase the certainty and viability of available solutions for Councils.

SUMMARY

This memorandum provides a review of biosolids costs from a range of processes and locations around New Zealand. Costs have been adjusted to net present value (NPV, as at November 2019). Data from the review is presented in this memorandum for use to develop high level costings for planning of biosolids end use options. Steps to prepare costs for biosolids end use options are as follows:

1. Determine the amount of material to be processed

2. Assign costs from the tables provided below for each stage as follows



3. Sum and assess the NPV of the option for comparison and decision making

OVERVIEW

A series of biosolids end-use scenarios have been developed for communities in the lower North Island. Options for each component of the processing, stabilising and discharge of biosolids have been evaluated and pathways identified which lead to an end-use option.

Preferred scenarios have been identified for more detailed investigation. Additional investigation includes comparative costing of options for various components in the extraction and management of sludges.

A key consideration of the investigation has been to identify possibilities for and benefits of shared resources. This may include equipment in common, facilities in common or simply procedures in common.

The communities covered by the various councils produce a mix of sludge types (oxidation pond, continuous belt press, digestor), rates of production (<1,500 persons serviced to ~80,000 persons serviced) and required frequency for sludge removal (1 per 10 y to daily). Correspondingly a range of desludging and stabilisation options and scales should be considered.

This work presents a costing exercise that incorporates reuse and disposal options and essentially provides a high-level costing summary for a toolbox of options associated with biosolids end use scenarios.

METHODOLOGY

Lowe Environmental Impact (LEI) has engaged with Beca to compile actual costs associated with a range of biosolids management processes for systems in use around New Zealand. Costs have been adjusted to reflect present day value (inflation rate of 5 % and a discount rate of 6 %). This includes material from oxidation ponds and higher rate treatment processes.

In order to develop a costing model which can be used for the scenarios identified for the lower North Island, the following costs have been considered:

- Capital costs such as:
  - Land area for processing activities;
  - Land area for storage/stockpiling;
  - Physical infrastructure for sludge removal, dewatering, stabilisation (drying, composting, geobags, etc); and
  - Land application infrastructure (machinery, application site storage, etc).
- Operational costs such as:
  - Repair and maintenance for processing and application infrastructure;
  - Operational time;
  - Fees.
- Transport costs including:
  - Mileage;
  - Time; and
  - Fuel and road user charges.
- Consenting costs including:
  - Technical advice and consent application preparation;
  - Consultation;
  - Monitoring and mitigation.

Costings are highly variable, being technology, site and material specific. The costings consider the feed material being:

- One-off (1 in 10 year) desludging (oxidation pond); or
- Continuous process (digestor, belt press, etc).

The costs also consider the material to be discharged i.e.:

- Undewatered sludge (5% dry solids);
- Dewatered sludge (20% dry solids, no stabilisation);
- Restricted biosolids (20% solids, stabilised);
- Aa biosolids (20% solids, stabilised, may include dilution with clean fill material);
- Composted biosolids (20% solids, stabilised and combined at 1:4 with greenwaste and woody material);
- Vermi-composted biosolids (20% solids, stabilised and combined at 1:1 with carbon rich material); or
- Thermally dried biosolids (90% solids, stabilised).

As noted above, the final material for discharge varies substantially both in moisture content and in discharge volume where additional material is added e.g. for compost. For this memo the costs have been determined for the material as supplied and as discharged and then presented on a dry solids basis to enable the options to be compared.

A key consideration for the costings is the impact of scale. From the range of examples assessed, a relationship has been developed between the equivalent dry solids amount and each parameter. This acknowledges that economies of scale exist and through basing the costings on a wide range of actual projects enables this to be quantified.

Costings were correct at November 2019. Use of net present value (NPV) analysis is recommended when these costs are applied to scenario costings. The costing tables developed are suitable for high level analyses for the purpose of planning and comparison. Detailed, site specific costs should be sought for design purposes.

RESULTS

<u>Processing</u>

One-Off or Infrequent Large Volumes
Oxidation pond desluging typically occurs as a one-off or one in ten-year events. A large volume of sludge requires handling over a brief period. Commonly, a desludging rig is mobilised to the site for the length of time it takes to desludge the pond(s). The process includes removal of sludge from the pond, dewatering and potentially storage. Additional options would include direct removal of undewatered sludge to an off-site facility for further processing. This has been examined in earlier collaboration scenarios but is unlikely to be adopted due to high transport costs (see transport discussion below).

Costs for processing of one-off events have been evaluated as follows.

- <u>Removal only</u>
  In some cases where handling and dewatering infrastructure already exists, there may only be a need to remove the sludge (dredge).

- <u>Oxidation pond sludge removal and dewatering</u>
  Most sludges removed from oxidation ponds undergo some form of dewatering. The extent of dewatering depends on the extraction technique and the targeted moisture content for further handling. Most plants used are mobile and the service is offered by contractors, with costs being inclusive of removal and processing. Costs typically cover set up, operation, chemical and testing.

The following table tracks the cost per dry tonne of solids for processing of a one-off event. The costs include the CAPEX and OPEX combined but exclude the cost of additional land for dewatering or storage (discussed below). Due to the one-off nature of this activity separation of OPEX and CAPEX is not useful.

Dry tonnes of solids	Sludge for transport (wet tonnes)	Processing cost per tonne dry solids		
		Dredging only	Dredge and geotube	Dredge, dewater, bunker/pit
200	1,000	$386	$946	$1,322
500	2,500	$198	$831	$795
1,000	5,000	$135	$793	$619
3,200	16,000	$92	$792	$498
16,000	80,000	$76	$819	$454
18,880	94,400	$76	$820	$453
100,000	500,000	$73	$825	$445

The table above shows a variation in cost based on the total amount of dry solids to be processed. A mass of 3,200 t/y over five years is anticipated if the oxidation ponds in the investigation area are progressively desludged. If all ponds were desludged in one year around 16,000 dry tonnes (80,000 tonnes at 20% dry solids) would be processed.

Continuous dewatering
Where there is a continuous production of sludge that requires dewatering, permeant infrastructure can be established. There are a range of technologies including belt presses and centrifuges, but most typically utilise some form of chemical dosing to assist with removing water. Included in the infrastructure are facilities to handle and in some cases store material prior to removal off site.

There are existing facilities of this nature in the investigation area. Costings provided here allow for full replacement or establishment of a new facility.

Dry tonnes processed	CAPEX	OPEX
	Cost per tonne dry solids	
100	$5,273	$507
2,000	$2,135	$79
10,000	$2,003	$61
15,680[1]	$1,991	$60
18,880[2]	$1,988	$59

[1] Currently processed
[2] Total annual sludge for processing in the investigation area

The total amount of sludge for processing has an impact on the cost but only at low sludge volumes.

<u>Stabilisation</u>

As discussed in previous reporting, there are a number of methods for stabilising sludges and assisting with improving the biosolid grade. Composting, vermicomposting and solar drying are options. It should be noted that once stabilised the material is ready for end use, but stabilisation is not an end use in itself.

Composting is a process used internationally and at a number of sites around NZ to stabilise sludges. One of the biggest limitations is managing the supply of green waste to enable the appropriate ratio for effective compositing. In a number of instances sludges are additions to an existing compositing operation, while others are dedicated sludge compost facilities; and this variation contributes to a price variance.

Vermicomposting is similar to composting but is typically using a dedicated site.

Solar or thermal drying uses passive processes such as lined shallow beds that allow water/leachate (including stormwater) to be collected and returned to the treatment system; or active processes such as passing sludge through a heated bed or through a glasshouse type facility. In some cases, it can use existing ponds within a treatment system, with the ponds taken off line for a period of time to allow the moisture content to be reduced. For this investigation active processing units have been used to develop costs.

The table below summarises costs associated with facilities developed throughout New Zealand. The per tonne dry solids cost did not tend to vary by total sludge volume and so a single value has been chosen which represents the geomean for the costed examples.

Stabilisation costs	**Land for storage and stabilisation**	**CAPEX**	**OPEX**
	Cost per tonne dry solids		
Geobag	$25	Included in processing costs	Minimal
Bunker/pit (continuous process)	$4	$100	$20
Composting	$21	$50	$60
Vermi-composting	$13	$130	$80
Thermal Drying	$6	$7,800	$205

Land required for stabilisation and storage of the material has been determined based on the expected footprint of the stabilisation method and takes into account the effect of adding material i.e. greenwaste addition to biosolids for composting. Purchase of land for these operations has been assumed. Costs for the geobags and preparation of a storage area is included in the costs given in the processing table earlier.

<u>Transport</u>

Transport costs for trucking sludge are significantly influenced by two factors – moisture content (or dilution with other materials) and distance. Trucking water is expensive, so dewatering is critical. Distance results in a sliding cost scale with longer distances being cheaper per kilometre, as loading and unloading costs are effectively fixed costs irrespective of the distance. Relationships with the trucking firm and the potential for back loading can also influence costs, but this is predominately a factor should long haul options be considered.

While there may be volume limitations with trucks, the biggest limitation is typically weight. Consequently, costs are expressed on a weight basis, and have been corrected to being cost per dry tonne. The table below gives the costs of moving a range of different materials which reflect the varied moisture contents and the addition of other materials. A slurry tanker is required for transport of raw sludge while truck trailers can be used

Distance to travel (km)	**10**	**20**	**50**	**80**	**100**
	Cost per tonne dry solids for transport				
Raw sludge (not dewatered)	$32.52	$34.88	$41.98	$49.09	$53.82
Dewatered sludge, restricted use or Aa biosolids	$6.47	$6.94	$8.35	$9.76	$10.70
Composted biosolids	$10.78	$11.56	$13.92	$16.27	$17.84
Vermi-composted biosolids	$6.47	$6.94	$8.35	$9.76	$10.7
Thermally dried biosolids	$1.62	$1.73	$2.09	$2.44	$2.68

<u>Landfill Disposal</u>

The vast majority of sludge disposal in NZ is to landfills. Landfill costs are variable and often reflect negotiated rates which may be influenced by refuse disposal contracts. The costs are essentially a tipping fee, which covers placement, spreading and any levies. The table below gives landfilling fees for dewatered sludge (20% solids) based on the geomean of fees from five NZ landfills ($185 per wet tonne).

Dry tonnes landfilled	Fees ($)
3,200[1]	$2,967,000
15,680[2]	$14,539,000
18,880[3]	$17,506,000

[1] Annual mass from 20% of oxidation ponds in investigation area
[2] Annual mass from continuous process
[3] Total annual sludge for processing in the investigation area

As with transport, the drier the material the more that can be deposited for the same cost.

End use

As noted in previous reporting, a large volume of sludge material goes to landfill. A key objective of the biosolids strategy is to facilitate beneficial use of biosolids. The end use options available are typically dependent on the material produced by the stabilisation process (maturing, composting, thermal drying, etc).

In some cases decisions about end use are stalled at the dewatering/stabilisation stage, with Councils intentionally choosing to leave the material in the dewatering/stabilisation facility e.g. leave the dried sludge in solar drying beds or geobags. Examples of beneficial use and their costs are not readily available. The table below gives costs for a mine rehabilitation project and spreading of a biosolids slurry to forest.

	CAPEX	OPEX
Stockton (transport and spreading)	Minimal	$105 / wT (3,600 dT / y)
Rabbit Island – slurry (pipeline, storage and spreading)	$ 1,900 / dT (1,100 dT / y)	$31 / wT (1,100 dT / y)

Given similarity in material handling, there is the opportunity to draw on experience with agricultural wastes, with land spreading of solids and slurries from dairy and poultry operations being more common. Often such operations see material generated on the farm and spread on the same farm, and the transport is undertaken by the same wagon as doing the spreading. Costs below are for spreading alone and include transport within a farm operation and do not include resource consents and other approvals.

It is assumed that a contractor will be engaged to undertaking the spreading. However, there is potential for a cost/benefit analysis to favour in-house purchase of equipment and operational control for a combined option between councils.

Discharge	Method	Cost per dry tonne ($)
Slurry spreading (< 4% solids)[1]	Tank and splash plate	$220
Solids spreading (> 15% solids)[2]	Muck spreader	$70
Dry solids spreading (> 80% solids)[3]	Fertiliser spreader	$15

[1] Minimally dewatered biosolids/sludge
[2] Dewatered sludge, restricted use or Aa biosolids, compost or vermi-compost
[3] Thermally dried

WHOLE OF BIOSOLIDS PROCESS COSTS

Using the preceding tables the appropriate costs for each stage of the biosolids management process (processing, stabilisation, transport and end use) can be combined to determine comparative costs for a land based end use.

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