REPORT

Tonkin+Taylor

Residual Waste Management in Wellington City - Alternatives Assessment

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Executive summary

This report considers the options for managing residual waste generated in Wellington City. Wellington City Council (WCC) currently accepts residual waste for disposal at Southern Landfill from kerbside refuse collections, commercial refuse collections and materials brought by residents and businesses to the site. The existing Stage 3 of Southern Landfill disposal area will reach capacity in the next few years and WCC has identified a Stage 4 Landfill extension as a feasible option. The purpose of this report is to consider all potentially feasible options for the management of residual waste generated in Wellington City.

Current situation

The Southern Landfill is a critical piece of sanitation infrastructure for Wellington. WCC accepts residual waste for disposal at Southern Landfill from kerbside refuse and commercial refuse collections as well as materials delivered by residents and businesses to the on-site transfer station. The Landfill is the only facility in Wellington City that accepts special waste including all of the city's dewatered sewage sludge, contaminated soil and asbestos containing materials. The existing disposal area will likely reach capacity as early as 2023.

Waste generation is projected to rise in line with population and GDP growth. However, not all waste is landfilled. Wellington City Council has committed to reducing the amount of material landfilled by 30% by 2026. A range of initiatives will be employed to achieve the reduction focusing on household waste, business waste and sewage sludge.

Values and evaluation framework

A framework comprising six values was developed to evaluate options for the management of residual waste generated in Wellington City. The frameworks reflect key risks associated with the management of residual waste, issues of concern to Council and the community and consideration of cost to households, businesses and ratepayers. The table below reproduces the values shared with the community for feedback and comment.

Table E.1: Values used to evaluate options for the management of residual waste

Technology risk	**Community impacts/values**	**Legislative/Resource Management Act risks**
• Availability of experts and equipment to maintain, operate and fix equipment • Is the technology future-proof – risk of obsolescence? • Refer to existing applications/ examples at a similar scale • Scalability of the technology – can it be scaled up or down easily if waste quantities change?	• Traffic volumes • Dust, noise, litter, odour, visual impacts • Cultural concerns • Community image impacts • Resilience implications for Wellington City – ability to manage waste within the boundaries of Wellington City in an emergency • Impacts on public health	• Relevant policy direction and political environment for process • Risk of securing consents

Product risks	Financial	Environmental
• Products produced by the alternative? • How much product is produced as a proportion of the initial input tonnage? • Are there established and enough markets for the final product? • What would the residual waste be and how do we manage this safely?	• Capital cost of option from decision to operation • Operational costs • Funding option	• Impacts on the surrounding environment, including fauna (animals) and plants • Groundwater pollution risk • Carbon emissions • Recreational use of land upon completion • Residual risks upon Landfill closure • Risk of technology in a seismically active environment

Options for managing residual waste

For the purposes of this evaluation, we have considered a range of options for managing residual waste generated in Wellington City. This assumes that the current range of initiatives to reduce waste generation and capture materials for reuse, recycling or recovery continue. Current initiatives include:

- Education to encourage Wellington City residents and businesses to avoid the generation of waste
- Provision of a kerbside recycling collection service for residential properties in Wellington City
- Accepting reusable items at the Southern Landfill's Tip Shop
- Providing free recycling and discounted green waste drop off at Southern Landfill
- A range of commercial recycling and recovery services including paper, cardboard, food waste, green waste, metals, e-waste and plastics

The current arrangement for management of residual waste in Stage 3 of the Southern Landfill will no longer be available from around 2023 depending on filling rates. Once Stage 3 has reached its capacity, options for the management of residual waste at the Southern Landfill include:

1) ***Closure of the existing Landfill*** – Waste no longer accepted at the Landfill. Waste will need to be transported directly to another landfill by collection companies, households or businesses, most likely Silverstream Landfill (Lower Hutt) and/or Spicer Landfill (Porirua).

2) ***Closure of the existing Landfill and continued operation of the transfer station*** – Waste accepted at the transfer station at Southern Landfill with material transferred to another landfill by Council, most likely Silverstream Landfill (Lower Hutt) and/or Spicer Landfill (Porirua).

3) ***Extension of the existing Landfill*** - Development of Stage 4 of the Landfill by 2023 to allow ongoing disposal of waste.

4) ***Conventional (mass burn) incineration*** - Treatment of waste through conventional incineration with rejects, bottom ash and air pollution control residues disposed of in a new dedicated stage at the Landfill.

5) Advanced thermal treatment

    a) ***Advanced thermal treatment (gasification)*** – Treatment of waste through gasification with char, air pollution control residues and rejects disposed of in a new dedicated stage at the Landfill.

b) ***Advanced thermal treatment (pyrolysis)*** – treatment of waste through pyrolysis with char, air pollution control residues and rejects disposed of in a new dedicated stage at the Southern Landfill.

6) ***Mechanical heat treatment (MHT)*** – Treatment of waste through MHT with heat treated material and rejects disposed of in a new dedicated stage at Southern Landfill.

7) ***Mechanical biological treatment (MBT)*** – Treatment of waste through MBT with stabilised biodegradable material and rejects disposed of in a new dedicated stage at the Landfill.

Options evaluation

The values and evaluation framework presented above was used to evaluate the options identified. Figure E.1 summarises the evaluation outcome including weightings developed with input from the community and Council. Figure E.1 stacks the scores for each of the values to provide an indication of the relative contribution to the overall evaluation score. A higher score indicates a more favourable option.

The evaluation suggests that option 3: *Extension of the existing Landfill*, option *2: Closure the existing Landfill and continued operation of the transfer station* and option 1*. Closure of the existing Landfill* are the most favourable options. The remaining options received less favourable scores for legislative/Resource Management Act risks, product risks, technology risks and financial impact.

Option 3*. (Extension of the existing Landfill)* has the most favourable score for cost while options *2. (Closure of the existing Landfill and continued operation of the transfer station)* and option 1 *(Closure of the existing Landfill)* benefit from favourable legislative/Resource Management Act scores. Costs are high for options *2 (Closure the existing Landfill and continued operation of the transfer station)* and *1 (closure of the existing Landfill)* due to the cost of transporting and landfilling 15,000 tonnes per year of biosolids elsewhere and the loss of generated revenue.

On balance option *3. Extension of the existing Landfill* is the most favourable option with cost and product risk (ability and willingness of other landfills to accept all of Wellington City's waste) helping to differentiate between the options. Cost and legislative/Resource Management Act factors are key in the less favourable scores for the evaluation of the advanced waste treatment options (Option 4 – 7).

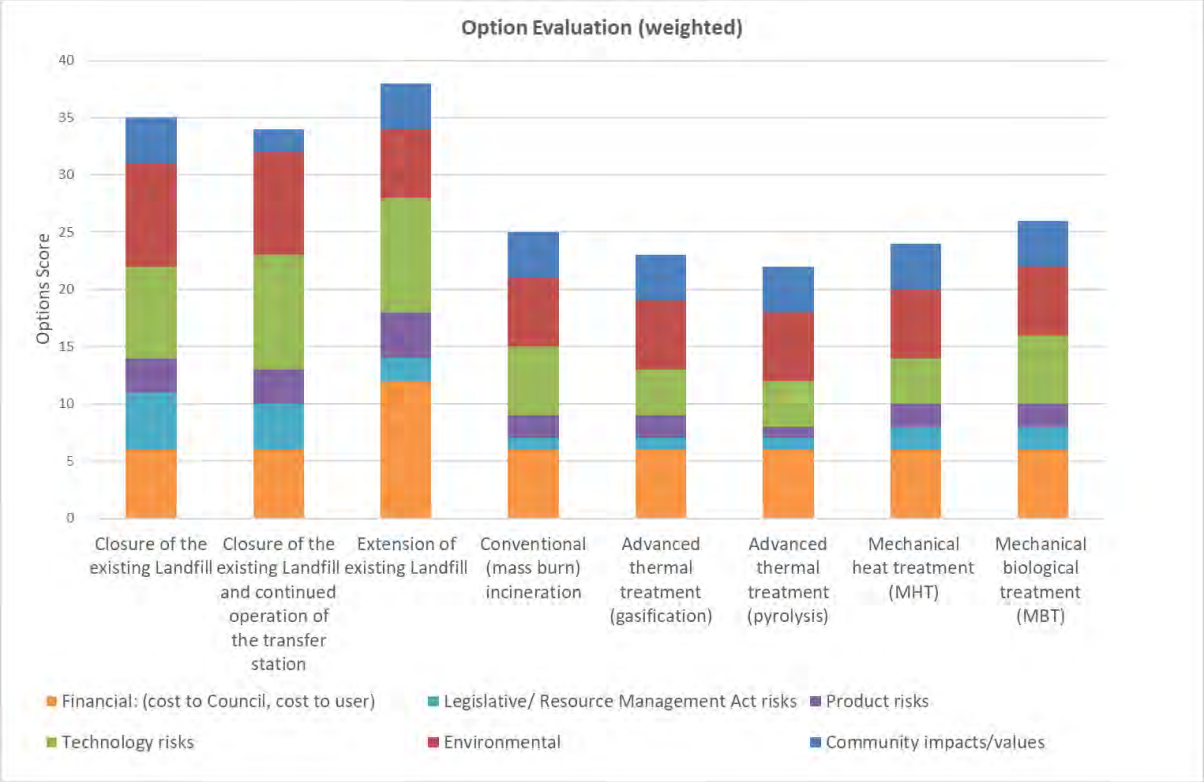

Figure E.1: Weighted evaluation results

Evaluation outcome

Based on the evaluation of options summarised in this report, option 3: *Extension of the Southern Landfill* is considered the most favourable option. This reflects that good practice landfill design, construction and operation is well proven in New Zealand, that there is a relatively low environmental risk with appropriate design and operation and that the cost of the Landfill extension is relatively low compared to other options.

The evaluation highlighted the need to progress design, construction and operation for the extension taking into account the values developed for this evaluation process. Implementation of option 3 *Extension of the Southern Landfill* should follow good practice landfill design and construction, delivering a cost effective solution for the management of residual waste. This should be done in conjunction with working closely with consent authorities and continuing to engage with the community to understand and address community issues and impacts.

1 Introduction

This report considers the options for managing residual waste generated in Wellington City. Wellington City Council (WCC) currently accepts residual waste for disposal at Southern Landfill from kerbside refuse collections, commercial refuse collections and materials brought by residents and businesses to the site. The existing disposal area will reach capacity in the next few years and WCC has identified an extension as a feasible option. The purpose of this report is to consider all potentially feasible options for the management of residual waste generated in Wellington City.

It is important to note that the Southern Landfill is a critical piece of sanitation infrastructure for Wellington City. The landfill provides for the appropriate management of residual waste with a focus on protecting public health and minimising impacts on the environment.

The landfill itself does not generate waste, rather it provides options for the management of residual waste generated by residents and businesses in Wellington City. Waste minimisation begins well upstream of the landfill.

The remainder of this document:

- Summarises the current situation with respect to residual waste management in Wellington City (Section 2)
- Sets out objectives for residual waste management and presents a framework for evaluating potential feasible options (Section 3)
- Summarises potential feasible options with reference to experience across New Zealand and internationally (Section 4 and Appendix A)
- Presents an evaluation of potentially feasible options (Section 5)
- Summarises the conclusions from the analysis in Sections 2-5 (Section 6)

2 Current Situation

The Southern Landfill is a Council-owned and operated landfill located at 201 Landfill Road off Happy Valley Road. The site was opened in 1974 and is currently in the third stage of a multi-stage development. It sits on land specifically set aside in the District Plan for landfilling, with around 100 years of filling space left.

The Southern Landfill is a critical part of the city's public health and sanitation infrastructure, dealing with the city's waste, sewage and disposal of contaminated material (e.g. asbestos) from developments. It also forms part of the city's resilience network, providing an area under the direct control of the Council to dispose of large amounts of demolition waste in case of a possible natural disaster.

Surpluses from the Southern Landfill subsidise recycling collection services, green-waste diversion to produce compost, the Tip Shop and other waste-minimisation activities contributing $6 million dollars per annum.

Any solution for managing residual waste will include current waste-diversion initiatives and be flexible enough to do more of these in the future. Currently activity at the Southern Landfill diverts approximately 8,000 tonnes of waste from the Landfill each year. This consists of:

- Green waste diverted to compost – approximately 5,800 tonnes a year
- Food waste diverted to compost – approximately 1,600 tonnes per year
- Scrap metal diversion – approximately 575 tonnes each year
- Salvaged material from the transfer station and voluntary drop-offs of material to the Tip Shop for resale – estimated at 250 tonnes per year

The Landfill also funds kerbside recycling and a free recycling drop-off at the Southern Landfill. This diverts approximately 11,500 tonnes of recyclable material from disposal in the landfill each year.

2.1 Waste quantity and composition

Southern Landfill accepts all residual waste produced in Wellington City. In 2019 this equates to around 100,000 tonnes per annum of waste. The waste managed at Southern Landfill includes material from:

- Kerbside refuse collections (Council and private)
- Commercial waste collections
- Materials taken to transfer station by households and businesses
- Special wastes taken directly to the landfill area including:
    - contaminated soil
    - asbestos – dedicated cell for the disposal of asbestos only
    - Dewatered sewage sludge

The transfer station at Southern Landfill accepts approximately 10,000 tonnes per annum from households and businesses.

In addition to accepting residual waste for disposal, Wellington City Council provides a range of services to reduce waste and where possible reuse or recycle materials prior to disposal. These include:

- Education to encourage city residents and businesses to avoid the generation of waste
- Provision of a kerbside recycling collection service for residential properties in Wellington City
- Accepting reusable items at the Southern Landfill's Tip Shop

- Providing free recycling and discounted green waste drop off at Southern Landfill

There is also a range of commercial recycling and recovery services available in Wellington City targeting paper, cardboard, food waste, green waste, metals, e-waste and plastics.

2.2 Projected future waste streams

The Regional Waste Minimisation and Management Plan (WMMP) assumes that waste generation will grow with population and economic growth in the region. The WMMP states that:

> *Total waste and recovered material quantities in the Wellington region are estimated to grow slowly over the next 10 years in line with population and economic growth. For the purposes of projecting total waste quantities, it has been assumed that kerbside refuse, greenwaste, and all recyclables will grow in line with population. The Statistics New Zealand medium population projection has been used for estimating kerbside recycling and refuse. It is assumed that other waste to landfill (mainly industrial/commercial/institutional waste and drop-off materials) and C & D waste will grow at a similar rate as GDP, with an assumed growth rate of 2% per annum.*

The WMMP has a target to reduce waste per person by 30% by 2026. Actions to achieve this include addressing waste from of households (food waste), businesses (construction and demolition waste) and targeting dewatered sewage sludge. Addressing these wastes streams is likely to involve additional sorting and/or processing of materials at Southern Landfill.

Any solution for the management of residual waste from Wellington City needs to be able to handle 100,000 tonnes of waste per year (including any future growth). The solution should be able to scale up or down in response changes in waste requiring management over time.

2.3 Regional context

There are two other landfills accepting general waste in the Wellington Region.

Spicer Landfill (Porirua) services Porirua and northern Wellington City. The site is managed by Porirua City Council and is jointly owned by Porirua City Council and Wellington City Council. The site accepts around 60,000 tonnes of waste per annum including asbestos and dewatered sewage sludge from the Porirua Wastewater Treatment Plant.

Silverstream Landfill services the Hutt Valley. The site is managed by Hutt City Council and is owned by Hutt City Council and Upper Hutt City Council. The site accepts over 100,000 tonnes of waste per annum including asbestos and dried sewage sludge from the Hutt Valley Wastewater Treatment Plant.

While most waste generated in each area is taken to the closest landfill, disposal costs and logistics also influence where materials go. A relatively small difference in disposal costs can result in waste being transported some distance.

3 Values and evaluation framework

When considering options for the management of residual waste generated in Wellington City it is useful to consider factors that are important to Council and the community. A set of values were developed and discussed with the community. A range of approaches were used to seek community feedback on the values. These included:

- Community workshops held in Brooklyn and Ōwhiro Bay
- Publishing the values and seeking feedback via Council's Let's Talk community engagement website
- Promoting the values and feedback survey via a Facebook Live Forum

Feedback from the community was used to refine and flesh out the values. The values are summarised in Figure 3.1 and explained in more detail in Table 3.1.

Figure 3.1: Values for evaluating options for the management of residual waste

Table 3.1: Values for evaluating options for the management of residual waste

Technology risk	**Community impacts/values**	**Legislative/Resource Management Act risks**
• Availability of experts and equipment to maintain, operate and fix equipment • Is the technology future-proof – risk of obsolescence? • Refer to existing applications/ examples at a similar scale • Scalability of the technology – can it be scaled up or down easily if waste quantities change?	• Traffic volumes • Dust, noise, litter, odour, visual impacts • Cultural concerns • Community impacts • Resilience implications for Wellington City – ability to manage waste within the boundaries of Wellington City in an emergency • Impacts on public health	• Relevant policy direction and political environment for process • Risk of securing consents

Product risks	Financial	Environmental
• Products produced by the alternative? • How much product is produced as a proportion of the initial input tonnage? • Are there established and enough markets for the final product? • What would the residual waste be and how do we manage this safely?	• Capital cost of option from decision to operation • Operational costs • Funding option	• Impacts on the surrounding environment, including fauna (animals) and plants • Groundwater pollution risk • Carbon emissions • Recreational use of land upon completion • Residual risks upon Landfill closure • Risk of technology in a seismically active environment

Each option has been evaluated against the values with commentary recorded (Appendix B) reflecting the detailed explanation of each value. In some cases modelling of an option scenario has been carried out to provide information to support the evaluation, for example likely costs or relative carbon emissions.

In addition to seeking comment on the values, survey participants were asked to rank the values in order of importance. Community feedback along with input from Council staff was used to develop weightings for the values. Feedback was provided by almost 100 members of the community with a mix of residents close to the Southern Landfill and other contributors.

A weighting of 3 means that the score for that value is three times more important than the score for a value weighted as 1.

Table 3.2: Values ranking and weighting adopted

Value	Community Survey ranking	WCC priorities	Weighting adopted	Comments
Environmental	1	2	**3**	Top ranking for community and high priority for WCC.
Community	2	3	**2**	Medium - High priority for the community and WCC.
Technology	3	4	**2**	Medium priority for the community and WCC.
Product Risks	4	6	**1**	Medium ranking for community, low priority for WCC.
Legislative/RMA	5	5	**1**	Low priority for community and WCC.
Financial	6	1	**3**	Low ranking for community, Top priority for WCC.

The results from the community survey mirrored WCC`s priorities with the exception of Financial. WCC has an obligation to deliver value for money in delivering services to the community. This means cost is an important consideration alongside delivering services that reflect values that are important to the community. The weightings adopted reflect the importance of cost alongside the remaining values.

To provide consistency in scoring, guidance was developed to enable scoring options against each value from 1 (poor) to 5 (very good). For each value comments are also captured reflecting the descriptions presented in Table 3.1 (detailed comments and modelling to support the scoring are presented in Appendix B). The scoring guidance is presented below.

Table 3.3: Values, weightings and scoring guidance

Criteria	Weighting	Scoring Guidance	
Community impacts/values	2	1	Significant community impacts are anticipated
		2	More than minor but less than significant community impacts are anticipated
		3	Minor community impacts are anticipated
		4	Less than minor community impacts are anticipated
		5	Negligible community impacts are anticipated
Environmental	3	1	Significant environmental impacts are anticipated
		2	More than minor but less than significant environmental impacts are anticipated
		3	Minor environmental impacts are anticipated
		4	Less than minor environmental impacts are anticipated
		5	Negligible environmental impacts are anticipated.
Technology risks	2	1	Hasn't been implemented at commercial scale before
		2	Some applications internationally, no applications in New Zealand
		3	Well established technology internationally, no applications in New Zealand
		4	Applications of technology in New Zealand
		5	Well established technology in New Zealand
Product risks	1	1	No markets available/ defined for products or outputs
		2	Markets defined/ available in other country's for products/outputs
		3	Markets defined but unproven for products/outputs in New Zealand
		4	Single or uncertain markets for products outputs in New Zealand
		5	Clear and multiple markets available and accessible in New Zealand
Legislative/ Resource Manageme	1	1	Extreme risk of not securing approval, for example extended or untested consenting process, activity with no precedent
		2	High risk of not securing approvals, business as usual consenting process but potential for no approval
		3	Medium risk of not securing approvals, activity with no precedent, consistent with plan requirements
		4	Low risk of not securing approvals, business as usual consenting process, consistent with plan requirements.
		5	No risk - consistent with existing approvals, no further consents required
Financial: (cost to Council, cost t	3	1	Net cost to Council 5-10M and/or projected gate rate > $300/T
		2	Net cost to Council 0-5M and/or projected gate rate <$300/T
		3	Net cost to Council -5-0M and/or projected gate rate <$250/T
		4	Net cost to Council <-5M and/or projected gate rate <$200/T
		5	Net cost to Council <-10M and/or projected gate rate <$150/T

4 Options for managing residual waste

For the purposes of this evaluation, we have considered a range of options for managing residual waste generated in Wellington City. This assumes that the current range of initiatives to reduce waste generation and capture materials for reuse, recycling or recovery continue. Each of the options has also been considered with respect to the ability to handle current waste quantity and composition. Consideration has also been given to the ability to manage changes in waste composition and quantity based on measures proposed to achieve a 30% reduction in waste disposed of to landfill set out in the regional WMMP.

Current initiatives include:

- Education to encourage Wellington City residents and businesses to avoid the generation of waste
- Provision of a kerbside recycling collection service for residential properties in Wellington City
- Accepting reusable items at the Southern Landfill's Tip Shop
- Providing free recycling and discounted green waste drop off at Southern Landfill
- A range of commercial recycling and recovery services including paper, cardboard, food waste, green waste, metals, e-waste and plastics

There is also a range of commercial recycling and recovery services including paper, cardboard, food waste, green waste, metals, e-waste and plastics.

The current arrangement for management of residual waste in Stage 3 of Southern Landfill will no longer be available from around 2023 depending on filling rates. Once Stage 3 has reached its capacity, options for the management of residual waste include:

1) ***Closure of the existing Landfill*** – Waste no longer accepted at the Landfill. Waste will need to be transported directly to another landfill by collection companies, households or businesses, most likely Silverstream Landfill (Lower Hutt) and/or Spicer Landfill (Porirua).
2) ***Closure of the existing Landfill and continued operation of the transfer station*** – Waste accepted at the transfer station with material transferred to another landfill by Council, most likely Silverstream Landfill (Lower Hutt) and/or Spicer Landfill (Porirua).
3) ***Extension of the existing Landfill*** – Development of Stage 4 of the Landfill by 2023 to allow ongoing disposal of waste.
4) ***Conventional (mass burn) incineration*** – Treatment of waste through conventional incineration with materials unsuitable for incineration, bottom ash and air pollution control residues disposed of in a new dedicated stage at the Landfill.
5) Advanced Thermal Treatment
    a) ***Advanced thermal treatment (gasification)*** – Treatment of waste through gasification with char, air pollution control residues and rejects disposed of in a new dedicated stage at the Landfill.
    b) ***Advanced thermal treatment (pyrolysis)*** – treatment of waste through pyrolysis with char, air pollution control residues and rejects disposed of in a new dedicated stage at the Southern Landfill.
6) ***Mechanical heat treatment (MHT)*** – Treatment of waste through MHT with heat treated material and rejects disposed of in a new dedicated stage at Southern Landfill.

7) ***Mechanical biological treatment (MBT)*** – Treatment of waste through MBT with stabilised biodegradable material and rejects disposed of in a new dedicated stage at the Landfill.

These options are described in more detail in the following sections. Further details on technology can be found in Appendix A. Each option has been modelled to provide an estimate of materials flows, costs and relative carbon emissions. The modelling provides a basis for comparing options. The information presented for each option (Figures 4.1 – 4.7) includes an estimate of waste quantities in 2023/24 based on population and economic growth with current waste diversion activities in place. All of the options, except for Options 1 and 2, will require disposal of some waste at Southern Landfill (although the volume and type of waste would vary between options). All options also include the continued sewage sludge dewatering at Southern Landfill.

4.1 Option 1 – Closure of the existing Landfill

In this option Southern Landfill will stop accepting waste once Stage 3 is completed. The on-site transfer station will also stop accepting waste from households and businesses. All materials currently disposed of at Southern Landfill will need to be taken directly to an alternative landfill. This includes residential and commercial collections and special waste.

Existing infrastructure (weighbridge, transfer station) will no longer be required. The processing and dewatering of sewage sludge will continue at Southern Landfill, with the residues following this processing being transported to an alternative landfill site within the region.

Council will need to maintain the closed landfill site. This includes maintaining the current stream diversion in a tunnel under the existing landfill.

Table 4.1: Closure of the existing Landfill

Input materials	No input materials
Transfer	Domestic and small scale commercial self- haul, kerbside collections and commercial collections direct to out of city landfill Special wastes direct to out of city landfill including 15,000 tonnes of dewatered sewage sludge from the dewatering plant at Southern Landfill.
Processing	N/A
Residual material	N/A
Residual Disposal	N/A
Costs[1]	Assume **per tonne** rate of $180/T based on gate rate at remote transfer station ($150/T) or landfill ($110/T) and individual transport costs. Assume **net cost** to Council is $3.5M. This reflects costs for transport and disposal of special waste ($230/T, $3.45M) and costs for maintaining the stream diversion tunnel (estimated at 0.1M per year).

[1] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.

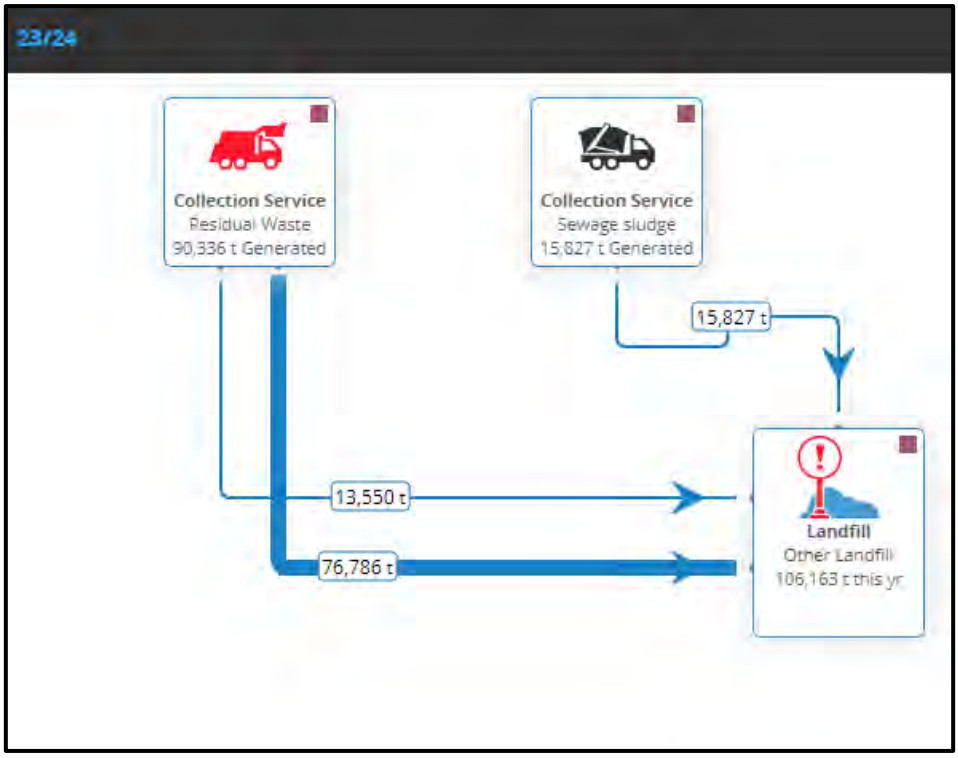

Figure 4.1: Closure of the existing Landfill (2023/24)

4.2 Option 2 – Closure of the existing Landfill and continued operation of the transfer station

In this option Southern Landfill will stop accepting waste for disposal on site once Stage 3 is completed. The on-site transfer station will continue to accept waste from households and businesses. The majority of materials currently taken directly to landfill will be transported directly to alternative landfills. This includes residential and commercial collections and special waste. An increase in the quantity of material passing through the transfer station is anticipated. An increase from 10,000 to 15,000 tonnes per year has been modelled. If there was a larger increase in materials passing through the transfer station a substantial upgrade may be required.

Existing infrastructure (weighbridge, transfer station) will continue to be used. The existing on-site transfer station will continue to accept domestic and small scale commercial self-haul waste for transfer to another landfill for final disposal. Various options are available to optimise transport of consolidated material including variations of transporting with minimal compaction and compacting waste into specialised containers for transport.

Once waste has been consolidated, transportation of this waste to other landfills within the region (most likely Spicer Landfill in Porirua or Silverstream Landfill in Upper Hutt) will be required. The processing and dewatering of sewage sludge will continue at Southern Landfill, with dewatered sludge transported to an alternative landfill. There is a risk that landfills in the region are not able to accept all of the materials resulting in the transport of waste further to a suitable site. The closest large site is in Marton.

In addition to transfer station operations and dewatered sewage sludge disposal (including transport) Council will need to maintain the closed landfill site. This includes maintaining the current stream diversion in a tunnel under the existing landfill.

Table 4.2: Closure of the existing Landfill and continued operation of the transfer station

Input materials	General waste from domestic (drop-off) and self haul General waste from commercial Special waste (for example contaminated soil, asbestos, sewage sludge)
Transfer	The existing on-site transfer station will accept domestic and small scale commercial waste for transfer to another landfill. Some kerbside and commercial collection material may also be accepted at the transfer station. The majority of kerbside waste collections, commercial collections and all special wastes will go directly to another landfill including 15,000 tonnes of dewatered sewage sludge.
Processing	Picking of materials at transfer station (metals, cardboard, reusable items). Consolidation of waste for transfer.
Residual material	General waste from domestic (collections and drop-off) General waste from commercial (collections and drop-off) Special waste (for example contaminated soil, asbestos, sewage sludge)
Residual Disposal	Disposal of general and special waste out of Southern Landfill most likely Spicer Landfill (Porirua) or Silverstream Landfill (Lower Hutt)
Costs[2]	Assumed **per tonne** rate of $160/T based on gate rate at remote landfill similar to current ($110/T + GST), transfer station operations costs and transport cost. Assume **net cost** to Council is $3.0M. This reflects costs for transport and disposal of special waste ($230/T, $3.45M), costs for maintaining the stream diversion tunnel (estimated at 0.1M per year), a small margin on transfer station operation and loss of commercial general waste revenue.

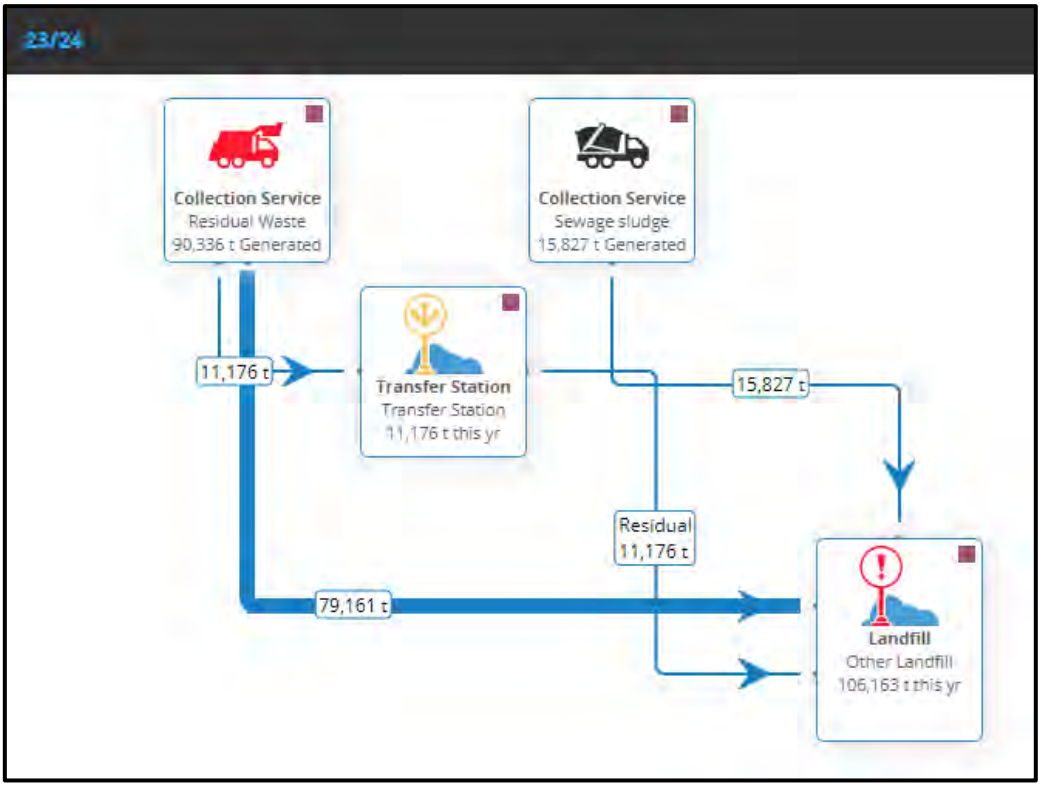

Figure 4.2: Closure of the existing Landfill and continued operation of the transfer station (2023/24)

[2] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.

4.3 Option 3 – Extension of the existing Landfill

In this option special waste and residual waste from households and businesses is disposed of in a new Stage 4 at Southern Landfill from 2023. Households and business can continue to bring waste to Southern Landfill with materials handled via the on-site transfer station. Waste collected from households and businesses and special waste will continue to be taken directly to the landfill for disposal.

Existing infrastructure (weighbridge, transfer station, access roads, landfill gas management system) will continue to be used. The existing on-site transfer station will continue to accept domestic and small scale commercial waste for transfer to the landfill for final disposal. Vehicle flows to and from Southern Landfill are expected to be similar the current situation.

Table 4.3 and Figure 4.3 summarise Option 3 in more detail. Figure 4.3 presents the projected 'flow' of residual waste in 2023/24.

Table 4.3: Extension of the existing Landfill (Stage 4)

Input materials	General waste from domestic (collections and drop-off) and self haul General waste from commercial Special waste (for example contaminated soil, asbestos and sewage sludge)
Transfer	The existing on-site transfer station will accept domestic and small scale commercial waste for transfer to the landfill. Kerbside waste collections, commercial collections and special wastes will go directly to landfill.
Processing	Picking of materials at transfer station (metals, cardboard, reusable items)
Residual material	General waste from domestic (collections and drop-off) General waste from commercial (collections and drop-off) Special waste (for example contaminated soil, asbestos and sewage sludge)
Residual Disposal	Disposal of general waste at a new Stage 4 at Southern Landfill Disposal of special waste at a new Stage 4 at Southern Landfill
Costs[3]	Assumed per tonne rate similar to current ($110/T + GST) Assumed net cost to Council is -$4M (i.e. a profit of $4M), a reduction from the current -$6M. The reduction is based on the cost of funding capital expenditure.

[3] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.

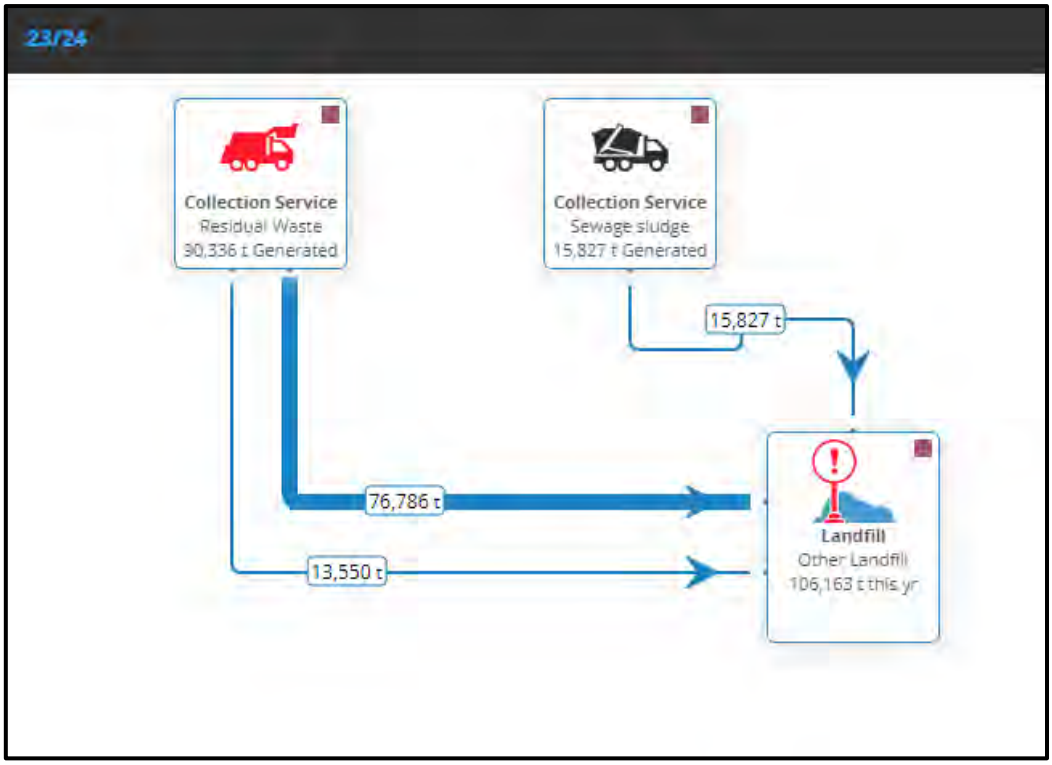

Figure 4.3: Extension of the existing Landfill (2023/24)

4.4 Option 4 - Conventional (mass burn) incineration

In this scenario residual waste (domestic, commercial and some special wastes) will be treated by conventional incineration with energy recovery. Residual materials will include bottom ash, air pollution control residues and materials unsuitable for incineration. Further information on conventional incineration is provided in Appendix A1.

Existing infrastructure (weighbridge, transfer station) will continue to be used. The existing on-site transfer station will continue to accept domestic and small scale commercial self haul waste for transfer to the incineration facility. Kerbside and commercial collections and combustible special wastes (for example dewatered sewage sludge) will be delivered directly to the incineration facility. The processing and dewatering of sewage sludge will continue at Southern Landfill, with dewatered sewage sludge transferred directly to the incineration facility.

A modern incineration facility with full air pollution control (EU/USEPA compliant) will be located at the existing Southern Landfill site. A new landfill stage will be required to accept bottom ash, air pollution control residues and materials unsuitable for incineration. The total quantity of material to landfill is estimated to be around 30% by weight of the residual waste accepted for disposal. Air pollution control residues and special wastes unsuitable for combustion will require special management for landfilling.

Table 4.4: Conventional (mass burn) incineration

Input materials	General waste from domestic (collections and drop-off) and self haul General waste from commercial Special waste (for example contaminated soil, asbestos, sewage sludge)
Transfer	On-site transfer station for domestic and small scale commercial self haul Kerbside and commercial collections direct to incineration facility Special wastes unsuitable for incineration direct to landfill Dewatered sewage sludge direct to incineration facility
Processing	Picking of materials at transfer station (metals, cardboard, reusable items) Pre-processing of general waste (removal of metals and materials unsuitable for combustion) Conventional incineration of combustible materials with full (EU/USEPA compliant) air pollution control and recovery of energy
Residual material	Incinerator bottom ash Air pollution control residues Unsuitable materials (concrete, large metal items) Special wastes unsuitable for incineration (for example asbestos-containing material)
Residual Disposal	Disposal of bottom ash and materials unsuitable for incineration at a new Stage 4 at Southern Landfill Disposal of air pollution control residues and other special wastes at a new Stage 4 at Southern Landfill
Costs[4]	Assume **per tonne** rate of $300/T[5] based on WRAP[6] (UK) gate rate reports extrapolated to 80,000-100,000 tonnes per year. Available data is for larger sites (200,000 tonnes per year or more) but suggests cost per tonne increases as scale reduces. Assume **net cost** to Council is zero. This assumes that the gate rate reflects capital (for waste combustion, air pollution control and disposal of residual materials) and operation costs. A lower gate rate (to compete with landfills in the Wellington Region) would increase net cost to Council. A higher gate rate would enable Council take revenue from the operation. A gate rate significantly higher than landfill rates in the region (currently $110-120 per tonne) is likely to result in a significant amount of waste currently accepted at Southern Landfill moving to other landfills in the region to secure cheaper disposal.

[4] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.
[5] This cost (gate rate) reflects revenue from energy produced through processing and management of residual materials
[6] Waste and Resources Action Programme (WRAP) UK works with governments, businesses and communities to deliver practical solutions to improve resource efficiency. The rate presented here is based on WRAP Gate Fees report that summarises publicly available information on gate fees for conventional incineration in the UK.

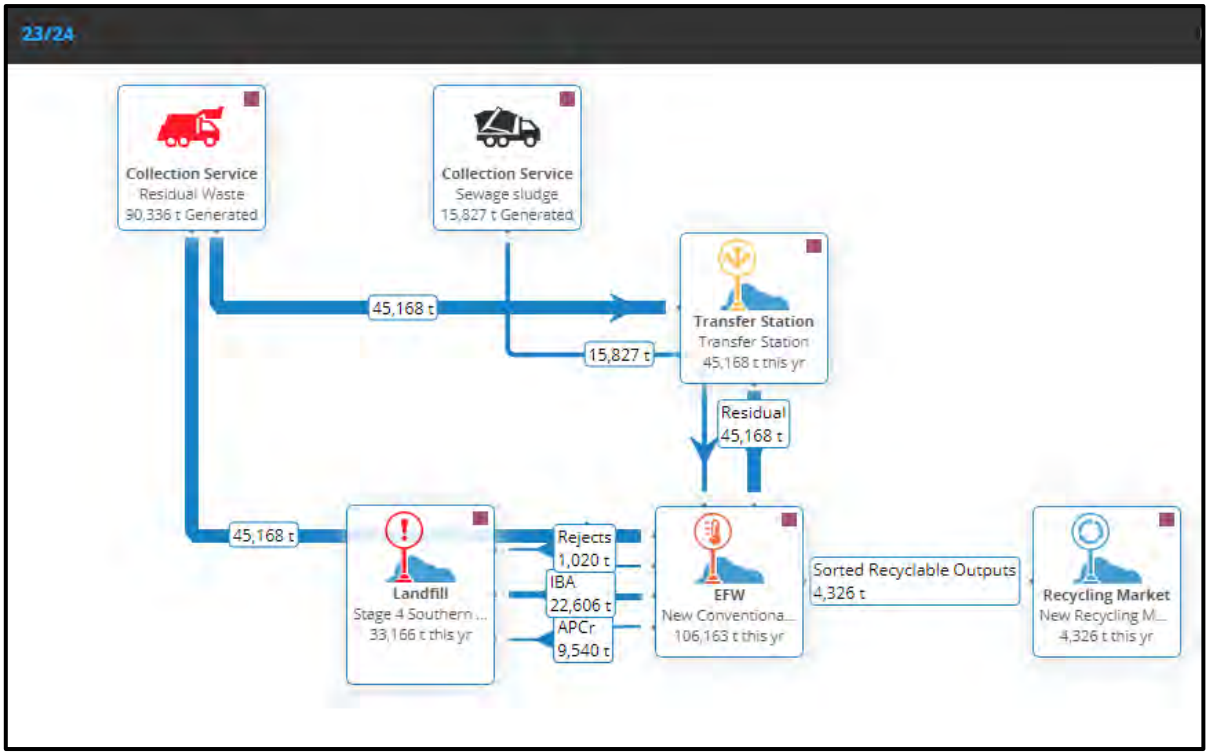

Figure 4.4: Conventional (mass burn) incineration (2023/24)

4.5 Option 5a – Advanced thermal treatment (gasification)

In this scenario residual waste (domestic, commercial and some special wastes) will be treated by gasification with energy recovery. Residual materials will include char, air pollution control residues and materials unsuitable for gasification. Further detail on gasification is provided in Appendix A2.1.

Existing infrastructure (weighbridge, transfer station) will continue to be used. The existing on-site transfer station will continue to accept domestic and small scale commercial self haul waste for transfer to the gasification facility. Kerbside and commercial collections and suitable special wastes (such as dewatered sewage sludge) will be delivered directly to the gasification facility. The processing and dewatering of sewage sludge will continue at Southern Landfill, with dewatered sludge transferred directly to the gasification facility.

A gasification facility with full air pollution control (EU/USEPA compliant) will be located at the existing Southern Landfill site. A new landfill stage will be required to accept char, air pollution control residues and materials unsuitable for gasification. The materials landfilled are estimated to be around 30% by weight of the residual waste accepted for disposal. Air pollution control residues and special wastes unsuitable for gasification will require special management for landfilling.

Gasification requires a homogeneous feedstock input, therefore pre-processing will be required to remove unsuitable materials. The process also includes upgrading of gasification products to produce syngas, suitable for energy generation.

Table 4.5: Advanced thermal treatment (gasification)

Input materials	General waste from domestic (collections and drop-off) and self haul General waste from commercial Special waste (for example contaminated soil, asbestos and sewage sludge)
Transfer	On-site transfer station for domestic and small scale commercial self haul. Kerbside and commercial collections direct to gasification facility Special wastes direct to landfill or gasification facility
Processing	Picking of materials at transfer station (metals, cardboard, reusable items) Pre-processing of material to be gasified (remove unsuitable material, homogenise to provide consistent feedstock) Gasification of materials with full air pollution control Upgrade of gasification products (syngas, char) Combustion of syngas with energy recovery
Residual material	Char Air pollution control residues Unsuitable materials (concrete, large metal items) Special wastes (for example asbestos -containing material, contaminated soil)
Residual Disposal	Disposal of char and material unsuitable for gasification at a new Stage 4 at Southern Landfill Disposal of air pollution control residues and other special wastes at a new Stage 4 at Southern Landfill
Costs[7]	Assume **per tonne** rate of $290/T[8] based on small discount from conventional incineration rates WRAP (UK)[9]. As for conventional incineration cost per tonne increases as scale decreases. Assume **net cost** to Council is zero. This assumes that the gate rate reflects capital (for waste combustion, air pollution control and disposal of residual materials) and operation costs. A lower gate rate (to compete with landfills in the Wellington Region) would increase net cost to Council. A higher gate rate would enable Council take revenue from the operation. A gate rate significantly higher than landfill rates in the region (currently $110-120 per tonne) is likely to result in a significant amount of waste currently accepted at Southern Landfill moving to other landfills in the region to secure cheaper disposal.

[7] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.
[8] This cost (gate rate) reflects revenue from energy produced through processing and management of residual materials
[9] Waste and Resources Action Programme (WRAP) UK works with governments, businesses and communities to deliver practical solutions to improve resource efficiency. The rate presented here is based on WRAP Gate Fees report that summarises publicly available information on gate fees for gasification in the UK.

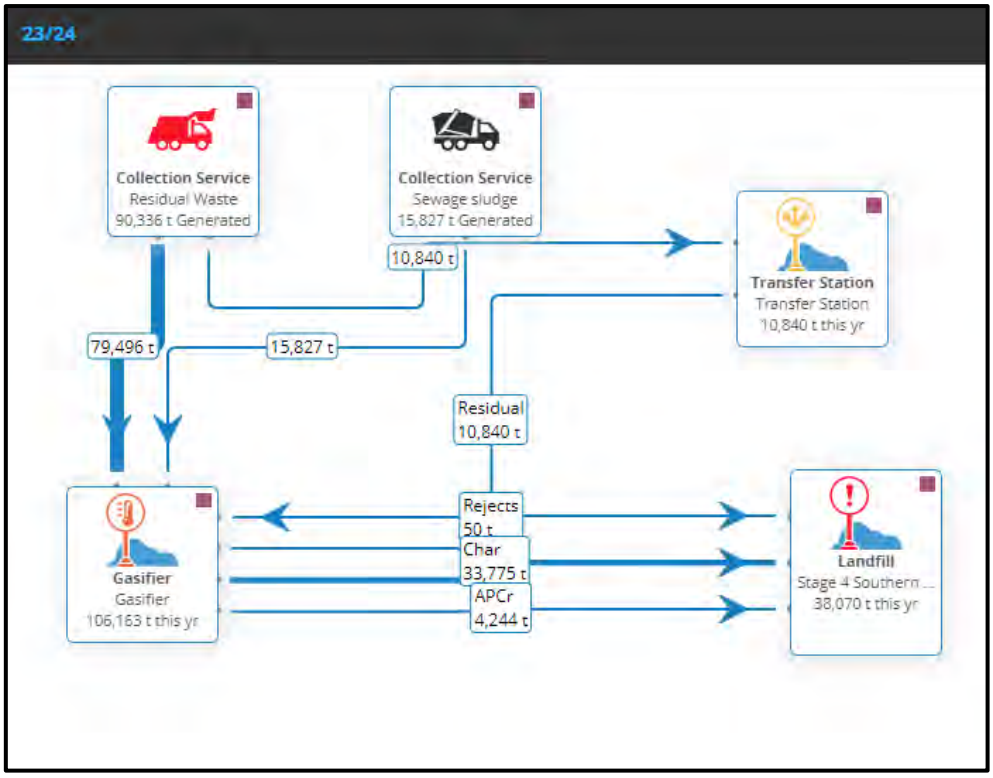

Figure 4.5: Advanced thermal treatment (gasification) (2023/24)

4.6 Option 5b – Advanced thermal treatment (pyrolysis)

In this scenario residual waste (domestic, commercial and some special wastes) will be treated by pyrolysis with energy recovery. Residual materials will include char, air pollution control residues and materials unsuitable for pyrolysis. Further information on pyrolysis is provided in Appendix A2.2.

Existing infrastructure (weighbridge, transfer station) will continue to be used. The existing on-site transfer station will continue to accept domestic and small scale commercial self haul waste for transfer to the pyrolysis facility. Kerbside and commercial collections and suitable special wastes (for example dewatered sewage sludge) will be delivered directly to the pyrolysis facility. The processing and dewatering of sewage sludge will continue at Southern Landfill, with dewater sewage sludge transferred directly to the pyrolysis facility.

A pyrolysis facility with full air pollution control (EU/USEPA compliant) will be located at the existing Southern Landfill site. A new landfill stage will be required to accept char, air pollution control residues and materials unsuitable for pyrolysis. This is estimated to be around 30% by weight of the residual waste accepted for disposal. Air pollution control residues and special wastes unsuitable for pyrolysis will require special management for landfilling.

Pyrolysis requires a homogeneous feedstock input, therefore pre-processing will be required to remove unsuitable materials. The process includes upgrading of pyrolysis products to produce pyrolysis oil, suitable for combustion or potentially further chemical processing.

Table 4.6: Advanced thermal treatment (pyrolysis)

Input materials	General waste from domestic (collections and drop-off) and self haul General waste from commercial Special waste (for example contaminated soil, asbestos, sewage sludge)
Transfer	On-site transfer station for domestic and small scale commercial self haul Kerbside and commercial collections direct to pyrolysis facility Special wastes direct to landfill or pyrolysis facility
Processing	Picking of materials at transfer station (metals, cardboard, reusable items) Pre-processing of material to be processed (remove unsuitable material, homogenise to provide consistent feedstock) Pyrolysis of materials with full air pollution control Upgrade of pyrolysis products (pyrolysis oil, char)
Residual material	Char Air pollution control residues Unsuitable materials (concrete, large metal items) Special wastes (for example asbestos containing material, contaminated soil)
Residual Disposal	Disposal of char and materials unsuitable for pyrolysis at a new Stage 4 at Southern Landfill Disposal of air pollution control residues and other special wastes at a new Stage 4 at Southern Landfill
Costs[10]	Assume **per tonne** rate of $290/T[11] based on small discount from conventional incineration rates WRAP[12] (UK). As for conventional incineration cost per tonne increases as scale decreases. Assume **net cost** to Council is zero. This assumes that the gate rate reflects capital (for waste combustion, air pollution control and disposal of residual materials) and operation costs. A lower gate rate (to compete with landfills in the Wellington Region) would increase net cost to Council. A higher gate rate would enable Council take revenue from the operation. A gate rate significantly higher than landfill rates in the region (currently $110-120 per tonne) is likely to result in a significant amount of waste currently accepted at Southern Landfill moving to other landfills in the region to secure cheaper disposal.

[10] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.
[11] This cost (gate rate) reflects revenue from energy produced through processing and management of residual materials
[12] Waste and Resources Action Programme (WRAP) UK works with governments, businesses and communities to deliver practical solutions to improve resource efficiency. The rate presented here is based on WRAP Gate Fees report that summarises publicly available information on gate fees for pyrolysis in the UK.

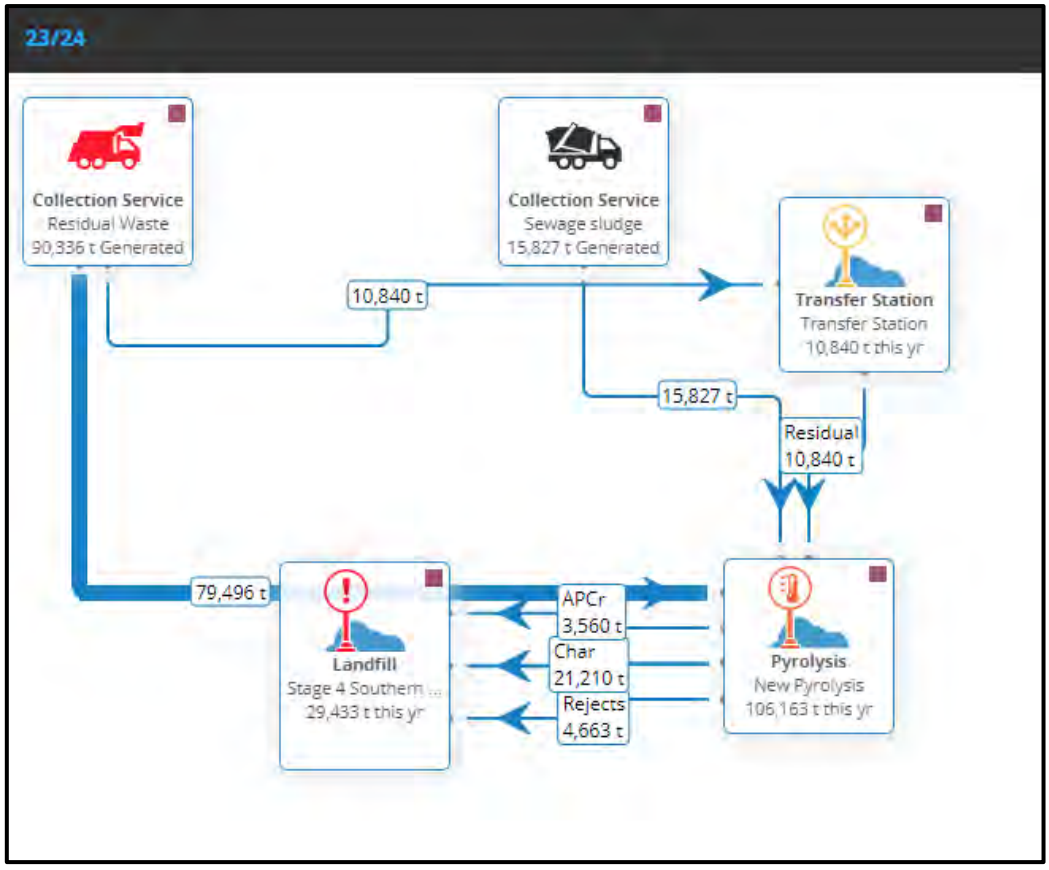

Figure 4.6: Advanced thermal treatment (pyrolysis) (2023/24)

4.7 Option 6 – Mechanical heat treatment (MHT)

In this scenario residual waste (domestic, commercial and some special wastes) will be treated through a Mechanical Heat Treatment (MHT) process. Residual materials will include stabilised degradable material, recyclables and materials unsuitable for the MHT process.

Existing infrastructure (weighbridge, transfer station) will continue to be used. The existing on-site transfer station will continue to accept domestic and small scale commercial self haul waste for transfer to the MHT facility. Kerbside and commercial collections and suitable special wastes will be delivered directly to the MHT facility. The dewatering of sewage sludge will continue at Southern Landfill, dewatered sewage sludge being transferred direct to a new Stage 4 at Southern Landfill.

A MHT facility with air pollution/odour control will be located at the existing Southern Landfill site. A new landfill stage will be required to accept stabilised material, and materials unsuitable for MHT. This is estimated to be 80-85% of the residual waste accepted for disposal. Special wastes unsuitable for MHT will require special management for landfilling.

Table 4.7: Mechanical heat treatment (MHT)

Input materials	General waste from domestic (collections and drop-off) General waste from commercial (collections and drop-off) Special waste (for example contaminated soil, asbestos, sewage sludge)
Transfer	On-site transfer station for domestic and small scale commercial self haul Kerbside and commercial collections direct to MHT facility Special wastes direct to landfill or MHT facility
Processing	Picking of materials at transfer station (metals, cardboard, reusable items) Mechanical sorting of mixed waste to remove recyclable and unsuitable items Heat treatment of degradable fraction of mixed waste to stabilise prior to use or disposal Venting of process area via a biofilter
Residual material	Recyclable materials recovered from residual waste through mechanical treatment (to recycle markets) Stabilised fraction Unsuitable materials Special wastes (for example asbestos containing material, contaminated soil, dewatered sewage sludge)
Residual Disposal	Disposal of stabilised materials and materials unsuitable for MHT at a new Stage 4 at Southern Landfill Disposal of special wastes at a new Stage 4 at Southern Landfill
Costs[13]	Assumed **per tonne** rate of $260/T based on a similar scale facility in Australia (Coffs Waste Services, Coffs Harbour, and NSW). Assume **net cost** to Council is zero. This assumes that the gate rate reflects capital (for waste processing and disposal of residual materials) and operation costs. A lower gate rate (to compete with landfills in the Wellington Region) would increase net cost to Council. A higher gate rate would enable Council to take revenue from the operation. A gate rate significantly higher than landfill rates in the region (currently $110-120 per tonne) is likely to result in a significant amount of waste currently accepted at Southern Landfill moving to other landfills in the region to secure cheaper disposal.

[13] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.

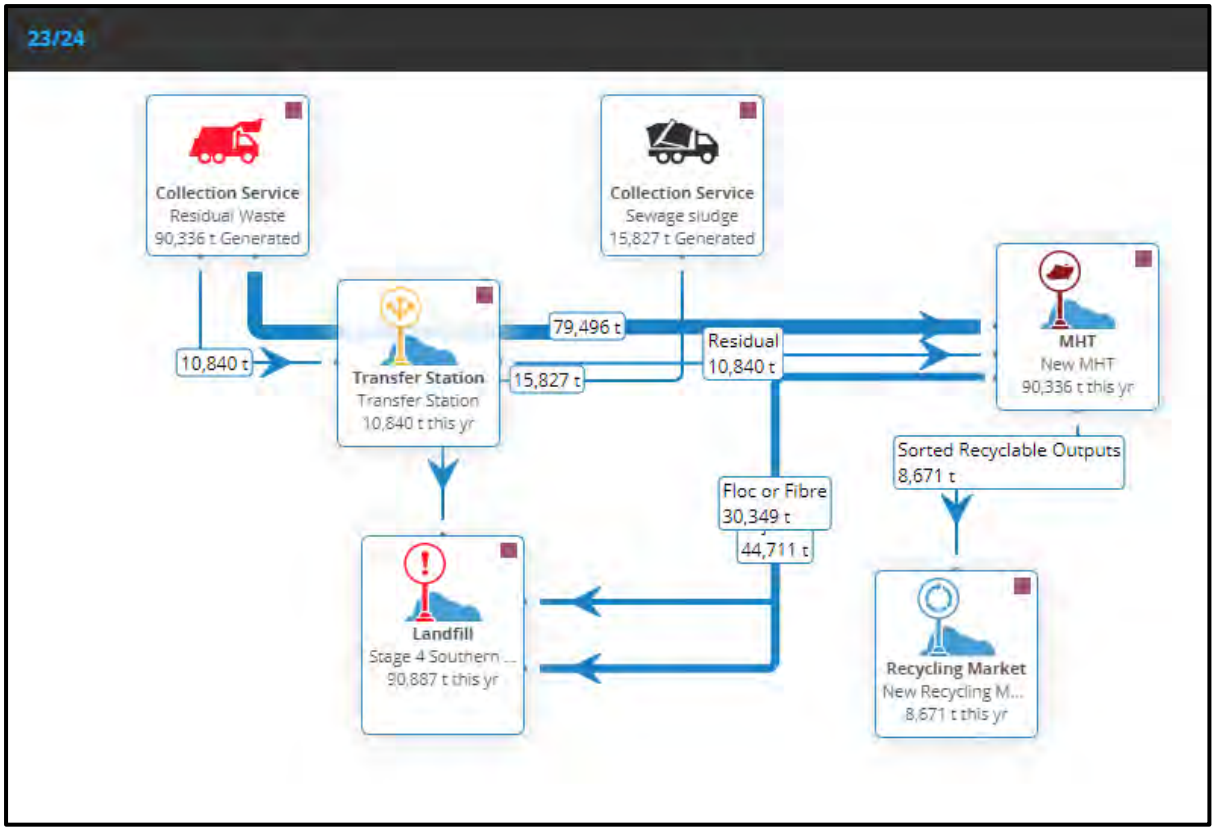

Figure 4.7: Mechanical heat treatment (MHT) (2023/24)

4.8 Option 7 - Mechanical biological treatment (MBT)

In this scenario residual waste (domestic, commercial and some special wastes) will be treated through a Mechanical Biological Treatment (MBT) process. Residual materials will include stabilised degradable material, recyclables and materials unsuitable for the MBT process. Further information on MBT processing is provided in Appendix A3.

Existing infrastructure (weighbridge, transfer station) will continue to be used. The existing on-site transfer station will continue to accept domestic and small scale commercial self haul waste for transfer to the MBT facility. Kerbside and commercial collections and suitable special wastes (potentially including dewatered sewage sludge) will be delivered directly to the MBT facility. The processing and dewatering of sewage sludge will continue at Southern Landfill, with dewatered sewage sludge transferred directly to the MBT facility.

A MBT facility with air pollution/odour control will be located at the existing Southern Landfill site. A new landfill stage will be required to accept stabilised degradable material, and materials unsuitable for MBT. This is estimated to be 75-80% of the residual waste accepted for disposal. Special wastes unsuitable for MBT will require special management for landfilling.

Table 4.8: Mechanical biological treatment (MBT)

Input materials	General waste from domestic (collections and drop-off) General waste from commercial (collections and drop-off) Special waste (for example contaminated soil, asbestos, sewage sludge)
Transfer	On-site transfer station for domestic and small scale commercial self haul Kerbside and commercial collections direct to MBT facility Special wastes direct to landfill or MBT facility
Processing	Picking of materials at transfer station (metals, cardboard, reusable items) Mechanical sorting of mixed waste to remove recyclable and unsuitable items. Biological processing (aerobic) of degradable fraction of mixed waste (including dewater sewage sludge) to stabilise prior to use or disposal Venting of process area via a biofilter
Residual material	Recyclable materials recovered from residual waste through mechanical treatment (to recycle markets) Stabilised degradable fraction Unsuitable materials Special wastes (for example asbestos containing material, contaminated soil)
Residual Disposal	Disposal of stabilised degradable and material unsuitable for MBT at a new Stage 4 at Southern Landfill Disposal of special wastes at a new Stage 4 at Southern Landfill
Costs[14]	Assumed **per tonne** rate of $250/T based on similar facilities in Australia (Eastern Creek, Spring Farm, Cairns and Raymond Terrace). Assume **net cost** to Council is zero. This assumes that the gate rate reflects capital (for waste processing and disposal of residual materials) and operation costs. A lower gate rate (to compete with landfills in the Wellington Region) would increase net cost to Council. A higher gate rate would enable Council take revenue from the operation. A gate rate significantly higher than landfill rates in the region (currently $110-120 per tonne) is likely to result in a significant amount of waste currently accepted at Southern Landfill moving to other landfills in the region to secure cheaper disposal.

[14] The cost per tonne reflects current rates for waste disposal.
The net cost to Council reflects assumed costs (cost of funding capital investment, operational costs, management of residuals) offset by income (gate fees, sale of energy, product sales). A lower number is preferable, a negative number (income is larger than costs) means the operation is making a profit for Council.

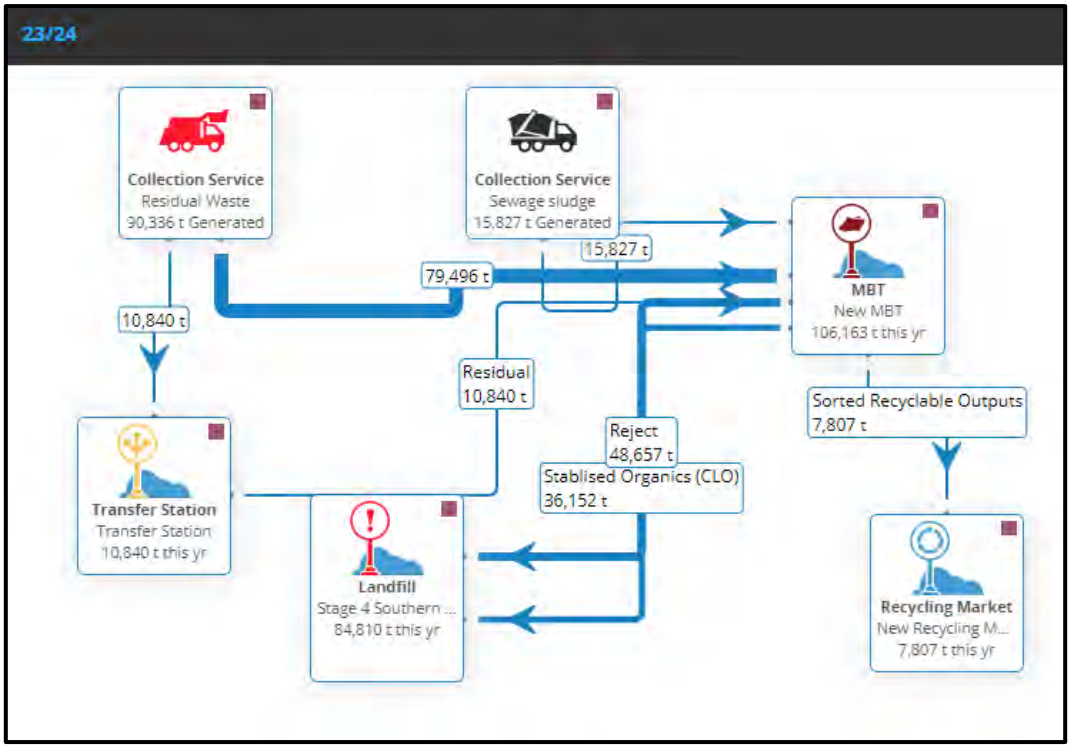

Figure 4.8: Mechanical biological treatment (MBT) (2023/24) Options evaluation

4.9 Overall evaluation results

The values and evaluation framework presented in Section 3 were used to evaluate the options presented in Section 4. The details of the evaluation carried out – scoring against criteria, commentary on the value descriptors and modelling results – are provided in Appendix B.

The figures below present the results of the evaluation in graphical form. Figure 4.9 presents the unweighted scores, Figure 4.10 provides the scores with the weightings noted in Table 3.2 applied. Both figures 'stack' the scores for each of the values to provide an indication of the relative contribution to the overall evaluation score. In all cases a higher score indicates a more favourable option.

The unweighted scoring (Figure 4.9) suggests that *3. Extension of the existing Landfill*, *2. Closure of the existing Landfill and continued operation of the transfer station* and *1. Closure of the existing Landfill* are the most favourable options. The combination of less favourable scores for Legislative/Resource Management Act risks, product risks, technology risks and cost make the remaining options less favourable. *3. Extension of the existing Landfill* has the most favourable score for cost, while Options 1 and 2 benefit from favourable scores for legislative/Resource Management Act risks.

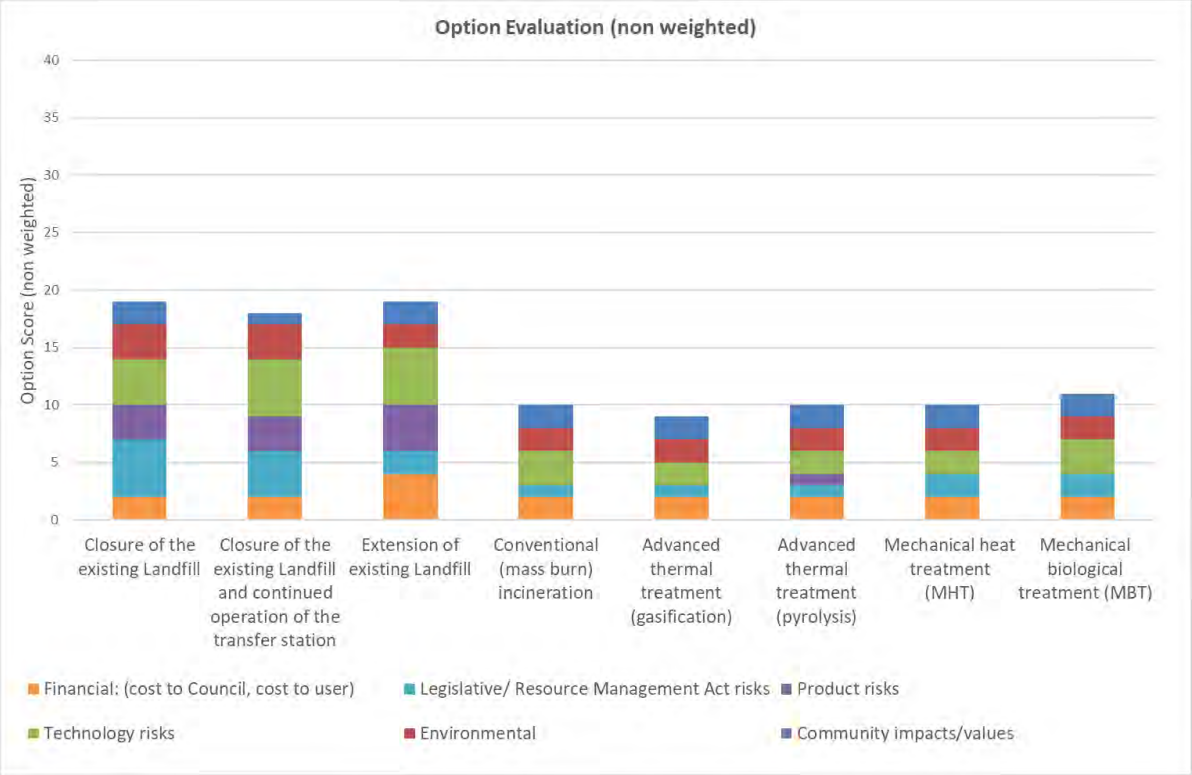

Figure 4.9: Unweighted evaluation results

The weighted scores (Figure 4.10) provide a similar picture with *3. Extension of the existing Landfill*, *2. Transfer Station at Southern Landfill* and *1. No waste acceptance at Southern Landfill* being the most favourable options. The weighting increases the impact of cost and environmental factors, and to a lesser degree the impact of community and technology risk. On this basis *3. Extension at Southern Landfill* is the most favourable option with cost and product risk (ability and willingness of other landfills to accept all of Wellington City's waste) less favourable for options 1 and 2. Cost and legislative/Resource Management Act factors contribute to making options 4 to 7 less favourable.

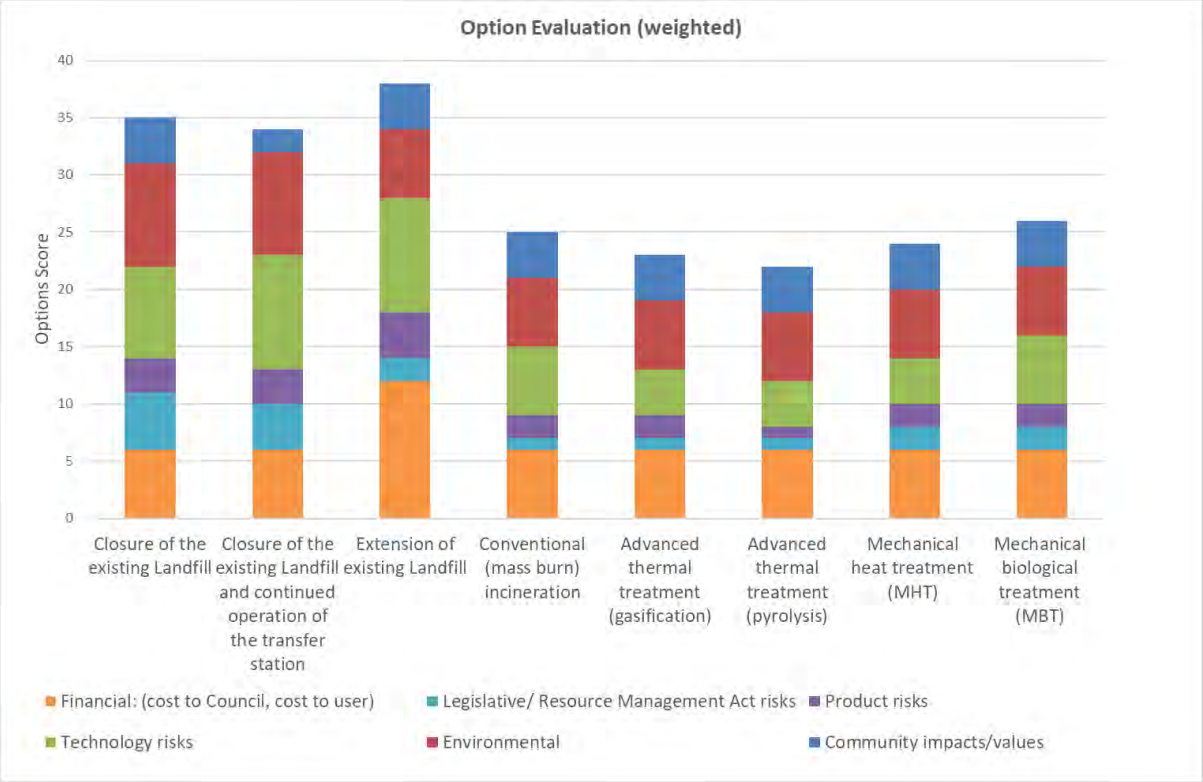

Figure 4.10: Weighted evaluation results

4.10 Interpreting the results

In completing a multi-criteria evaluation of this type, it is useful to provide commentary on the evaluation outcome for each of the options considered and/or those that could be considered the leading options. Based on the results presented in Section 4, option *3. Extension of the existing Landfill*, *2. Closure of the existing Landfill and continued operation of the transfer station* and *1. Closure of existing Landfill* are the most favourable options. These are considered further in Section 4.11. The remainder of this section provides brief comment on options 4 to 7.

Community impacts/values

For Options 4 to 7, the community impacts/values evaluation suggested the net impact would be similar. Specifically:

- Transport movements through Brooklyn and Ōwhiro Bay will be similar (the same amount of waste is transported to the Southern Landfill site
- In all cases residual waste will be accepted at the transfer station and directed to the treatment facility with potential for associated dust, odour and litter
- A waste processing facility and associated residual material to landfill is likely to be perceived similarly to an ongoing landfill operation at Southern Landfill
- The need to have some form of ongoing facility for the disposal of residual material means there will be a facility available to manage waste in the event of disaster severing transport links to/from Wellington City
- Similarly to an extension at Southern Landfill, the processing and treatment options would all be developed to meet local and relevant international requirements to protect public health

Environmental

Options 4 to 7 involve treatment of waste with landfilling of various residual materials including bottom ash, char, air pollution control residues and stabilised materials. The environmental evaluation suggests the net impact would be similar for Options 4 to 7. This reflects the need for a site for the processing facility and development of further landfill capacity of varying scale depending on the processing solution employed.

Technology

The technology risk evaluation varied depending on how well established the processing technology is internationally. This means this value favoured *4. Conventional (mass burn) incineration* (established in Europe, Asia and the USA) and *7. Mechanical Biological Treatment* (established in Europe and several plants in Australia).

Product Risks

The product risk evaluation was similar for Options 4 to 7 reflecting a high level of uncertainty for options other than landfill for process outputs. Examples include:

- Bottom ash – potential aggregate but unproven
- Char – potential soil amendment or raw material for chemical manufacturing, but unproven
- Stabilised degradable material/stabilised material – potential soil amendment but typically low quality. New South Wales is currently re-examining approvals for the use of stabilised organics for landfill and mine rehabilitation
- Recyclables from MBT and MHT – low grade recyclable commodities are difficult to market with international markets limited or no longer open to low grade materials

The evaluation assumes that residual materials will be disposed of in a new stage at Southern Landfill. These materials could be transported to another disposal site but this is likely to increase costs and increase transport movements in the vicinity of the landfill. As outlined in the evaluation of Options 1 and 2, access to alternative landfill sites for large quantities of residual waste is uncertain. This is discussed further in Section 4.11.1 and 4.11.2.

Legislative/RMA

Options 4 to 7 were all evaluated as having a high legislative/Resource Management Act risk. This reflects the lack of clear policy framework or precedent for any of the technologies in New Zealand. In some cases (conventional incineration) there is clear opposition within segments of the community to their implementation[15].

Financial

All of the treatment options have been evaluated as having a significantly higher cost than landfilling in a New Zealand context. This reflects a number of factors including:

- The relatively low cost of landfill construction compared to the comparatively complex process and mechanical equipment required for treatment options.
- A relatively (internationally) low landfill levy. The current $10 per tonne levy in New Zealand compares to levies in the range $70 - $150 in Australia and Europe.

[15] For example http://zerowaste.co.nz/waste-to-energy-incineration/. Associate Minister for the Environment Eugene Sage has indicated that waste to energy plants "don't fit with the Government's waste reduction plans"

- The high cost of appropriate air pollution control equipment for thermal processes (conventional incineration, gasification and pyrolysis), particularly for small scale (less than 200,000 tonnes per year) operations.
- The need to manage residual materials including special wastes (air pollution control residues, special wastes unsuitable for treatment), materials unsuitable for treatment and products where markets are not identified or proven.

For each of these options the high costs suggest a high gate rate that is likely to encourage waste to be transported to other disposal sites. Setting a gate rate closer to prevailing disposal rates in the region would require a significant subsidy from Council but is more likely to secure a suitable quantity of waste.

4.11 Most favourable options

4.11.1 Closure of the existing Landfill

Option 1 – *Closure of the existing Landfill* had a relatively high (favourable) score. This was due to:

- No technology risk – no technology will be employed by Council for residual waste disposal.
- Low environmental risk – based on minimal disruption to existing flora and fauna at the proposed Stage 4 area compared with an extension of Southern Landfill (with or without other operations). There are residual risks associated with the need for ongoing maintenance of the stream diversion in a tunnel under the existing landfill.
- Negligible legislative/Resource Management Act risk with the removal of all waste acceptance activities on site removing the need for some existing approvals.

The evaluation highlighted cost (for transport and disposal of Council's sewage sludge, for households and businesses) and product risk (uncertainty regarding the ability of other landfills to accept all of the waste generated in Wellington City). The lack of an operational disposal facility in Wellington City poses a risk in the event of a major natural disaster event disrupting transport links to the Hutt Valley or Porirua. Closure of the transfer station at Southern Landfill will also remove the service currently available to households and businesses currently using the facility.

This option would be more favourable if:

- Secure disposal options were available.
  The total quantity of residual waste generated in Wellington City will have a significant impact if transferred to other landfills in the Wellington Region. This is subject to other landfill operators accepting this volume of waste, additional to their existing volumes and ultimately limiting the lifetime of their existing facilities. Other alternatives include Levin Landfill (limited capacity) and Bonny Glen Landfill (Marton). Alternative transportation would be required if residual waste was sent outside of the region. Kerbside and commercial collections would require consolidation prior to transport out of the region. This would require a new, much larger transfer station and specialised compaction and transportation equipment.

  Challenges for other landfills accepting waste from Wellington City include:

  - Reducing the lifetime of available capacity in the receiving facility, accelerating closure
  - Managing large quantities of special wastes including dewatered sewage sludge

  Disposal of 15,000 tonnes per year of dewatered sewage sludge typically requires combination of the sludge with several times as much general waste. This may pose a challenge for other landfills with Spicer Landfill already accepting sludge from Tītahi Bay Wastewater Treatment Plant and Silverstream accepting dried sludge from the Hutt Valley Wastewater Treatment Plant.

- Lower cost disposal could be secured.
  Given current capacity and total site life of the two other landfills in the Wellington Region there is limited potential to negotiate significant discounts on published rates for disposal of general or special wastes. Bonny Glen Landfill has negotiated a range of disposal rates for Councils across the lower North Island, but transport costs will be significant.

  The cost for transport and disposal of dewatered sewage sludge is a significant cost factor. Because dewatered sludge requires special handling (immediate burial, mixing with other waste) disposal costs will be higher. Specialised transport equipment will also be required to ensure the dewatered sludge is contained during transport.

4.11.2 Closure of the existing Landfill and continued operation of the transfer station

Option 2 – *Closure of the existing Landfill and continued operation of the transfer station* also had a relatively high (favourable) score. This was due to:

- Low technology risk – transfer station with transport to offsite landfill is a well proven approach in New Zealand and a transfer station already exists on the site
- Low environmental risk – based on minimal disruption to existing flora and fauna at the proposed Stage 4 area compared with an extension of Southern Landfill (with or without other operations)
- Very low Legislative / Resource Management Act risk with a transfer station likely to be able to operate under existing approvals

The evaluation highlighted cost (for transport and disposal of Council's sewage sludge, for households and businesses) and product risk (uncertainty regarding the ability of other landfills to accept all of the waste generated in Wellington City). The lack of an operational disposal facility in Wellington City also poses a risk in the event of a major natural disaster disrupting transport links to the Hutt Valley, Porirua or beyond the Wellington region.

This option would be more favourable if:

- A secure disposal arrangement was in place.
  The total quantity of residual waste generated in Wellington City will have a significant impact if transferred to other landfills in the Wellington Region. This is subject to other landfill operators accepting this volume of waste, additional to their existing volumes and ultimately limiting the lifetime of their existing facilities. Other alternatives include Levin Landfill (limited capacity) and Bonny Glen Landfill (Marton). Alternative transportation would be required if residual waste was sent outside of the region. Kerbside and commercial collections would require consolidation prior to transport out of the region. This would require a new, much larger transfer station and specialised compaction and transportation equipment.

  Challenges for other landfills accepting waste from Wellington City include:

  - Reducing the lifetime of available capacity in the receiving facility, accelerating closure
  - Managing large quantities of special wastes including dewatered sewage sludge

  Disposal of 15,000 tonnes per year of dewatered sewage sludge typically requires combination of the sludge with several times as much general waste. This may pose a challenge for other landfills with Spicer Landfill already accepting sludge from Tītahi Bay Wastewater Treatment Plant and Silverstream accepting dried sludge from the Hutt Valley Wastewater Treatment Plant.

- Lower cost disposal could be secured.
  Given current capacity and total site life of the two other landfills in the Wellington Region there is limited potential to negotiate significant discounts on published rates for disposal of

general or special wastes. Bonny Glen Landfill has negotiated a range of disposal rates for Councils across the lower North Island, but transport costs will be significant. As noted above transport to Bonny Glen Landfill would require development of a larger transfer station facility and specialised compaction and transport equipment.

The cost for transport and disposal of dewatered sewage sludge is a significant cost factor. Because dewatered sludge requires special handling (immediate burial, mixing with other waste) disposal costs will be higher. Specialised transport equipment will also be required to ensure the dewater sludge is contained during transport.

4.11.3 Extension of the existing Landfill

Option 3 – *Extension of the existing Landfill* had a relatively high (favourable) score due to:

- Low technology risk – landfill is a well proven technology in New Zealand
- Relatively low environmental risk – based on good practice design and operations and the ability to restore the stream currently piped under the existing landfill to flow around completed Stage 4
- Low cost compared to other options

The evaluation highlighted legislative/Resource Management Act risks (likely extended consent process, potential for no approval) and ongoing community impacts. Both factors applied to all options involving ongoing processing or disposal at Southern Landfill. The assessment suggests that Option 3 is currently the most feasible option if the design, construction and operation are progressed with a focus on the values developed for this evaluation process. This includes:

- Completing the project consistent with good practice landfill design and construction (as set out in the Technical Guidelines for Disposal to Land (August 2018)[16]
- Optimising design, construction and operations to deliver a cost effective solution for the management of residual waste including continuing to provide revenue to Council (that can be used to offset other expenditure)
- Working closely with the community and consent authorities (Greater Wellington Regional Council and Wellington City Council Planning) to ensure that approvals progress smoothly and all parties are well informed throughout the process
- Continue to engage with the community to understand community impacts and either avoid, remedy or implement appropriate mitigation

4.12 Evaluation outcome

Based on the evaluation of options summarised in this report, Option 3 *Extension of the existing Landfill* is considered the most favourable option. This reflects that good practice landfill design, construction and operation is well proven in New Zealand, presents a relatively low environmental risk with appropriate design and operation and is relatively low cost compared to other options.

The evaluation highlighted the need to progress design, construction and operation and focus on the values developed for this evaluation process. Implementation of Option 3 *Extension of the existing Landfill* should follow good practice landfill design and construction, delivering a cost effective solution for the management of residual waste, working closely with the community and consent authorities and continuing to engage with the community to understand and address community impacts.

[16] https://www.wasteminz.org.nz/pubs/technical-guidelines-for-disposal-to-land-april-2016/

5 Conclusions

This report has considered a range of options for the management of residual waste from Wellington City. The evaluation used values developed with input from the community to consider options from a range of perspectives.

Based on the evaluation of options summarised in this report, Option 3 *Extension of the existing Landfill* is considered the most favourable option. This reflects that good practice landfill design, construction and operation is well proven in New Zealand, presents a relatively low environmental risk with appropriate design and operation and is relatively low cost compared to other options.

The evaluation highlighted the need to progress design, construction and operation and focus on the values developed for this evaluation process. Implementation of Option 3 *Extension of the existing Landfill* should follow good practice landfill design and construction, delivering a cost effective solution for the management of residual waste, working closely with the community and consent authorities and continuing to engage with the community to understand and address community impacts.

6 Applicability

This report has been prepared for the exclusive use of our client Wellington City Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report in support of an application for resource consent and that Wellington City Council and Greater Wellington Regional Council as the consenting authorities will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
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Chris Purchas, Anna Ainsworth	Hugh Cherrill
Senior Consultant, Consultant	Project Director

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Appendix A: Technology options

A1 Conventional (mass burn) incineration

Incineration is the combustion (thermal treatment) of waste and generally includes the recovery of energy in the form of electricity generation, heat generation or both (combined heat and power (CHP)). Incineration is also referred to as energy from waste or direct combustion.

How does the technology work?

Incineration in essence involves the combustion of unprepared residual waste. Incineration involves the introduction of oxygen into the process to oxidise the waste. The combustion temperatures typically reach in excess of 850C (a minimum temperature requirement). Those parts of the waste stream which are non-combustible (e.g. metals and glass) remain in their original state. This material along with solid residue following combustion produces a waste material called bottom ash.

Plant design and configuration varies from plant to plant, with different technology providers and required outputs. However plant will generally have these key elements:

- Waste reception and handling
- Combustion chamber – a range of combustion technologies exist which can be adopted depending on drivers
- Energy recovery plant – using heat through a boiler to produce steam
- Emission cleanup for gases produced through processing – strict requirements for the discharge of emissions, typically referencing EU and/or US standards
- Bottom ash handling and air pollution control residue handling

All waste incineration facilities in the European Union must comply with the requirements set out in the Industrial Emissions Directive. There are stringent emission controls for the processes which are set to minimise any environmental and health impacts.

Outputs

There are a number of outputs from incineration, these include:

- carbon dioxide (and other combustion products)
- air pollution control residues (hazardous)
- bottom ash
- energy e.g. heat and/or power

The cleanup of gases produces solid residue, which comprise fly-ash (light combustion products that scale from the combustion chamber with hot air), lime/bicarbonate and activated carbon. These residues are classified as hazardous.

Bottom ash is a non-combustible residue material produced from processing residual waste via incineration. It consists of approximately 20-30% of the original waste weight and 10% of the volume. Metals may be recoverable for recycling from bottom ash. Bottom ash can be used as aggregate and backfill material, but will require further processing prior to use.

In most incineration applications, energy is converted to electricity that is distributed and sold via power networks. Facilities where heat is produced, require consumers (district heating, industrial heat) to be local to the facility location, as a dedicated distribution system is required. Heat and power demand varies and a combined heat and power (CHP) plant can be designed to cater for

changing requirements. CHP also offers lower carbon emissions per unit of energy utilised compared to heat or power only plants.

Issues and considerations

Most modern incineration facilities operate within full integrated waste management systems. Waste prevention, preparation for re-use and recycling are prioritised first, with the remaining, residual, waste sent for incineration.

Larger scale facilities (250,000 tonnes per annum or more) have shown a realisation of a lower cost per unit of waste compared to operation of smaller tonnage facilities. This is a trend across Europe and most developing countries.

There is a high capital cost for incineration, support in the UK over a number of years has been via funding schemes, which are not available in New Zealand.

A need for longevity within waste contracts for infrastructure of this scale, particularly where funding is sourced from banks. This requires feedstock security and contracts which enable this.

Case Study: Eastcroft Energy from Waste Facility, Nottingham, UK[17].

Eastcroft Energy processes input tonnage of 140,000 tonnes per annum of non-hazardous residual waste from households and businesses. The site produces approximately 12MW energy output (steam is used to produce heat and electricity – combined heat and power). Capital costs for the facility were GBP85 million (approximately NZ$160 million). Heat is used at local leisure centres for swimming pool heating, electricity is used to provide power to the same facilities. A number of commercial premises and local customers in Nottingham City also utilise power produced by the facility.

Figure A1.1 Energy from waste facility[18]

[17] https://www.fccenvironment.co.uk/green-energy/eastcroft/

[18] Photograph by Norbert Nagel – own work

A2 Advanced Thermal Treatment: Gasification, Pyrolysis[19]

Advanced Thermal Treatment (ATT) involves the thermal treatment decomposition of waste and use of secondary products produced e.g. syngas. The key difference between incineration and advanced thermal treatment is the conditions that waste is exposed to. Incineration involves heat and excess air (providing oxygen) to enable complete combustion of the waste. Pyrolysis and gasification limit the oxygen content, temperature and pressure to thermally treat the waste and generate secondary products (gas, liquid or solids), from which energy is generated.

A2.1 Gasification

During gasification, waste materials are exposed to some oxygen, enabling partial oxidation. This process produces a synthetic gas (syngas), composed of mainly carbon monoxide, hydrogen and small quantities of other hydrocarbon gases.

How does the technology work?

Key elements include:

- Preparation of the feedstock – incoming waste typically requires drying and homogenisation prior to entering the gasification process. Inputs may be in the form of refuse derived fuel (RDF) prepared off site or incoming mixed waste may be pre-processed on site
- Partial combustion of the waste - this produces syngas and other products including char
- Cleanup of syngas – removing where possible particulates, hydrocarbons and soluble matter
- Cleaning of flue gases – once syngas has combusted, prior to release to the atmosphere, removing toxic pollutants to meet discharge requirements

Gasification can be considered a process between pyrolysis and combustion. Temperatures during gasification are around 650°C (varying between 400C and over 1,000C). Mechanical preparation and separation is required prior to processing of residual waste.

More recently these technologies have adopted a plasma (electric) arc at very high temperatures to gasify the waste, producing a higher quality syngas with reduced contaminants.

The development of pyrolysis and gasification technologies within the UK is still in the early stages. However the technology is further advanced in North America, Europe and Japan. Mixed waste gasification has a limited track record compared with single stream waste management.

Outputs

There are a number of outputs from gasification, these include:

- Gasification is targeted to produce syngas, containing carbon monoxide, hydrogen and methane. Most facilities have a secondary combustion chamber where syngas is burnt for energy recovery through a steam circuit
- A solid residue of non-combustible materials (ash) - containing relatively low level of carbon

Issues and considerations

One key issue for use of syngas in energy recovery at advanced thermal treatment facilities is problems related to tarring. The deposition of tars can cause blockages and other operational challenges and has been associated with plant failures and inefficiencies at a number of pilot and

[19] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/221035/pb13888-thermal-treatment-waste.pdf

commercial scale facilities. Tarring issues may be overcome by higher temperature secondary processing.

Smaller scale solutions can provide for more local/ integrated waste management needs and potentially enable identification of local markets for heat generated from a facility. Gate fees may be higher than equivalent larger scale facilities.

Gasification technologies have a more limited track record than incineration, Mechanical Heat Treatment (MHT) and MBT applications for residual waste application. Application for single waste streams e.g. wood, tyres and plastics are more common.

Case Study: Laverton North, Melbourne Waste to Energy plant. Capital cost $100 million accepting up to 200,000 tonnes a year of residual household waste[20].

A2.2 Pyrolysis

During pyrolysis, waste is heated in the absence of oxygen, targeting the production of pyrolysis oil and / or char (carbon). Unlike gasification, syngas is a secondary consideration.

How does the technology work?

Pyrolysis typically follows a batch process involving the thermal degradation of a substance in the absence of oxygen. An external heat source is required to provide this heat source, whereas gasification produces its own heat. Lower temperatures, between 300C to 850C, are achieved during pyrolysis of residual waste. Mechanical preparation and separation of inert materials via pre-processing is required.

Key elements include:

- Preparation of the feedstock – the form maybe of RDF (from offsite processing), or process incoming mixed waste through a materials recovery facility. This mixed waste will require drying and homogenisation prior to entering the pyrolysis process
- Full pyrolysis of the waste to produce oil and/or char, lower levels of syngas is produced compared to gasification
- Cleanup of syngas – removing where possible particulates, hydrocarbons and soluble matter
- Cleaning of flue gases - where syngas has combusted, prior to release to the atmosphere, removing toxic pollutants to meet discharge requirements

Outputs

There are a number outputs from pyrolysis, these include:

- A solid residue (referred to as char) which is a combination of non-combustible materials and carbon
- Syngas is a mixture of gases (combustible constituents include carbon monoxide, hydrogen, methane and a broad range of other volatile organic carbons (VOCs). A proportion of the OVC can be condensed to produce oils, waxes and tars

Issues with technology

One key issue for use of syngas in energy recovery at advanced thermal treatment facilities is problems related to tarring. The deposition of tars can cause blockages and other operational challenges and has been associated with plant failures and inefficiencies at a number of pilot and

[20] https://www.smh.com.au/environment/sustainability/waste-to-energy-plant-planned-for-melbourne-s-west-20181019-p50asd.html

commercial scale facilities. Tarring issues may be overcome by higher temperature secondary processing.

Smaller scale solutions can provide for more local/ integrated waste management needs and potentially enable identification of local markets easier for heat generated from a facility. Gate fees may be higher than equivalent larger scale facilities.

Pyrolysis technologies have a more limited track record than incineration, Mechanical Heat Treatment (MHT) and MBT applications for residual waste application. Application for single waste streams e.g. wood, tyres and plastics are more common.

Pyrolysis is typically a batch process (due to the need to exclude oxygen). This means the process vessel is loaded with the waste to be processed, pyrolysis occurs and by-products are removed. Other technologies allow for continuous input of materials.

Figure 11 Advanced thermal treatment[21]

[21] Photograph by Meriolisis – Own work

A3 Mechanical Heat Treatment

Mechanical Heat Treatment (MHT) is used to describe a configuration of both mechanical and thermal technology which uses steam and/or pressure to treat waste. This process enables the separation of a mixed waste stream to enable further recycling and/or recovery and sanitises/stabilises residual waste.

How does the technology work?

Plant design and configuration vary from plant to plant. The general key elements:

- Mechanical preparation - removal of large items and materials suitable for processing, this could involve shredding to create a homogenous waste stream
- Heat treatment (use of heat/steam) in a treatment vessel – batch (autoclave) or continuous processing. This produces floc/fibre – stabilised organic and fibre (cardboard/paper) waste
- Mechanical separation – separation of recyclables and rejects (generally sent to landfill)
- Floc/ fibre (heat treated materials may be sent for onward biological treatment (composting or anaerobic digestion
- Recycling of fibre where biological treatment is not undertaken
- Production of RDF

The autoclave approach utilises a pressure vessel which directs steam to treat residual waste at a constant temperature and pressure. Autoclave can be applied as a pre-treatment process to pasteurise, clean and break down organic matter and lignin structures, while removing contaminants. This makes mechanical separation of recyclable materials easier and the stabilised organic and fibre waste can be used as feedstock for biological processing with biogas generation and digestate quality.

Outputs

There are a number of outputs from MHT processes which include:

- A low grade stabilised floc product (floc), sometimes marketed as RDF. RDF remains classed as a waste in the UK[22]
- Recyclables - which may include glass, metals and plastics
- A mixture of fibrous material from the breakdown of paper, card and green/ kitchen waste constituents

Issues and considerations

Configuring the plant should take into account the availability of markets for products which will be produced from this process.

Pre-processing requirements may include screening to remove large and unsuitable elements of the waste steam. Post treatment separation for extraction of recyclable materials e.g. trommels and screeners, manual separation, magnetic, eddy currents, air classification, ballistic and optical separation.

Recyclables derived from MHT are a lower quality than source separated from the residual waste stream. However, the quality of recyclables from MHT is higher than recyclable materials derived from incineration. The saleability of these materials will depend on the quality required for markets within New Zealand. Most plastics are deformed having undergone heat processing and are unlikely to be extracted for onward processing.

[22] RDF is a term given to a solid fuel derived from MBT/ MHT processes, primarily referrred to in the UK.

Onward processing of RDF produced and potential markets will require consideration.

Case Study: Aero Thermal Group[23]

Autoclave and anaerobic digestion (with CHP and gasification) – Lee Moor, Plymouth, UK.

Input tonnage 75,000 tonnes per annum of mixed residual waste.

The facility utilises a front-end autoclave technology, separation of recyclables and back-end anaerobic digestion of the floc product (biogas production). The overall process achieves a reduction in waste volume by approximately 60%[24].

The compost like material produced from the anaerobic digestion process is used for restoration projects and electricity produced is transferred to the UK national grid for distribution.

The facility produces approximately 26GW electrical energy.

The project had a reported NZ$56 million capital cost.

Figure 12 Mechanical heat treatment example[25]

[23] http://docplayer.net/26606365-Mechanical-heat-treatment-of-municipal-solid-waste-february-2013.html
[24] http://www.wrap.org.uk/sites/files/wrap/Digestates%20from%20Anaerobic%20Digestion%20A%20review%20of%20enhancement%20techniques%20and%20novel%20digestate%20products_0.pdf
[25] Photograph by Moltimedia – Own work

A4 Mechanical Biological Treatment

Mechanical Biological Treatment (MBT) is the generic term for an integrated system of several mechanical and biological processes more commonly found in other waste management facilities. These include Materials Recovery Facilities (MRFs), composting or anaerobic digestion plants. An MBT plant can incorporate a number of different processes in a variety of combinations. It also involves treatment of biological processes and configuration will take into account feedstock composition and outputs for by-products.

How does the technology work?

Residual waste requires preparation prior to biological treatment or sorting of materials. Initial waste preparation may take the form of simple removal of materials unsuitable for processing, such as mattresses, carpets or other bulky wastes. These items could cause problems with processing equipment downstream.

Plant design and configuration varies from plant to plant. The general key elements include:

- Mechanical separation of recyclable materials, for example magnetic separators to remove iron and steel
- Biological treatment of residual waste to produce biogas and a digestate (anaerobic processes) and/or a compost like material

Outputs

There are a number of potential outputs from MBT processes which include:

- Low grade compost like product will be produced through the separation of the biodegradable component (CLO)
- Recyclables
- Refuse derived fuel (known as RDF), this may comprise dried (through the heat from the biological process) degradable material and homogenised plastics and other combustible waste
- Digestate – from anaerobic digestion based processes
- Biogas will be produced for those MBT plants which utilise anaerobic digestion. Biogas can be used as a natural gas substitute and converted into fuel, or used in fuel boilers to produce heat (hot water and steam), or fuel generators for CHP applications producing electricity and heat

Issues and considerations

Recyclables derived from various MBT processes are typically of a lower quality than those derived from a separate household or commercial recyclable collection system. Metals are a recoverable material which MBT processes almost always enable extraction and in many cases, this may be the only recyclable material extractable.

Glass is commonly extracted as part of MBT processes and it is unlikely that paper will be have value where extracted. The extraction of recyclables must consider the markets available in New Zealand.

The early generation of mixed waste processing facilities encountered technical and marketing difficulties. Second and third generation technologies have since been developed focused on marketable products including RDF, metals and stabilised degradable material.

Case Study: Wrexham Recycling Park[26], UK.

[26] https://www.fccenvironment.co.uk/wrexham/recycling-park-phase-2/

Mechanical Biological Treatment Facility with in-vessel composting and dewatering of street cleansing waste.

Input tonnage 70,000 tonnes per annum, 25 year contract accepting residual waste, which would otherwise be sent to landfill.

Capital cost of approximately NZ$16 million.

Figure A4.1 Mechanical Biological Heat treatment facility[27]

[27] Photograph by original uploader was Vortexrealm at English Wikipedia

Appendix B: Options evaluation

Appendix B Table 1: Summary of option evaluation

Criteria	Landfill Disposal		
	Closure of the existing Landfill	**Closure of the existing Landfill and continued operation of the transfer station**	**Extension of existing Landfill**
Community impacts/values	More than minor but less than significant community impacts are anticipated	Significant community impacts are anticipated	More than minor but less than significant community impacts are anticipated
Environmental	Minor environmental impacts are anticipated	Minor environmental impacts are anticipated	More than minor but less than significant environmental impacts are anticipated
Technology risks	Applications of technology in New Zealand	Well established technology in New Zealand	Well established technology in New Zealand
Product risks	Markets defined but unproven for products/outputs in New Zealand	Markets defined but unproven for products/outputs in New Zealand	Single or uncertain markets for products outputs in New Zealand
Legislative/ Resource Management Act risks	No risk - consistent with existing approvals, no further consents required	Low risk of not securing approvals, business as usual consenting process, consistent with plan requirements.	High risk of not securing approvals, business as usual consenting process but potential for no approval
Financial: (cost to Council, cost to user)	Net cost to Council 0-5M and/or projected gate rate <$300/T	Net cost to Council 0-5M and/or projected gate rate <$300/T	Net cost to Council <-5M and/or projected gate rate <$200/T

Criteria	Treatment of residual waste with landfilling of some outputs		
	Conventional incineration at Southern Landfill	**Gasification oat Southern Landfill**	**Pyrolysis at Southern Landfill**
Community impacts/values	More than minor but less than	More than minor but less than	More than minor but less than
Environmental	More than minor but less than	More than minor but less than	More than minor but less than
Technology risks	Well established technology internationally, no applications in New Zealand	Some applications internationally, no applications in New Zealand	Some applications internationally, no applications in New Zealand
Product risks	Markets defined/ available in other countrys for products/outputs	Markets defined/ available in other countrys for products/outputs	No markets available/ defined for products or outputs
Legislative/ Resource Management Act risks	Extreme risk of not securing approval, for example extended or untested consenting process, activity with no precedent	Extreme risk of not securing approval, for example extended or untested consenting process, activity with no precedent	Extreme risk of not securing approval, for example extended or untested consenting process, activity with no precedent
Financal: (cost to Council, cost to user)	Net cost to Council 0-5M and/or projected gate rate <$300/T	Net cost to Council 0-5M and/or projected gate rate <$300/T	Net cost to Council 0-5M and/or projected gate rate <$300/T

Criteria	Treatment of residual waste with landfilling of some outputs	
	Mechanical heat treatment (MHT)	**Mechanical biological treatment (MBT)**
Community impacts/values	More than minor but less than significant community impacts are anticipated	More than minor but less than significant community impacts are anticipated
Environmental	More than minor but less than significant environmental impacts are anticipated	More than minor but less than significant environmental impacts are anticipated
Technology risks	Some applications internationally, no applications in New Zealand	Well established technology internationally, no applications in New Zealand
Product risks	Markets defined/ available in other countrys for products/outputs	Markets defined/ available in other countrys for products/outputs
Legislative/ Resource Management Act risks	High risk of not securing approvals, business as usual consenting process but potential for no approval	High risk of not securing approvals, business as usual consenting process but potential for no approval
Financial: (cost to Council, cost to user)	Net cost to Council 0-5M and/or projected gate rate <$300/T	Net cost to Council 0-5M and/or projected gate rate <$300/T

Appendix B Table 2: Modelling summary results (2023/24)

Scenario name	Waste landfilled	Transport CO2eq	Markets CO2eq	Treatment/ Disposal CO2eq	Net cost to Council ($ per year)	Likely gate rate ($/T)
1 Closure of Landfill	106,163	215,744	0	30,709,552	$3,645,000	$180
2 Closure of Landfill, continued operation of transfer station	106,163	265,093	0	30,748,678	$3,465,000	$160
3 Extension of the existing Landfill	106,163	0	0	30,747,504	$-4,245,000	$110
4 Conventional (mass burn) incineration	33,165[28]	0	-2,012,138	-3,787,988	0	$300
5a Advanced thermal treatment (gasification)	38,069[29]	0	0	-3,994,925	0	$290
5b Advanced thermal treatment (pyrolysis)	29,432[30]	0	0	-3,577,852	0	$290
6 Mechanical Heat Treatment	90,886[31]	0	-10,439,314	36,543,945	0	$260
7 Mechanical Biological Treatment	84,809[32]	0	-2,976,678	20,773,161	0	$250

Appendix B Table 3: Detailed evaluation commentary (overleaf)

[28] For conventional incineration waste to landfill is estimated to comprise materials unsuitable for incineration (approx. 1,000 T) bottom ash (approx. 22,500 T) and air pollution control residues (approx. 9,500 T).
[29] For gasification waste to landfill is estimated to comprise materials unsuitable for gasification (approx. 50 -100 T) bottom ash (approx. 33,000 T) and air pollution control residues (approx. 4,500 T).
[30] For pyrolysis waste to landfill is estimated to comprise materials unsuitable for pyrolysis (approx. 4,500 T) bottom ash (approx. 21,000 T) and air pollution control residues (approx. 3,500 T).
[31] For mechanical heat treatment waste to landfill is estimated to comprise materials unsuitable for treatment (approx. 45,000 T), biosolids and stabilised material (approx. 30,000 T).
[32] For mechanical biological treatment waste to landfill is estimated to comprise materials unsuitable for treatment (approx. 50,000 T) and stabilised biodegradable material (approx. 35,000 T).

Criteria	Weighting	Landfill Disposal			Treatment of residual waste with landfilling of some outputs		
		Closure of the existing Landfill	**Closure of the existing Landfill and continued operation of the transfer station**	**Extension of existing Landfill**	**Conventional (mass burn) incineration**	**Advanced thermal treatment (gasification)**	**Advanced thermal treatment (pyrolysis)**
Community impacts/values	**2**	**More than minor but less than significant community impacts are anticipated**	**Significant community impacts are anticipated**	**More than minor but less than significant community impacts are anticipated**	**More than minor but less than significant community impacts are anticipated**	**More than minor but less than significant community impacts are anticipated**	**More than minor but less than significant community impacts are anticipated**
** Traffic volumes.* ** Dust, noise, litter, odour, visual impacts* ** Cultural concerns.* ** Community image.* ** Resilience implications for Wellington City – ability to manage waste within the boundaries of Wellington City in an emergency.* ** Impacts on public health.*		*Community impacts are expected to be more than minor but less than significant.* ** Negligible - traffic to/from the site will be minimal* ** Negligible - No residual waste management activities will be undertaken at the site* ** Moderate to Significant - the disposal of waste rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Negligible - no residual waste management activities will be undertaken at the site* ** Significant - the site provides a suitable staging but not disposal site for disaster waste (debris, spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua. Ceasing landfilling operations means disposal would need to recommence or materials be stored until links are re-established. The lack of a local disposal solution for dewatered sludge has the potential to be significant challenge in a major event.* ** Negligible - No residual waste management activities are proposed at the site*	*Community impacts are expected to be more than minor but less than significant* ** Significant - traffic volumes to/from the site will be high higher than current with general vehicles going to Southern Landfill and transfer vehicles going from Southern Landfill) combining heavy vehicles (refuse collection vehicles), light commercial and trailers and cars. Some heavy vehicles will transport residual waste directly to other landfills for disposal.* ** Moderate to Significant - dust, noise and visual impacts will be carefully managed but may be moderate where weather has an impact or specific activities take place. Litter and odour associated with materials passing through the transfer station will be carefully managed but have the potential to be moderate to significant due to challenging weather conditions (high winds for litter, still weather for odour).* ** Moderate to Significant - the disposal of waste rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Moderate to Significant - the presence of a transfer station (often considered similar to a landfill from a community perspective) in the community does have and will continue to have a moderate to significant adverse impact on the community image.* ** Moderate to Significant - the site provides suitable staging but not disposal site for disaster waste (debris, spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua. Ceasing landfilling operations means disposal would need to recommence or materials be stored until links are re-established. The lack of a local disposal solution for dewatered sludge has the potential to be significant challenge in a major event.* ** Minor - the site will be carefully managed to minimise the potential for adverse*	*Community impacts are expected to be more than minor but less than significant.* ** Significant - traffic volumes to/from the site will be high (consistent with current) combining heavy vehicles (refuse collection vehicles), light commercial and trailers and cars.* ** Moderate to Significant - dust, noise and visual impacts will be carefully managed but may be moderate where weather has an impact or specific activities take place. Litter and odour will be carefully managed but have the potential to be moderate to significant due to unusual loads (odour) and challenging weather conditions (high winds for litter, still weather for odour).* ** Moderate to Significant - the disposal of waste rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Moderate to Significant - the presence of a landfill in the community does have and will continue to have a moderate to significant adverse impact on the community image.* ** Minor - the site provides a suitable disposal site for disaster waste (debris, spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua.* ** Minor - the site will be carefully managed to minimise the potential for adverse public health impacts. Examples include daily covering of waste to discourage vermin and immediate burial of hazardous wastes (such as asbestos containing materials).*	*Community impacts are expected to be more than minor but less than significant* ** Significant - traffic volumes to/from the site will be high (consistent with current) combining heavy vehicles (refuse collection vehicles), light commercial and trailers and cars* ** Moderate to Significant - dust, noise and visual impacts will be carefully managed but may be moderate where weather has an impact or specific activities take place. Litter and odour will be carefully managed but have the potential to be moderate to significant due to unusual loads (odour) and challenging weather conditions (high winds for litter, still weather for odour).* ** Moderate to Significant - the incineration of waste with energy recovery rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Moderate to Significant - the presence of a conventional waste to energy facility is likely to have a moderate to significant adverse impact on the community image* ** Minor - the site provides a suitable disposal site for disaster waste (spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua subject to the operation continuing post emergency. The associated ash disposal facility (landfill) should be designed to accept disaster debris if required.* ** Minor - the site will be carefully managed to minimise the potential for adverse public health impacts. Examples include managing waste acceptance (odour, windblown litter), comprehensive air pollution control (to USEPA and EU standards) arrangements for immediate burial of hazardous wastes (such as asbestos containing materials).*	*Community impacts are expected to be more than minor but less than significant* ** Significant - traffic volumes to/from the site will be high (consistent with current) combining heavy vehicles (refuse collection vehicles), light commercial and trailers and cars* ** Moderate to Significant - dust, noise and visual impacts will be carefully managed but may be moderate where weather has an impact or specific activities take place. Litter and odour will be carefully managed but have the potential to be moderate to significant due to unusual loads (odour) and challenging weather conditions (high winds for litter, still weather for odour).* ** Moderate to Significant - the gasification of waste with energy recovery rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Moderate to Significant - the presence of an advanced thermal (gasification) waste to energy facility is likely to have a moderate to significant adverse impact on the community image* ** Minor - the site provides a suitable disposal site for disaster waste (spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua subject to the operation continuing post emergency. The associated ash disposal facility (landfill) should be designed to accept disaster debris if required.* ** Minor - the site will be carefully managed to minimise the potential for adverse public health impacts. Examples include managing waste acceptance (odour, windblown litter), comprehensive air pollution control (to USEPA and EU standards) arrangements for immediate burial of hazardous wastes (such as asbestos containing materials).	*Community impacts are expected to be more than minor but less than significant.* ** Significant - traffic volumes to/from the site will be high (consistent with current) combining heavy vehicles (refuse collection vehicles), light commercial and trailers and cars.* ** Moderate to Significant - dust, noise and visual impacts will be carefully managed but may be moderate where weather has an impact or specific activities take place. Litter and odour will be carefully managed but have the potential to be moderate to significant due to unusual loads (odour) and challenging weather conditions (high winds for litter, still weather for odour).* ** Moderate to Significant - the pyrolysis of waste with energy recovery rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Moderate to Significant - the presence of an advanced thermal (pyrolysis) waste to energy facility is likely to have a moderate to significant adverse impact on the community image.* ** Minor - the site provides a suitable disposal site for disaster waste (spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua subject to the operation continuing post emergency. The associated ash disposal facility (landfill) should be designed to accept disaster debris if required.* ** Minor - the site will be carefully managed to minimise the potential for adverse public health impacts. Examples include managing waste acceptance (odour, windblown litter), comprehensive air pollution control (to USEPA and EU standards) arrangements for immediate burial of hazardous wastes (such as asbestos containing materials).
Environmental	**3**	**Minor environmental impacts are anticipated**	**Minor environmental impacts are anticipated**	**More than minor but less than significant environmental impacts are anticipated**	**More than minor but less than significant environmental impacts are anticipated**	**More than minor but less than significant environmental impacts are anticipated**	**More than minor but less than significant environmental impacts are anticipated**
** Impacts on the surrounding environment, including fauna (fish, birds, reptiles etc) and flora (plants, trees).* ** Groundwater pollution risk.* ** Carbon emissions.* ** Recreational use of land upon completion.* ** Residual risks upon Landfill closure.* ** Risk of technology in a seismically active environment*		*No ongoing management of residual waste at Southern Landfill* ** Negligible - no new or ongoing activities are proposed* ** Negligible - no new or ongoing activities are proposed. This does not consider risks associated with material in place from current (2019) and historic landfilling at Southern Landfill.* ** Moderate to Significant - the carbon emissions associated with the breakdown of biodegradable material within the other landfill are mitigated by the capture and flaring (with energy generation) of landfill gas. There will also be carbon emissions associated with transport 100,000 T of waste per year to another landfill in a mixture of small and heavy vehicles. Est 35 MTCO2eq/year* ** Minor - the site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely.* ** Moderate to Significant - there will be no discharge of waste to land so residual risks on closure will be negligible. This does not consider residual impacts from current (2019) and historic landfilling at Southern Landfill. With no further landfilling at the site the current piping of the stream under the existing landfill will continue with associated risks* ** Minor - There will be no discharge of waste to land so risks will be negligible. This does not consider risks associated with material in place from current (2019) and historic landfilling at Southern Landfill.*	*Environmental impacts are expected to be minor or moderate* ** Minor- The transfer station will be developed within the existing footprint of the landfill and associated infrastructure* ** Minor - there will be no discharge of waste to land so risks to groundwater will be negligible. This does not consider risks associated with material in place from current (2019) and historic landfilling at Southern Landfill.* ** Moderate to Significant - the carbon emissions associated with the breakdown of biodegradable material within the other landfill are mitigated by the capture and flaring (with energy generation) of landfill gas. There will also be carbon emissions associated with transport 100,000 T of waste per year to another landfill. Est 34 MTCO2eq/year* ** Minor - the site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely.* ** Moderate - there will be no discharge of waste to land so residual risks on closure will be negligible. This does not consider residual impacts from current (2019) and historic landfilling at Southern Landfill. With no further landfilling at the site the current piping of the stream under the existing landfill will continue with associated risks.* ** Minor - There will be no discharge of waste to land so risks associated with the transfer station will be negligible. This does not consider risks associated with material in place from current (2019) and historic landfilling at Southern Landfill. NOTE: This evaluation considers environmental impacts at Southern Landfill, many of the impacts noted here are also relevant for the alternative (high standard) disposal site. On this basis the environmental impacts may be considered More than minor but not sianificant.*	*Environmental impacts are expected to be minor or moderate* ** Moderate to Significant - The extension to Southern Landfill will require removal of regenerating native bush and diversion of a stream* ** Minor - Groundwater protection features of the design include capture of groundwater underneath the filled area with the ability to divert to leachate pipes if required and an engineered liner system to contain leachate (contaminated water from the landfill)* ** Moderate - the carbon emissions associated with the breakdown of biodegradable material within the landfill are mitigated by the capture and flaring (with energy generation) of landfill gas. Est 33 MTCO2eq/year* ** Minor - the site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely.* ** Minor - the design standards to be used provide for long term containment of waste and ongoing treatment of leachate and landfill gas. With the extension, will be possible to restore the stream that is currently piped underneath the existing and closed stages of this landfill. This will provide a significant environmental benefit.* ** Minor - The landfill will be designed to withstand the impacts of credible earthquake scenarios*	*Environmental impacts are expected to be minor or moderate* ** Moderate to Significant - The conventional incineration plant may be able to be constructed within the existing operational areas at Southern Landfill. A new ash disposal facility will be required, most likely in the same valley as that proposed for the Southern Landfill extension. This will require removal of regenerating native bush and diversion of a stream but on a smaller scale than the landfill extension.* ** Minor - Groundwater protection features for the ash landfill the design include capture of groundwater underneath the filled area with the ability to divert to leachate pipes if required and an engineered liner system to contain leachate (contaminated water from the landfill).* ** Moderate - the carbon emissions associated with the destruction of biodegradable material within the conventional incineration plant and offset of alternative energy generation reduces the net greenhouse gas emissions for the management of residual waste. Est -2.6 MTCO2eq/year* ** Minor - the site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely.* ** Minor - the design standards to be used provide for long term containment of waste and ongoing treatment of leachate and landfill gas. The new landfill area will be for incinerator bottom ash only. With the extension, will be possible to restore the stream that is currently piped underneath the existing and closed stages of this landfill. This will provide a significant environmental benefit.* ** Minor - The incinerator and ash landfill will be designed to withstand the impacts of credible earthquake scenarios*	*Environmental impacts are expected to be minor or moderate* ** Moderate to Significant - The advanced thermal (gasification) plant may be able to be constructed within the existing operational areas at Southern Landfill. A new inert materials disposal facility will be required, most likely in the same valley as that proposed for the Southern Landfill extension. This will require removal of regenerating native bush and diversion of a stream but on a smaller scale than the landfill extension.* ** Minor - Groundwater protection features for the inert landfill the design include capture of groundwater underneath the filled area with the ability to divert to leachate pipes if required and an engineered liner system to contain leachate (contaminated water from the landfill).* ** Moderate - the carbon emissions associated with the destruction of biodegradable material within the advanced thermal (gasification) plant and offset of alternative energy generation reduces the net greenhouse gas emissions for the management of residual waste. Est -2.6 MTCO2eq/year* ** Minor - the site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely. With the extension, will be possible to restore the stream that is currently piped underneath the existing and closed stages of this landfill. This will provide a significant environmental benefit.* ** Minor - the design standards to be used provide for long term containment of waste and ongoing treatment of leachate and landfill gas. The new landfill area will be for inert residuals (char) only.* ** Minor - The advanced thermal (gasification) and inert landfill will be designed to withstand the impacts of credible earthquake scenarios*	*Environmental impacts are expected to be minor or moderate* ** Moderate to Significant - The advanced thermal (pyrolysis) plant may be able to be constructed within the existing operational areas at Southern Landfill. A new inert materials disposal facility will be required, most likely in the same valley as that proposed for the Southern Landfill extension. This will require removal of regenerating native bush and diversion of a stream but on a smaller scale than the landfill extension.* ** Minor - Groundwater protection features for the inert landfill the design include capture of groundwater underneath the filled area with the ability to divert to leachate pipes if required and an engineered liner system to contain leachate (contaminated water from the landfill).* ** Moderate - the carbon emissions associated with the destruction of biodegradable material within the advanced thermal (pyrolysis) plant and offset of alternative energy generation reduces the net greenhouse gas emissions for the management of residual waste. Est -2.6 MTCO2eq/year* ** Minor - the site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely.* ** Minor - the design standards to be used provide for long term containment of waste and ongoing treatment of leachate and landfill gas. The new landfill area will be for inert residuals (char) only.* ** Minor - The advanced thermal (pyrolysis) and inert landfill will be designed to withstand the impacts of credible earthquake scenarios*
Technology risks	**2**	**Applications of technology in New Zealand**	**Well established technology in New Zealand**	**Well established technology in New Zealand**	**Well established technology internationally, no applications in New Zealand**	**Some applications internationally, no applications in New Zealand**	**Some applications internationally, no applications in New Zealand**
** Availability of experts and equipment to maintain, operate and fix equipment.* ** Is the technology future-proof – risk of obsolescence?* ** Refer to existing applications/examples at a similar scale.* ** Scalability of the technology – can it be scaled up or down easily if waste quantities change?*		** Relies on other facilities* ** Relies on other facilities* ** Relies on other facilities. This approach is adopted by a small number of local authorities around New Zealand including Western Bay of Plenty District, Far North District and Upper Hutt City.* ** Relies on other facilities*	** Required plant is common across NZ and technicians and equipment readily available. Relies on other facilities for disposal.* ** The transfer station will be designed to allow for future changes in waste generation and composition, other landfill sites or alternative destinations can handle a range of quantities and compositions. Relies on other facilities for disposal.* ** Transfer stations with out of area disposal at a similar scale are common in New Zealand and internationally. Landfilling at a similar scale is common in New Zealand and internationally. Relies on other facilities for disposal.* ** The transfer station operation can be scaled up or down to meet requirements, for example if less waste is produced. Relies on other facilities for disposal.*	** Required plant is common across NZ and technicians and equipment readily available* ** The landfill will be designed to allow for future changes in waste generation and composition* ** Landfilling at similar scale is common in New Zealand and internationally* ** The landfilling operation can be scaled up or down to meet requirements, for example if less waste is produced.*	** Required plant is not present in NZ and technicians and equipment are not available* ** Conventional incineration is well established but requires investment in equipment (including air pollution control equipment) with a service life of 25 years or more.* ** Conventional incineration at similar scale (100,000 T per year) is not common internationally. Plants are more typically designed for 250,000 tonnes or more per year.* ** Conventional incineration is designed for a specific quantity or composition of residual waste i.e. is not well suited to changing quantities or composition.*	** Required plant is not present in NZ and technicians and equipment are not available* ** Advanced thermal (gasification) is emerging at commercial scale but requires investment in equipment (including air pollution control equipment) with a service life of 25 years or more.* ** Advanced thermal (gasification) at similar scale (100,000 T per year) is emerging internationally., plants are more typically designed for 250,000 tonnes or more per year.* ** Advanced thermal (gasification) is designed for a specific quantity or composition of residual waste i.e. is not well suited to changing quantities or composition.*	** Required plant is not present in NZ and technicians and equipment are not available* ** Advanced thermal (pyrolysis) is emerging at commercial scale but requires investment in equipment (including air pollution control equipment) with a service life of 25 years or more.* ** Advanced thermal (pyrolysis) at similar scale (100,000 T per year) is emerging internationally., plants are more typically designed for 250,000 tonnes or more per year.* ** Advanced thermal (pyrolysis) is designed for a specific quantity or composition of residual waste i.e. is not well suited to changing quantities or composition.*
Product risks	**1**	**Markets defined but unproven for products/outputs in New Zealand**	**Markets defined but unproven for products/outputs in New Zealand**	**Single or uncertain markets for products outputs in New Zealand**	**Markets defined/ available in other country's for products/outputs**	**Markets defined/ available in other country's for products/outputs**	**No markets available/ defined for products or outputs**
** Products produced by the alternative (e.g. compost from a composting plant or electricity from a waste-to-energy plant)?* ** How much product is produced as a proportion of the initial input tonnage?* ** Are there established and enough markets for the final product and how will it be distributed? (e.g. Would we produce so much compost that we just end up disposing of it in a landfill?)?* ** What would the residual waste be and how do we manage this safely?*		** The product from a household and businesses is residual waste. In the other landfill as biodegradable waste degrades in the landfill it produces leachate (contaminated liquid captured for treatment) and landfill gas (captured and flared).* ** 100%* ** There is one site that is likely to have sufficient capacity to accept waste from Wellington City and another site that may be able to do so for a short period of time before reaching capacity. The 100,000 T from Wellington City will double the material entering the larger of the two sites and the operator may decide it is not operational or commercially viable to accept this much material. The 15,000 T of biosolids (included in the 100,000 T) is a significant quantity of special waste and may not be acceptable to either landfill (they already accept a range of special wastes).* ** 100,000 TPA. For the other landfill leachate will be captured and treated at the other landfill, gas will be captured and flared (with power generation).*	** The product from a transfer station is residual waste. In the other landfill as biodegradable waste degrades in the landfill it produces leachate (contaminated liquid captured for treatment) and landfill gas (captured and flared).* ** 100%* ** There is one site that is likely to have sufficient capacity to accept waste from Wellington City and another site that may be able to do so for a short period of time before reaching capacity. The 100,000 T from Wellington City will double the material entering the larger of the two sites and the operator may decide it is not operational or commercially viable to accept this much material. The 15,000 T of biosolids (included in the 100,000 T) is a significant quantity of special waste and may not be acceptable to either landfill (they already accept a range of special wastes).* ** 100,000 TPA. For the other landfill leachate will be captured and treated at the other landfill, gas will be captured and flared (with power generation).*	** As biodegradable waste degrades in the landfill it produces leachate (contaminated liquid captured for treatment) and landfill gas (captured and flared).* ** 100%* ** Leachate will be captured and treated through the city wastewater treatment plant at Moa Point, gas will be captured and flared (with power generation).* ** 100,000 TPA*	** Incineration 'products include energy, bottom ash (relatively inert) and fly ash/air pollution control residues (hazardous waste).* ** Bottom ash is 25-30% of the input materials, fly ash is a minor component (3-5%) but requires treatment and management as hazardous waste.* ** Bottom ash has some similarities to aggregate and may be marketed as an alternative aggregate product. This market is unproven in New Zealand and similar products have taken a long time to gain acceptance from regulators, designers and asset owners. Fly ash/pollution control residues will need to be treated/stabilised before disposal in a specialised hazardous waste facility or cell.* ** Residuals are estimated to be 30,000 TPA bottom ash and 5,000 TPA fly ash/pollution control residues.*	** Gasification 'products include energy (via the combustion of syngas), char (relatively inert) and air pollution control residues (hazardous waste).* ** Char is 25-30% of the input materials, air pollution control residues are a minor component (3-5%) but require treatment and management as hazardous waste.* ** Char is inert carbon has been proposed as a carbon additive for soils and may be marketed as an alternative soil amendment product. This market is unproven international is likely to take a long time to gain acceptance from regulators, designers and asset owners. Pollution control residues will need to be treated/stabilised before disposal in a specialised hazardous waste facility or cell.* ** Residuals are estimated to be 20-30,000 TPA char and 5,000 TPA pollution control residues.*	** pyrolysis 'products include energy, pyrolysis oil, char (relatively inert) and air pollution control residues (hazardous waste).* ** Char is 25-30% of the input materials, air pollution control residues are a minor component (3-5%) but require treatment and management as hazardous waste.* ** Char is inert carbon has been proposed as a carbon additive for soils and may be marketed as an alternative soil amendment product. This market is unproven international is likely to take a long time to gain acceptance from regulators, designers and asset owners. Pollution control residues will need to be treated/stabilised before disposal in a specialised hazardous waste facility or cell.* ** Residuals are estimated to be 20-30,000 TPA char and 5,000 TPA pollution control residues.*
Legislative/ Resource Management Act risks	**1**	**No risk - consistent with existing approvals, no further consents required**	**Low risk of not securing approvals, business as usual consenting process, consistent with plan requirements.**	**High risk of not securing approvals, business as usual consenting process but potential for no approval**	**Extreme risk of not securing approval, for example extended or untested consenting process, activity with no precedent**	**Extreme risk of not securing approval, for example extended or untested consenting process, activity with no precedent**	**Extreme risk of not securing approval, for example extended or untested consenting process, activity with no precedent**
** Relevant policy direction and political environment for process.* ** Risk of securing consents.*		*No ongoing residual waste management proposed at Southern Landfill.* ** The national waste levy, included a stated intention to increase the levy amount, signals governments intention to make alternatives to accepting materials for landfill more financially attractive.* ** No consent process required* *Note: If on site waste minimisation activities continue (e.g. composting and tip shop) consent will still be required for these activities post 2023.*	*Design and technical evaluation is straight forward, consent process may be complex and expensive. Consent still required after 2023 to operate a transfer station.* ** There are no national or regional policies that preclude establishing a transfer station. The national waste levy, included a stated intention to increase the levy amount, signals governments intention to make alternatives to accepting materials for landfill more financially attractive.* ** The consent process is likely to require consideration of community and environmental effects but will be considering a redevelopment within the existing operational area. Given ongoing transport movements and risk of odour and windblown litter it is likely that notified process will be required. It is considered a low risk that consents are not granted.*	*Design and technical evaluation is straight forward, consent process will be complex and expensive.* ** There are no national or regional policies that preclude landfill, the national waste levy, included a stated intention to increase the levy amount, signals governments intention to make alternatives to landfill more financially attractive.* ** The consent process is likely to be complex (multiple effects, detailed technical assessments, a wide range of community views, fully notified process) with a risk that consents are not granted.* *Note: Some scored this as Medium Risk.*	*Design and technical evaluation will be complex (new technology for New Zealand), the consent process is likely to be complex and expensive.* ** There are no clear national or regional policies addressing conventional incineration or waste to energy in New Zealand. The NES for Air Quality bans high temperature hazardous waste incineration - how this relates to conventional (high temperature) incineration of general waste with energy recovery has not been tested.* ** The consent process is likely to be complex (multiple effects, detailed technical assessments, a wide range of community views, fully notified process) with a high risk that consents are not granted.*	*Design and technical evaluation will be complex (new technology for New Zealand), the consent process is likely to be complex and expensive.* ** There are no clear national or regional policies addressing waste to energy in New Zealand. The NES for Air Quality bans high temperature hazardous waste incineration - how this relates to advanced thermal treatment of general waste with energy recovery has not been tested.* ** The consent process is likely to be complex (multiple effects, detailed technical assessments, a wide range of community views, fully notified process) with a high risk that consents are not granted.*	*Design and technical evaluation will be complex (new technology for New Zealand), the consent process is likely to be complex and expensive.* ** There are no clear national or regional policies addressing waste to energy in New Zealand. The NES for Air Quality bans high temperature hazardous waste incineration - how this relates to advanced thermal treatment of general waste with energy recovery has not been tested.* ** The consent process is likely to be complex (multiple effects, detailed technical assessments, a wide range of community views, fully notified process) with a high risk that consents are not granted.*
Financial: (cost to Council, cost to user)	**3**	**Net cost to Council 0-5M and/or projected gate rate <$300/T**	**Net cost to Council 0-5M and/or projected gate rate <$300/T**	**Net cost to Council <-5M and/or projected gate rate <$200/T**	**Net cost to Council 0-5M and/or projected gate rate <$300/T**	**Net cost to Council 0-5M and/or projected gate rate <$300/T**	**Net cost to Council 0-5M and/or projected gate rate <$300/T**
		Estimated net cost to Council $3.5M (cost of transport Council waste to other landfill and contribution to transfer station operations). *Estimated cost per tonne of $180/tonne*	*Estimated net cost to Council $3.5M (cost of transport Council waste to other landfill and contribution to transfer station operations).* *Estimated cost per tonne of $160/tonne*	*Estimated net cost to Council of -$4M (currently -$6M (profit), anticipate increased cost reflecting capital investment).* *Estimated cost per tonne of $110/tonne*	*Estimated net cost neutral to Council (gate rate reflects capital and operational costs of conventional incineration and ash landfill).* *Estimated cost per tonne of $300/tonne based on international examples*	*Estimated net cost to Council in the order of -$2M per annum (gate rate reflects capital and operational costs of gasification and inert landfill, provides small return to Council).* *Estimated cost per tonne of $290/tonne based on international examples*	*Estimated cost neutral for Council (gate rate reflects capital and operational costs of pyrolysis and inert landfill, provides small return to Council).* *Estimated cost per tonne of $290/tonne based on international examples*

Criteria	Weighting		
		Mechanical heat treatment (MHT)	**Mechanical biological treatment (MBT)**
Community impacts/values	**2**	**More than minor but less than significant community impacts are anticipated**	**More than minor but less than significant community impacts are anticipated**
** Traffic volumes.* ** Dust, noise, litter, odour, visual impacts* ** Cultural concerns.* ** Community image.* ** Resilience implications for Wellington City – ability to manage waste within the boundaries of Wellington City in an emergency.* ** Impacts on public health.*		*Community impacts are expected to be more than minor but less than significant* ** Significant - traffic volumes to/from the site will be high (consistent with current) combining heavy vehicles (refuse collection vehicles), light commercial and trailers and cars* ** Moderate to Significant - dust, noise and visual impacts will be carefully managed but may be moderate where weather has an impact or specific activities take place. Litter and odour will be carefully managed but have the potential to be moderate to significant due to unusual loads (odour) and challenging weather conditions (high winds for litter, still weather for odour).* ** Moderate to Significant - the mechanical heat treatment of waste prior to disposal of residual and stabilised material rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Moderate to Significant - the presence of an mechanical heat treatment facility and disposal facility for stabilised and residual material is likely to have a moderate to significant adverse impact on the community image* ** Minor - the mechanical heat treatment process and disposal facility for stabilised and residual waste site provides a suitable disposal site for disaster waste (spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua subject to the operation continuing post emergency.* ** Minor - the site will be carefully managed to minimise the potential for adverse public health impacts. Examples include managing waste acceptance (odour, windblown litter), air pollution control (for example biofilter) arrangements for immediate burial of hazardous wastes (such as asbestos containing materials).*	*Community impacts are expected to be more than minor but less than significant* ** Significant - traffic volumes to/from the site will be high (consistent with current) combining heavy vehicles (refuse collection vehicles), light commercial and trailers and cars* ** Moderate to Significant - dust, noise and visual impacts will be carefully managed but may be moderate where weather has an impact or specific activities take place. Litter and odour will be carefully managed but have the potential to be moderate to significant due to unusual loads (odour) and challenging weather conditions (high winds for litter, still weather for odour).* ** Moderate to Significant - the mechanical biological treatment of waste prior to disposal of residual and stabilised material rather than avoiding the generation of waste and maximising the reuse and recovery of materials is inconsistent with care for, or stewardship of, the land and the environment.* ** Moderate to Significant - the presence of an mechanical biological treatment facility and disposal facility for stabilised and residual material is likely to have a moderate to significant adverse impact on the community image* ** Minor - the mechanical biological treatment process and disposal facility for stabilised and residual waste site provides a suitable disposal site for disaster waste (spoiled items, ...) and day to day waste if the city is cut off from Lower Hutt or Tawa/Porirua subject to the operation continuing post emergency.* ** Minor - the site will be carefully managed to minimise the potential for adverse public health impacts. Examples include managing waste acceptance (odour, windblown litter), air pollution control (for example biofilter) arrangements for immediate burial of hazardous wastes (such as asbestos containing materials).*
Environmental	**3**	**More than minor but less than significant environmental impacts are anticipated**	**More than minor but less than significant environmental impacts are anticipated**
** Impacts on the surrounding environment, including fauna (fish, birds, reptiles etc) and flora (plants, trees).* ** Groundwater pollution risk.* ** Carbon emissions.* ** Recreational use of land upon completion.* ** Residual risks upon Landfill closure.* ** Risk of technology in a seismically active environment*		*Environmental impacts are expected to be minor or moderate* ** Moderate to Significant - The mechanical heat treatment process may be able to be constructed within the existing operational areas at Southern Landfill. A new landfill to accept residual and stabilised materials will be required, most likely in the same valley as that proposed for the Southern Landfill extension. This will require removal of regenerating native bush and diversion of a stream but on a similar scale to the landfill extension.* ** Minor - Groundwater protection features for the landfill design include capture of groundwater underneath the filled area with the ability to divert to leachate pipes if required and an engineered liner system to contain leachate (contaminated water from the landfill).* ** Moderate - the carbon emissions associated with the stabilisation of biodegradable material within the mechanical heat treatment plant reduces the generation of landfill gas but is offset by emissions associated with the heat input. This reduces the net greenhouse gas emissions for the management of residual waste. Est 26 MTCO2eq/year* ** Minor - the landfill site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely.* ** Minor - the design standards for the landfill to be used provide for long term containment of waste and ongoing treatment of leachate and landfill gas. The new landfill area will be for stabilised and residuals materials. With the extension, will be possible to restore the stream that is currently piped underneath the existing and closed stages of this landfill. This will provide a significant environmental benefit.* ** Minor - The mechanical heat treatment process and new landfill will be*	*Environmental impacts are expected to be minor or moderate* ** Moderate to Significant - The mechanical biological treatment process may be able to be constructed within the existing operational areas at Southern Landfill. A new landfill to accept residual and stabilised materials will be required, most likely in the same valley as that proposed for the Southern Landfill extension. This will require removal of regenerating native bush and diversion of a stream but on a similar scale to the landfill extension.* ** Minor - Groundwater protection features for the landfill design include capture of groundwater underneath the filled area with the ability to divert to leachate pipes if required and an engineered liner system to contain leachate (contaminated water from the landfill).* ** Moderate - the carbon emissions associated with the stabilisation of biodegradable material within the mechanical biological treatment plant reduces the generation of landfill gas and reduces the net greenhouse gas emissions for the management of residual waste. Est 19 MTCO2eq/year* ** Minor - the landfill site will be available for recreational purposes once completed, consistent with surrounding areas with walking, mountain biking and similar activities most likely.* ** Minor - the design standards for the landfill to be used provide for long term containment of waste and ongoing treatment of leachate and landfill gas. The new landfill area will be for stabilised and residuals materials. With the extension, will be possible to restore the stream that is currently piped underneath the existing and closed stages of this landfill. This will provide a significant environmental benefit.* ** Minor - The mechanical biological treatment process and new landfill will be desigaed to withstand the impacts of credible earthquake scenarios*
Technology risks	**2**	**Some applications internationally, no applications in New Zealand**	**Well established technology internationally, no applications in New Zealand**
** Availability of experts and equipment to maintain, operate and fix equipment.* ** Is the technology future-proof – risk of obsolescence?* ** Refer to existing applications/examples at a similar scale.* ** Scalability of the technology – can it be scaled up or down easily if waste quantities change?*		** Required plant is not present in NZ and technicians and equipment are not available* ** Mechanical heat treatment requires investment in equipment (including air pollution control equipment) with a service life of 25 years or more.* ** Mechanical heat treatment at similar scale (100,000 T per year) is implemented internationally (Australia one plant, UK/Europe, multiple plants).* ** Mechanical heat treatment plants are designed for a specific quantity or composition of residual waste i.e. is not well suited to changing quantities or composition.*	** Required plant is not present in NZ and technicians and equipment are not available* ** Mechanical biological treatment requires investment in equipment (including air pollution control equipment) with a service life of 25 years or more.* ** Mechanical biological treatment at similar scale (100,000 T per year) is implemented internationally (Australia several plants, UK/Europe, multiple plants).* ** Mechanical biological treatment plants are designed for a specific quantity or composition of residual waste i.e. is not well suited to changing quantities or composition.*
Product risks	**1**	**Markets defined/ available in other country's for products/outputs**	**Markets defined/ available in other country's for products/outputs**
** Products produced by the alternative (e.g. compost from a composting plant or electricity from a waste-to-energy plant)?* ** How much product is produced as a proportion of the initial input tonnage?* ** Are there established and enough markets for the final product and how will it be distributed? (e.g. Would we produce so much compost that we just end up disposing of it in a landfill?)?* ** What would the residual waste be and how do we manage this safely?*		** Mechanical heat treatment 'products' include low quality recyclable materials (metals, specific plastics), stabilised biodegradable materials and residual waste.* ** Estimated outputs including compost like output/stabilised biodegradable materials (30-35% of the input materials), residual waste (50-55% of input materials) and low quality recyclables (up to 10% of input materials).* ** The low quality recyclable materials are potentially marketable but markets are currently challenging for low quality plastics. Stabilised biodegradable materials have limited markets, internationally they are typically used for landfill or mine rehabilitation, they are likely to be disposed of to landfill in Wellington. Residual waste will need to be disposed of to landfill.* ** Residuals are estimated to be 85,000 TPA (stabilised biodegradable fraction and residual waste) and 10,000 TPA low quality recyclables.*	** Mechanical biological treatment 'products' include low quality recyclable materials (metals, specific plastics), 'compost like output (stabilised biodegradable materials) and residual waste.* ** Estimated outputs including compost like output/stabilised biodegradable materials (25-30% of the input materials), residual waste (50-55% of input materials) and low quality recyclables (up to 10% of input materials).* ** The low quality recyclable materials are potentially marketable but markets are currently challenging for low quality plastics. Stabilised biodegradable materials have limited markets, internationally they are typically used for landfill or mine rehabilitation, they are likely to be disposed of to landfill in Wellington. Residual waste will need to be disposed of to landfill.* ** Residuals are estimated to be 80,000 TPA (stabilised biodegradable fraction and residual waste) and 10,000 TPA low quality recyclables.*
Legislative/ Resource Management Act risks	**1**	**High risk of not securing approvals, business as usual consenting process but potential for no approval**	**High risk of not securing approvals, business as usual consenting process but potential for no approval**
** Relevant policy direction and political environment for process.* ** Risk of securing consents.*		*Design and technical evaluation will be complex for both a new landfill and a new mechanical heat treatment process (new technology for New Zealand), the consent process is likely to be complex and expensive.* ** There are no clear national or regional policies addressing mechanical heat treatment of general waste in New Zealand.* ** The consent process is likely to be complex (mechanical heat treatment and new landfill, multiple effects, detailed technical assessments, a wide range of community views, fully notified process) with a high risk that consents are not granted.*	*Design and technical evaluation will be complex for both a new landfill and a new mechanical biological treatment process (new technology for New Zealand), the consent process is likely to be complex and expensive.* ** There are no clear national or regional policies addressing mechanical biological treatment of general waste in New Zealand.* ** The consent process is likely to be complex (mechanical biological treatment and new landfill, multiple effects, detailed technical assessments, a wide range of community views, fully notified process) with a high risk that consents are not granted.*
Financial: (cost to Council, cost to user)	**3**	**Net cost to Council 0-5M and/or projected gate rate <$300/T**	**Net cost to Council 0-5M and/or projected gate rate <$300/T**
		Estimated small cost for Council in the order of $1M per year (gate rate reflects capital and operational costs of mechanical heat treatment and landfill, small return to Council). *Estimated cost per tonne of $260/tonne based on international examples*	*Estimated small return for Council in the order of -$1M per year (gate rate reflects capital and operational costs of mechanical biological treatment and landfill, provides small return to Council).* *Estimated cost per tonne of $250/tonne based on international examples*

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