# Food Waste Collection and Processing Solutions – Research and Initial Options Assessment

Prepared for Nelson City Council and Tasman District Council

**28 September 2023**

**Report for Nelson City Council and Tasman District Council**

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# Executive Summary

This report presents the results of a cost modelling exercise undertaken for Nelson City Council and Tasman District Council (the Councils) on the likely costs and performance of kerbside food waste collections.

The purpose of this report is to provide high level indicative data, and does not reflect the current or future availability of collection or organic processing options in the Nelson-Tasman region.

Nelson & Tasman has around 3.4kg per household per week in the kerbside rubbish, which is about a third of the rubbish by weight and the biggest fraction. Food waste is problematic in landfill and leads to greenhouse gas emissions. Providing a food waste collection for household could therefore reduce waste to landfill as well as reduce carbon emissions.

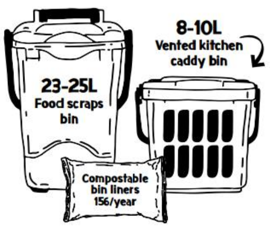
The Government has indicated they will require councils to provide food waste collections – and also offer some incentives to assist councils to introduce the services.

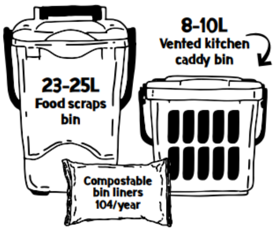
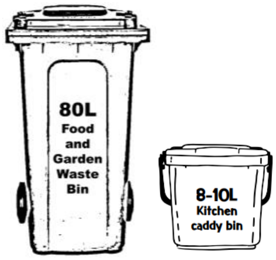
## E.1.0 Services Modelled

Food waste collection services are assumed to be provided to 43,500 households in the Nelson and Tasman area.

Five service option configurations (termed scenarios) were modelled. These are shown in the table below:

### Table E. 1: Food Waste Service Scenarios

| Scenario | Container | Frequency | Vehicles | Processing |
|---|---|---|---|---|
| **Low Cost** |  | Weekly | Side load, non-compacting food waste vehicle | Vermicomposting |
| **High Diversion** |  | Twice weekly | Side load, non-compacting food waste vehicle | In-vessel composting |

<table>
<tr><th>Scenario</th><th>Container</th><th>Frequency</th><th>Vehicles</th><th>Processing</th></tr>
<tr><td>Maximum Carbon Reduction</td><td>
</td><td>Weekly</td><td>Electric Side load, non-compacting food waste vehicle</td><td>Anaerobic digestion</td></tr>
<tr><td>Local</td><td>
</td><td>Weekly</td><td>Side load, non-compacting food waste vehicle</td><td>Vermicomposting</td></tr>
<tr><td>FOGO</td><td>
</td><td>Weekly</td><td>Side loading compacting vehicle</td><td>In-vessel composting</td></tr>
</table>

# E.2.0 Results

## E.2.1 Costs

### E.2.1.1 Total Collection and Processing Costs

The chart below shows the estimated cost of the service per household served.

**Figure E 1: Cost per Household Served**

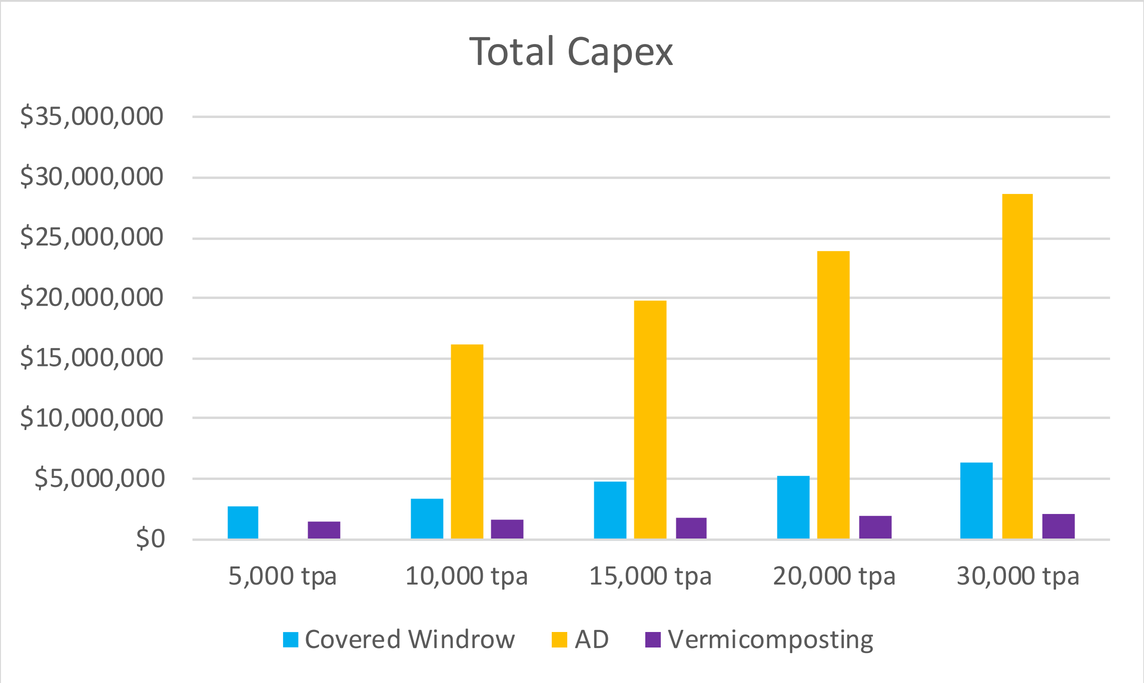

Modelling indicates that the net cost of the food waste service can be expected to be in the order of $57 per household per annum for the Low Cost service, through to approximately $112 for the High Diversion scenario.

It is worth noting that, while these are additional costs for households, the service would afford households the opportunity to reduce their rubbish collection costs which could offset the cost or even result in net cost savings for households. For example, a Tasman household with a rubbish bag service uses approximately 78 rubbish bags per year (1.5 per week). If they reduced this to one per week (52 per year), based on a bag price of $4.80[1], this would be a savings of $124.80 per annum.

[1] https://www.tasman.govt.nz/my-council/fees-and-charges/

### E.2.1.2 Capital Costs for Processing

**Figure E 2: Estimated Total Capex by Processing Technology**



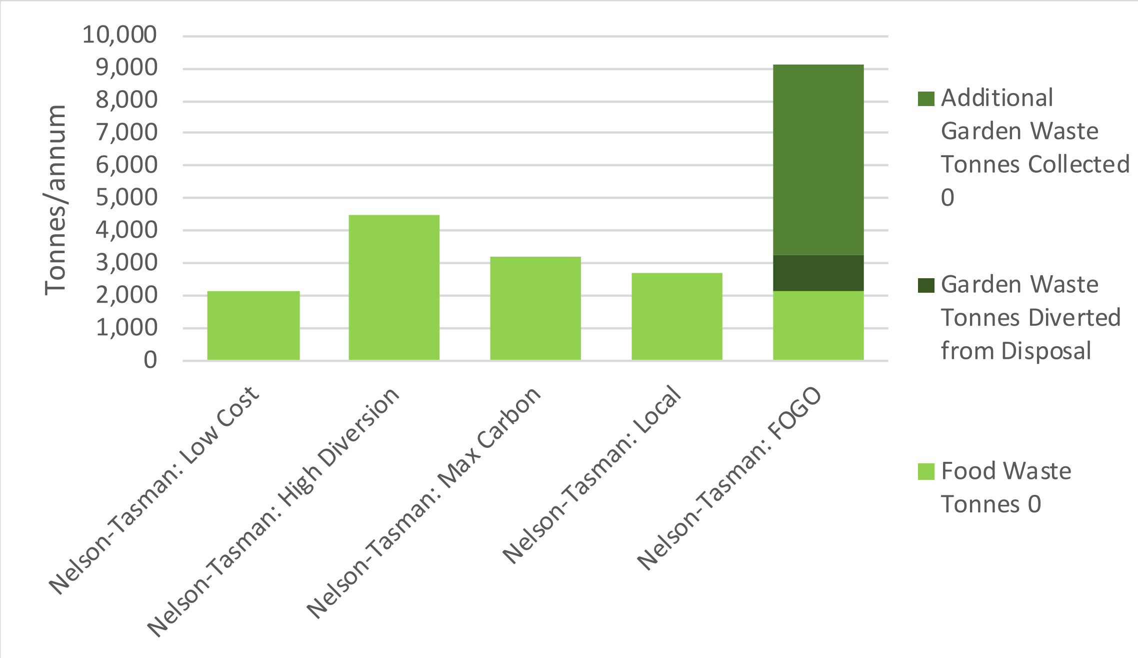

As can be seen from the above chart, AD technology represents the highest level of capital cost by some margin, while vermicomposting has a low capital cost. As the facility sizes scale up, capital costs increase but become proportionately cheaper on a per tonne basis.

Capital costs may not need to be met by the Councils if the facility is provided through a contracting arrangement. Further, while capital costs for AD are high, when operating costs and income are taken into account, it can still be cost competitive on a per tonne basis.

## E.2.2 Waste Diversion Performance

The estimated quantities of material collected through the food scraps/FOGO collection are shown in the chart below:

**Figure E 3: Food Waste Tonnes Collected per Annum (Households Served)**

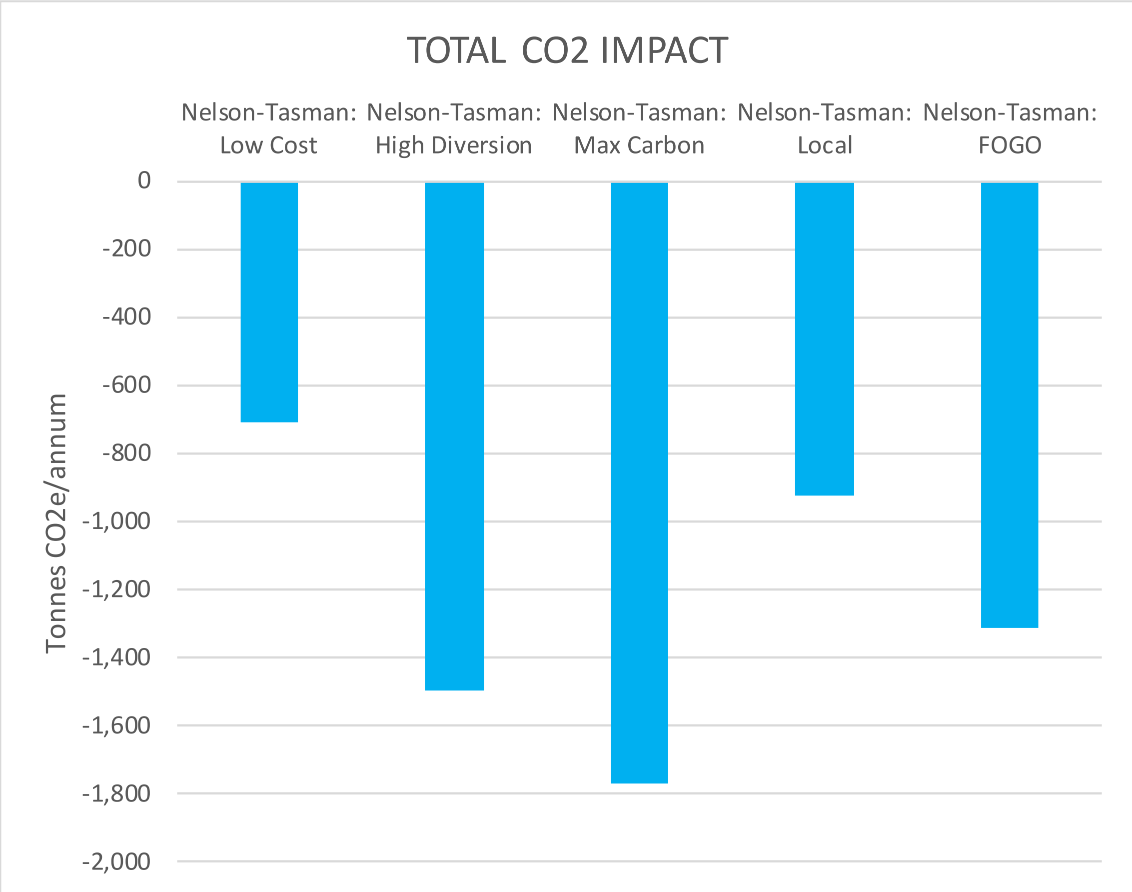



The High Diversion scenario collects the most food scraps and would be expected to divert roughly twice as much food scraps as the Low Cost scenario. The FOGO collection comfortably collects the largest total quantity of material by virtue of also collecting garden waste (an estimated 7,000 tonnes). However, it is vital to be aware that the majority of this material would not be diverted from kerbside rubbish collections. In fact, only an estimated 2,175 tonnes of garden waste go to landfill in current rubbish collections. The majority of the garden waste that would be collected in this scenario would be material diverted from private green waste collection services, home composting/mulching, or material that would have been taken to transfer stations as separate green waste.

### E.2.3 Carbon Performance

The chart below shows a summary of the carbon impacts of diverting organic wastes. This takes into account the net impacts from collection, processing, landfill diversion and use of the diverted organics as a soil amendment (e.g. compost). All impacts are shown as $CO_2$ equivalent ($CO_2e$) tonnes.

**Figure E 4: Net $CO_2e$ Emissions (Tonnes per Annum)**

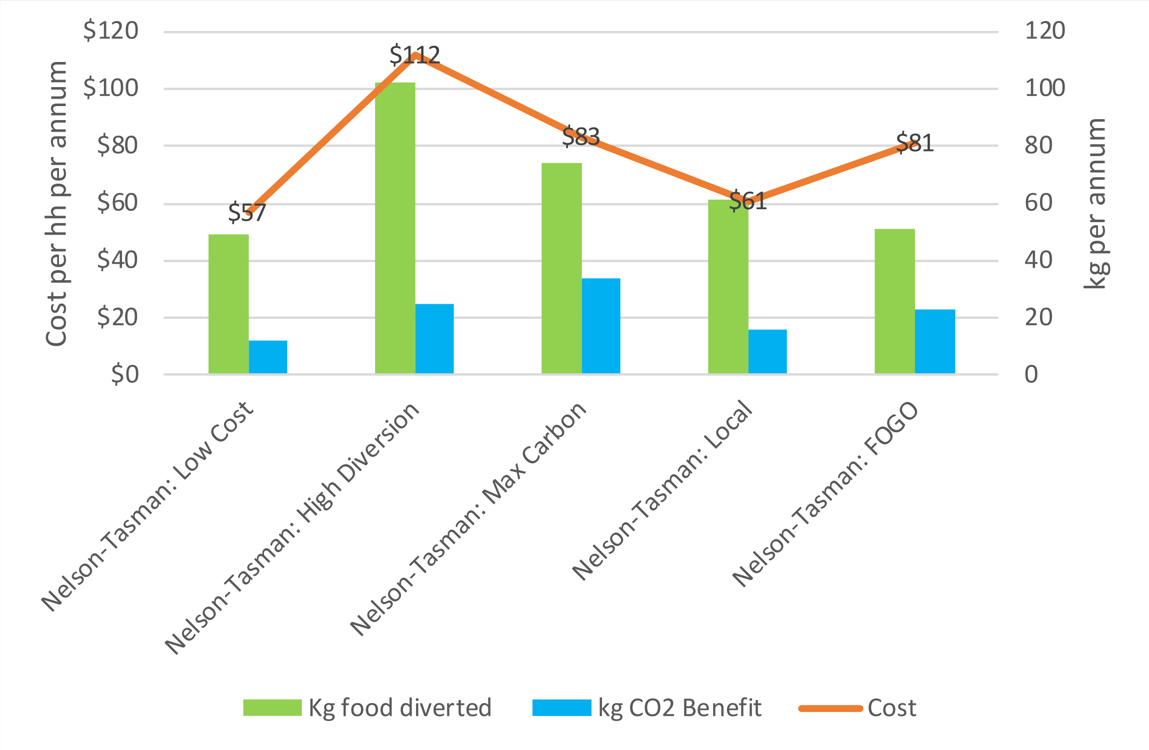



As can be seen from the chart above, all scenarios result in a reduction of carbon emissions with the greatest carbon benefit from the High Diversion scenario, while the lowest carbon benefit is from the Low-Cost scenario.

# E.3.0 Conclusions

The chart below summarises the cost and waste diversion performance the options modelled.

### Figure E 5: Per Household Cost, Recovery and Carbon Reduction




The key findings of the modelling are:

1. Collection costs make up the majority of costs across all the services.
2. The modelling suggests that services are likely to cost between $57 per household and $112 per household depending on the standard of service specified.
3. The Low Cost scenario has the lowest cost overall but also the lowest level of food waste recovery and carbon reduction.
4. The Local scenario costs around 7% more but also delivers 25% greater reduction in food waste to landfill and 32% more carbon savings.
5. The Maximum Carbon Reduction scenario costs 47% more than the Low Cost scenario but delivers 50% more food waste reduction and 187% more carbon savings.
6. The High Diversion scenario costs 97% more than the Low Cost scenario but delivers 108% more food waste diversion and 112% more carbon savings.
7. The FOGO scenario costs 43% more than the Low Cost scenario but delivers 4% more food waste diversion and 93% more carbon savings.
8. Anaerobic Digestion is the most expensive option in terms of capital cost; however, it delivers the highest level of carbon benefit, and can still be cost competitive on a per tonne basis.

# Contents

# Glossary

| | |
|---|---|
| Anaerobic digestion (AD) | A process for biological degradation of organic waste in the absence of oxygen. The AD process produces a biogas which can be used to generate energy or heat or both, and a digestate which can be used to improve soil. |
| ASP | Aerated static pile. A composting process that provides greater process control by forcing air into the pile. This helps stop the compost from becoming anaerobic when higher moisture content materials such as food waste are processed. |
| Diversion rate | This is the total quantity of recycling (and food waste) collected and recovered divided by the total quantity of all waste, recycling, and food waste collected. |
| Gross cost | Gross cost refers to costs before any income is taken into account. |
| Net cost | Net cost refers to costs once income has been deducted. |
| NZETS | New Zealand Emissions Trading Scheme. The NZETS puts a price on carbon emissions. Landfills emit carbon in the form of methane and are required to offset emissions through the NZETS by purchasing carbon credits. The amount of carbon emitted, and the price paid for carbon credits, can therefore affect the cost of disposing of waste to landfill. |
| Market share | In this context this refers to proportion of households in Nelson & Tasman that use the different companies' services for private rubbish collection. |
| Rates requirement | This is the portion of Council costs that are recovered from rates. This will be the cost Council pays to provide the service minus any income Council receives from the service or from other sources (such as waste disposal levy funding). |
| Vermicomposting | Using worms to process organic waste. The process produces 'vermicast', which is a high nutrient soil improver. |
| Waste disposal levy | From 1 July 2021 all Class 1 landfills are paying a landfill levy of $20 per tonne (up from $10), and this will go up to $30 on 1 July 2022, $50 on 1 July 2023, and $60 on 1 July 2024. |

| | |
|---|---|
| | The landfill levy has also been expanded to include Class 2-4 landfills; by 1 July 2024 the levy for these facilities will be $30 per tonne for Class 2 and $10 per tonne for Classes 3 and 4.<br><br>This will increase the cost of disposal, which is expected to incentivise the use of alternatives such as recycling and composting.<br><br>The funds gathered by the levy are ring-fenced under current legislation and 50% of the levy funds must be distributed to councils, pro-rated on a population basis. Councils must use this money for the purposes of waste minimisation. The remaining 50% (less administration costs) is distributed through a contestable fund for waste minimisation projects. Levy funds could be used to offset some of the costs of food waste or recycling services. |

# 1.0 Introduction

This report presents the results of a cost modelling exercise undertaken for Nelson City Council and Tasman District Council (the Councils) on the likely costs and performance of introducing food waste collections.

# 2.0 Scope

The Councils have commissioned Eunomia Research & Consulting (Eunomia) to provide consultancy support in respect of determining the potential impacts of introducing a food waste collection service to urban households in Nelson & Tasman.

The Councils have requested that Eunomia undertake cost modelling to provide estimated costs, diversion from landfill, and carbon impacts. These outcomes will help inform the Councils and elected members when considering service changes.

# 3.0 Methodology

## 3.1 Overview

A detailed explanation of the methodology and the key parameters used in the modelling is contained in the separate Parameter Report provided to The Councils which should be referred to if more detail is required.

The Parameter Report was developed prior to undertaking the modelling work. This allows key parameters (for example households covered, set out rates, vehicle and labour costs etc.) that will be used in the modelling to be discussed and agreed with the client beforehand, helping ensure transparency and avoiding unintentional bias.

Future likely collection options were identified with officers prior to undertaking the modelling. These options are presented in section 4.0 below.

For each option, the modelling calculates requirements for containers, staffing, and vehicles as well as expected waste diversion performance and a range of system costs.

## 3.2 Key Parameters

Key parameters used in the modelling are shown in the following tables. As noted above, these and other technical parameters were discussed extensively and agreed with Council officers prior to undertaking the modelling. The key parameters are recorded in the Parameter Report which should be referred to for further detail on the modelling methodology.[2]

### 3.2.1 Households and Collection Areas

Data supplied by the Councils indicates that the food waste collection services would be provided to approximately 43,500 properties. A breakdown of households and collections is shown in the table below:

**Table 1: Households Assumed to Receive a Food Scraps or Food and Garden Waste Kerbside Service**

| | Nelson | Tasman | Total |
|---|---|---|---|
| **Urban area** | 21,390 | 7,380 | 28,770 |
| **Rural** | 1,610 | 13,120 | 14730 |
| **Total** | **23,000** | **20,500** | **43500** |

## 3.3 Materials Collected by the Systems

For the purposes of the modelling, we have assumed the food waste only collection service would collect food scraps, and small quantities of garden waste (dead flowers etc.) hair etc. They are items that, in typical household amounts, will fit into the collection bins, and that will be able to be processed effectively in the nominated processing facilities.[3] In line with recent government guidance,[4] paper and compostable plastics (apart from compostable liners for food waste kitchen caddies) will not be accepted in the collection service.

The food and garden waste collection (referred to as Food Organics Garden Organics or FOGO), would accept the same food waste items noted above but would also accept organic garden waste such as grass clippings, hedge clippings and small branches etc.

[2] Since the parameter report was written we have become aware that there are some issues with existing organic waste processing facilities. This does not affect the modelling or outcomes of this report as the costs and locations were not tied to specific facilities.

[3] Other household organic items such as garden waste, manure and pet faeces, pet litter, vacuum cleaner dust, oils, dead animals etc. would potentially cause problems in terms of quantities, health and safety, or contamination.

[4] https://environment.govt.nz/assets/publications/Improving-household-recycling-and-food-scraps-collections.pdf

## 3.4 Baseline Model and Calibration

A key part of our methodology is to model existing collection systems prior to modelling any potential changes. This provides some assurance, to the extent possible, that the model is replicating the logistics and likely potential costs within the local context.

In this context we modelled the existing council contract recycling and rubbish (Tasman only) collection services. The result of the baseline modelling exercise across key parameters showed the following:

### Table 2: Calibration of Baseline Model

| Parameter | Actual value as reported | Modelled value | % Variation |
|---|---|---|---|
| **Total vehicle numbers** | 11 | 10.64 | 3% |
| **Cost (annual)*** | $3,313,029* | $3,288,238 | 0.7% |
| **Vehicle distance (annual)** | 342,000 | 346,439 | 1.3% |

*Based on actual costs supplied by the Councils, some adjustments to the supplied costs were made to arrive at as close to a like to like comparison as possible.

The table above indicates that the model produced very similar results to the current reported values. We usually aim to model within 5% of reported costs. The values produced are well within the likely margins of error and provide some confidence that the model is likely to produce a reasonable approximation of likely dynamics and costs.[5]

# 4.0 Modelled Options

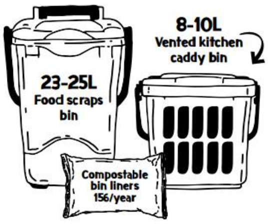
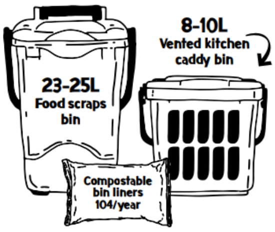
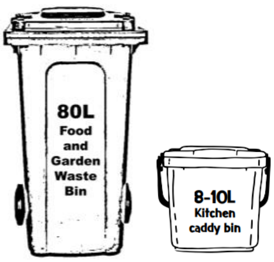
In order to determine possible impact of the service options, they were grouped into five 'scenarios'. Each of the scenarios is focused on achieving a particular outcome and so the different service components have been selected to align with these outcomes. For example, the 'Maximum Carbon Reduction' scenario utilises electric vehicles as well as

[5] As noted in the parameter report, we do not aim to exactly replicate existing costs or precisely predict future costs. There are a wide number of variables than can serve to alter the actual costs including how competitive the procurement process is, the degree to which other elements (e.g. transfer station operation etc) are wrapped up in a contract, whether a company is bidding for strategic reasons (e.g. to establish a base for commercial operations), recycling and commodity markets, the level of risk the council is asking the contractor to carry, contract structure, contract term, the pricing of variations and escalations, fuel prices, equipment supply, to name a few. It is also worth noting from our experience, that costs submitted during solid waste service procurements can vary substantially between bidders - sometimes by up to 100%.

sending the material to AD for processing (which has a better carbon profile).  It should be noted that other combinations of the different components are possible.

The scenarios chosen were discussed and agreed in a workshop with the Nelson & Tasman council officers before being modelled.

## Table 3: Scenarios to be Modelled

| Scenario | Container | Frequency | Vehicles | Processing |
|---|---|---|---|---|
| **Low Cost** |  | Weekly | Side load, non-compacting food waste vehicle | Vermicomposting |
| **High Diversion** |  | Twice weekly | Side load, non-compacting food waste vehicle | In-vessel composting |
| **Maximum Carbon Reduction** |  | Weekly | Electric Side load, non-compacting food waste vehicle | Anaerobic digestion |
| **Local** |  | Weekly | Side load, non-compacting food waste vehicle | Vermicomposting |
| **FOGO** |  | Weekly | Side loading compacting vehicle | In-vessel composting |

In the scenarios there are different levels of service. Specifically, the 'Low Cost' scenario only provides a kerbside container, while the 'Local' scenario adds a kitchen caddy, which helps increase the convenience (and thus participation) for householders. The 'Maximum Carbon Reduction' scenario adds compostable liners for the caddy; and the caddy provided is vented, which helps dry out the food waste and minimise odours and mess (again seen to increase participation from the community). The 'High Diversion' scenario has the same containers and caddy liners as the 'Maximum Carbon' but increases the frequency of collection to twice weekly. Finally the FOGO scenario uses a small wheeled bin for kerbside collection which can accept food scraps and garden waste (which is usually seen as a higher level of service by householders) and provides a kitchen caddy to encourage food waste separation.

The impact of higher levels of service is assumed to drive higher levels of participation, which is then reflected in the amount of food waste that is diverted through the scheme.

The processing options are assigned as follows:

- Vermicomposting is likely to be the lowest cost processing option (depending on transport costs) and is appropriate for a food waste-only stream, without compostable caddy liners. It is also very scalable and can operate effectively at small as well as large scales. This was therefore assigned to the Low-cost scenario as well as the Local scenario.
- The Maximum Carbon Reduction scenario specifies anaerobic digestion as this is likely to deliver the highest level of carbon benefit.
- In-vessel composting is specified for the High Diversion scenario as this process can accommodate compostable caddy liners which are a key feature of this scenario and is also specified for the FOGO scenario as invessel composting is appropriate for a mixed putrescible and garden waste feedstock.

## 4.1 Sensitivities

In addition to modelling the scenarios as described above, a number of sensitivities were run to determine the potential impact on the scenarios of different assumptions. Eunomia has also therefore run the model with some changes to the assumptions around the following:

- The impact of landfill gas capture rates on carbon benefits
- The impact of landfill gas utilisation on carbon benefits

Refer to section 5.7 for further discussion of the sensitivities.

# 5.0 Results

## 5.1 Costs

The costs developed in the modelling relate to the costs of providing the service. These costs will be the core costs that would be charged by a contractor for the provision of the service. However, it should be emphasised that cost modelling exercises cannot necessarily predict actual contract costs as these can be impacted by a wide range of factors not related to the cost modelling.[6] Nevertheless, the costs are expected to be broadly indicative and are useful to compare relative costs of different service options given a common set of assumptions. All cost shown in this report are exclusive of GST.

In terms of modelled costs, the following are included:

- All operational costs including labour, fuel, road user charges, overheads, maintenance etc.;
- All capital costs including vehicles and containers are spread out over 10 years;
- Processing of collected food waste including any transfer and bulking costs.

Costs associated with communications, contract management, compliance, and monitoring and reporting are not calculated by the modelling.

### 5.1.1 Modelled Costs

The costs shown below represent the estimated cost for a contractor to deliver the service (as opposed to the total cost of the service which would include the costs of administering the contract, communication and education and monitoring and compliance). A summary of these is shown in the table and chart below.

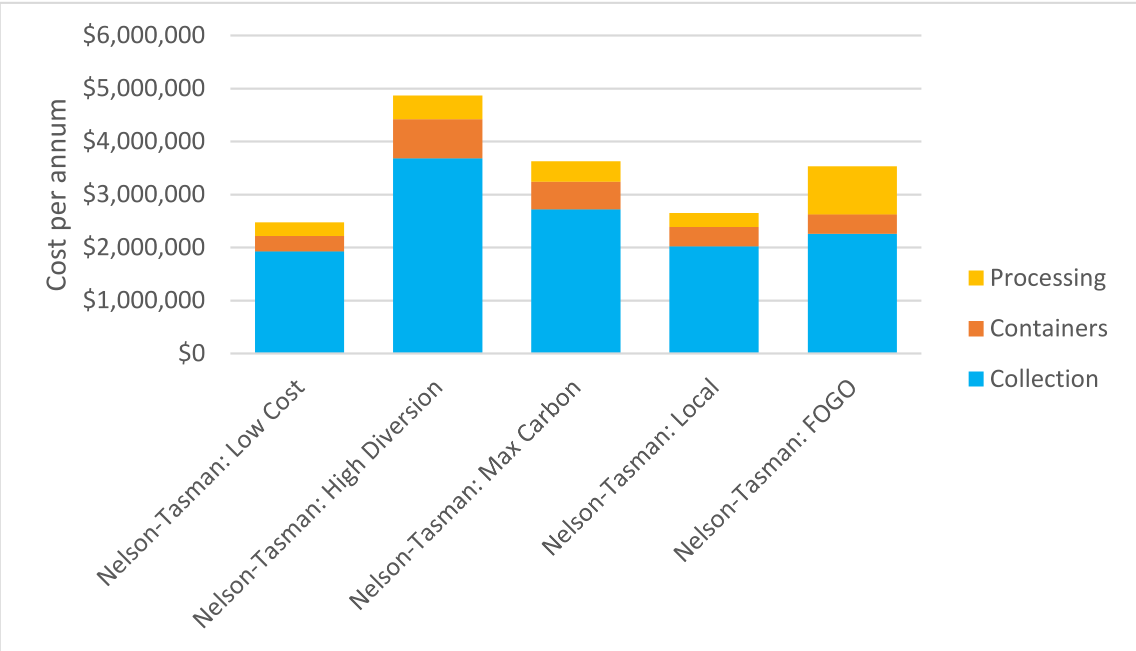
[6] There are a wide number of variables than can serve to alter the actual costs including how competitive the procurement process is, the degree to which other elements (e.g. transfer station operation etc) are wrapped up in a contract, whether a company is bidding for strategic reasons (e.g. to establish a base for commercial operations), compost markets, the level of risk the council is asking the contractor to carry, contract structure, contract term, the pricing of variations and escalations, the competitiveness of the procurement process, to name a few.

In addition, there is some uncertainty at present around what the participation in food waste collection services is likely to be. Contractors are therefore tending to assume that participation rates will be relatively high (compared to currently available indications from existing services), so as to ensure they resource the services sufficiently and that they are future-proofed. This could mean that the costs that are tendered are higher than actual costs for the contractor to deliver the service if the participation rate that eventuates is lower than assumed.

## Table 4: Modelled Annual Council Cost of Kerbside Services (Excl GST)

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| **Collection** | $1,925,080 | $3,685,407 | $2,716,534 | $2,021,610 | $2,257,612 |
| **Containers** | $294,844 | $736,819 | $527,316 | $364,106 | $365,867 |
| **Processing** | $257,454 | $445,851 | $386,181 | $268,181 | $910,664 |
| **TOTAL** | **$2,477,378** | **$4,868,077** | **$3,630,031** | **$2,653,898** | **$3,534,143** |

## Figure 1: Modelled Annual Cost of Council Kerbside Services




The total costs for a food waste collection system range from approximately $2.5m for the Low Cost scenario to around $4.9m for the High Diversion scenario.

The largest component of the cost is collections. This is driven by how often households set out their food scraps/FOGO containers, which in turn is a key factor in determining how many trucks are likely to be required (the more households that set out bins each week, the longer it takes to collect a route, and the quicker the trucks fill up). The increase in collection costs between the Low Cost, All Round and Maximum Carbon Reduction scenarios reflect increasing set out rates generated by providing more customer focussed kitchen caddies and bin caddy liners. The High Diversion scenario also reflects that there is an additional service each week. The FOGO service uses wheeled bins which are collected using an automated side arm lifter. This is marginally more efficient than the manual food scraps collection and so, even though set out rates are assumed to be higher for a FOGO service, collect costs are comparable.

The next largest component of cost is the processing cost. This is a function of the tonnes to be processed, and the cost per tonne for processing (which includes the gate rate for processing, and the transport and bulking costs to get the material to the facility).

The Low-Cost scenario has the lowest tonnage and uses the lowest cost per tonne processing option; hence it is the lowest overall processing cost. The Local scenario has slightly more tonnes requiring processing and is assumed to have a slightly higher cost per tonne, due to using smaller facilities which do not have the same economies of scale. The FOGO scenario has the highest processing cost because it collects the most material. Maximum Carbon Reduction scenario has moderate processing cost, due to collecting relatively high quantities of food waste and using a more expensive AD process. The High Diversion scenario has the second highest processing costs due to it recovering the largest amount of food waste.

The container costs reflect the numbers and types of containers provided. The Low-Cost scenario just provides a kerbside bin, while the Local scenario also adds a kitchen caddy. The Max Carbon Reduction and High Diversion scenarios each use a kerbside bin with vented caddy and compostable caddy liners. The Max Carbon Reduction scenario makes provision for 104 bin caddy liners per participating household per year (2 per week), while the High Diversion scenario makes provision for 156 caddy liners per participating household per year (3 per week)[7]. Finally, the FOGO scenario uses an 80L wheeled bin alongside a kitchen caddy.

### 5.1.2 Per household Costs

The chart below shows the estimated cost of the service per household served.

[7] Each liner costs approximately 8 cents. This translates to a cost of $8.32 per participating household for 104 caddy liners per year or $12.48 per participating household for 156 caddy liners per year.

### Figure 2: Cost per Household Served

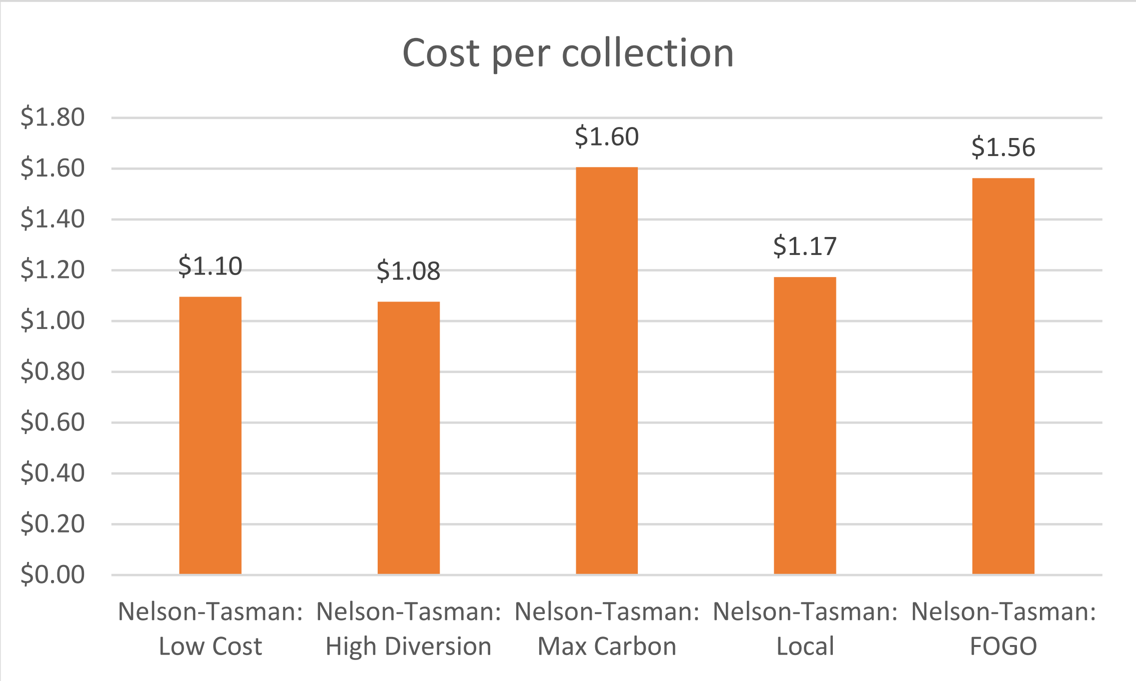

Modelling indicates that the net cost of the food waste service can be expected to be in the order of $57 per household per annum for the Low Cost service, through to approximately $112 for the High Diversion scenario.

It is worth noting that, while these are additional costs for households, the service would afford households the opportunity to reduce their rubbish collection costs which could offset the cost or even result in net cost savings for households. For example, if a Tasman household with a rubbish bag service uses approximately 78 rubbish bags per year (1.5 per week). If they reduced this to one per week (52 per year), based on a bag price of $4.80[8], this would be a savings of $124.80 per annum.

The chart below shows the cost on a cost per collection basis:

[8] https://www.tasman.govt.nz/my-council/fees-and-charges/

### Figure 3: Cost per Household per Collection




As can be seen from the chart the cost is around $1 - $1.20 per collection for the Low Cost, High Diversion and Local scenarios, with the Max Carbon and FOGO scenarios being around $1.60 per collection. This reflects the use of compostable caddy liners in the Max Carbon scenario and the higher processing costs in the FOGO scenario. The High Diversion scenario also uses caddy liners but remains around $1 per collection because it has a lower set out per collection (but twice as many collections) and some efficiencies in terms of overheads (on a per week basis the cost would be $2.16 per household).

## 5.2 Bin Costs

Bin costs are spread out over 10 years (financed at 8%) and included in the opex as per household costs presented above. There are broken out here for information and so that, if the Councils wish to take on any of the capex associated with the bins, it can be determined what the quantum is likely to be.

The Ministry for the Environment has announced that there is funding available for assisting in the rollout of food waste collections, including the purchase of bins, assistance in funding processing infrastructure, and subsidies for communications and rollout. Support from the Ministry for the Environment will not extend to ongoing service costs.

### Table 5: Bin Capex Costs by Scenario

| | Unit cost | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|---|
| **Bin Costs** | | | | | | |
| **23 Litre Roadside Bin (incl RFID)** | $22 | $957,000 | $957,000 | $957,000 | $957,000 | |
| **Kitchen Caddy** | $8 | | $348,000 | $348,000 | $348,000 | $348,000 |
| **80L Wheeled bin (incl RFID)** | $45 | | | | | $2,175,000 |
| **Subtotal** | | $957,000 | $1,305,000 | $1,305,000 | $1,305,000 | $2,305,500 |
| **MfE Subsidy** | | | | | | |
| **23 Litre Roadside Bin** | $15 | $652,500 | $652,500 | $652,500 | $652,500 | |
| **Kitchen Caddy** | $5 | | $217,500 | $217,500 | $217,500 | $217,500 |
| **80L Wheeled bin** | $40 | | | | | $1,740,000 |
| **Roll out Subsidy** | | $50,000 | $50,000 | $50,000 | $50,000 | $50,000 |
| **Subtotal** | | $702,500 | $920,000 | $920,000 | $920,000 | $2,007,500 |
| **Net Capex** | | | | | | |
| **TOTAL** | | **$254,500** | **$385,000** | **$385,000** | **$385,000** | **$298,000** |

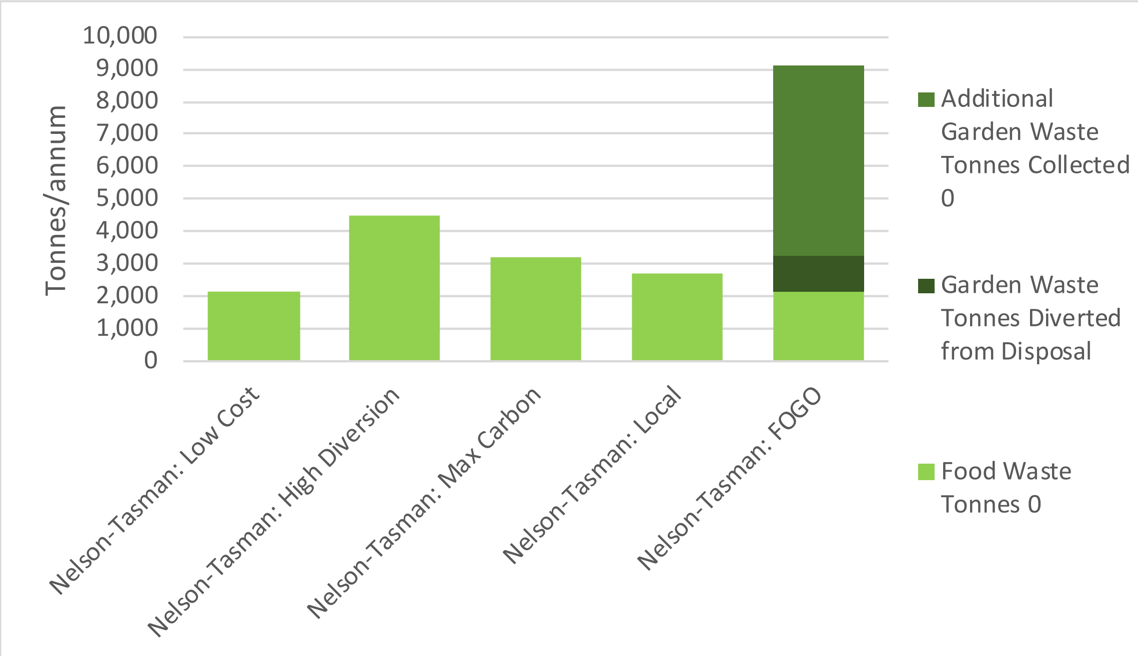
Note: the above costs do not include the costs of liners, bin replacements, delivery or maintenance.

Bin costs are lower for the Low Cost option as only a single kerbside bin per household is specified. The other systems specify kitchen caddies which increases cost, and the FOGO option has the highest capex for bins. However, with the government subsidy the bin costs even out.

## 5.3 Waste Diversion Performance

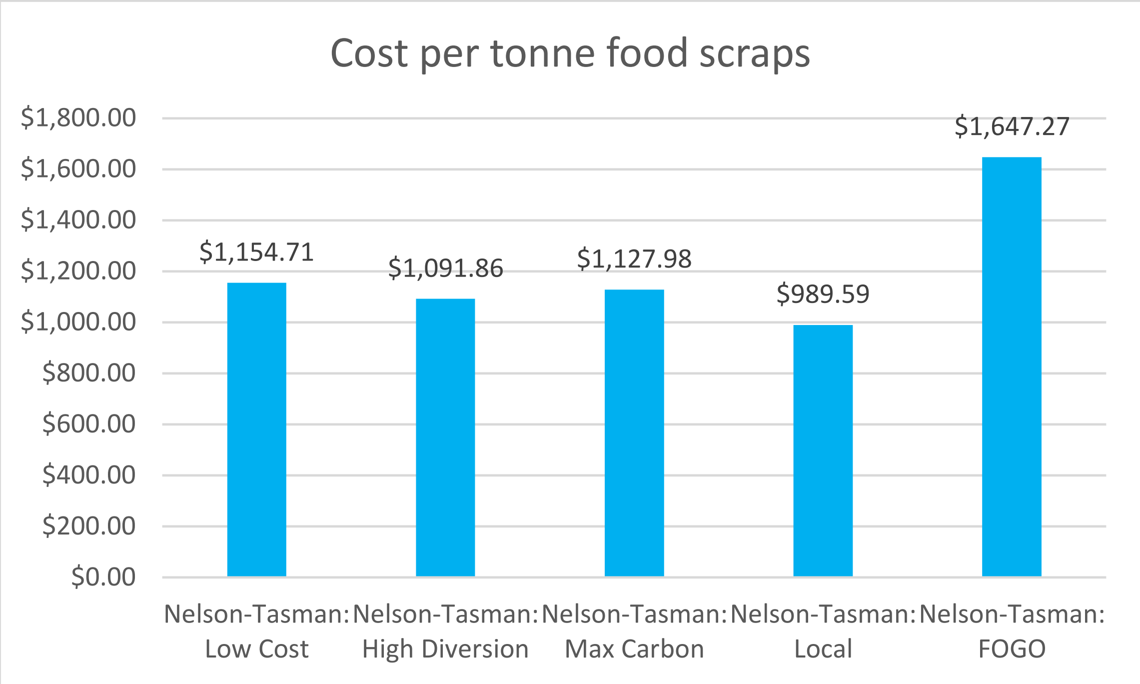
The estimated quantities of material collected through the food scraps/FOGO collection are shown in the chart below:

### Figure 4: Food Waste Tonnes Collected per Annum (Households Served)




The High Diversion scenario collects the most food scraps and would be expected to divert roughly twice as much food scraps as the Low Cost scenario. The FOGO collection comfortably collects the largest total quantity of material by virtue of also collecting garden waste (an estimated 7,000 tonnes). However, it is vital to be aware that the majority of this material would not be diverted from kerbside rubbish collections. In fact, only an estimated 2,175 tonnes of garden waste goes to landfill in current rubbish collections. The majority of the garden waste that would be collected in this scenario would be material diverted from private green waste collection services, home composting/mulching, or material that would have been taken to transfer stations as separate green waste.

**Figure 5: Cost per Tonne Recovered**




The above chart illustrates the cost per tonne of food waste recovered. The Local scenario has the lowest cost per tonne while the FOGO Scenario has the highest cost per tonne. Although the cost of the High Diversion scenario is high, the higher levels of diversion as a result of higher levels service (twice weekly collection, provision of caddy liners) mean that the cost per tonne is comparatively low.

For comparison, a household using a bag collection for rubbish would pay around $800 a tonne[9]. It is worth noting that the figures for rubbish disposal will increase by a further $30 per tonne (plus GST) by 2025 as the waste levy goes from its current $30 per tonne (at time of writing) to $60 per tonne. This increase will not be applied to organic matter that is getting correctly composted.

## 5.4 Carbon Performance

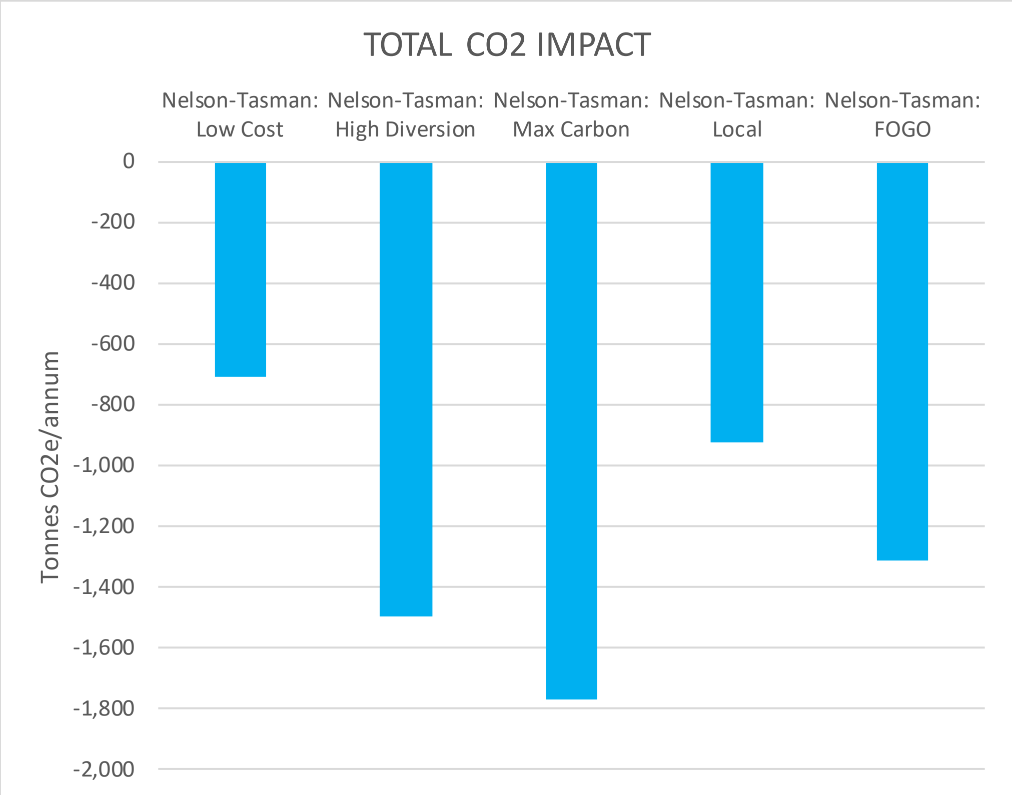
The carbon impacts of the different food waste scenarios were calculated. In terms of added emissions, the calculation took account of the emissions from the collection vehicles, transport to the processing site, and the lost benefit from less landfill gas being available for beneficial use (in this case replacement of coal for boilers at Nelson Hospital) In terms of carbon benefit, this comes from the avoided landfill gas emissions from not landfilling the food waste, avoided fossil fuel emissions from energy recovery (anaerobic digestion processing) and the carbon benefit from use of the product as a soil amendment (e.g. compost). The carbon benefit from soil amendment includes both the

[9] This assumes a bag contains 6kg of waste and the cost per bag is $4.80.

sequestration of carbon in the soil and the avoidance of fossil fuel-based fertilisers. For detail on how these impacts were calculated see Appendix A.3.0.

The table and charts below show a summary of these impacts. All impacts are shown as $CO_2$ equivalent ($CO_2$e) tonnes.

### Figure 6: Net $CO_2$e Emissions (Tonnes per Annum)




As can be seen from the chart above, all scenarios result in a reduction of carbon emissions with the greatest carbon benefit from the High Diversion scenario, while the lowest carbon benefit is from the Low-Cost scenario.

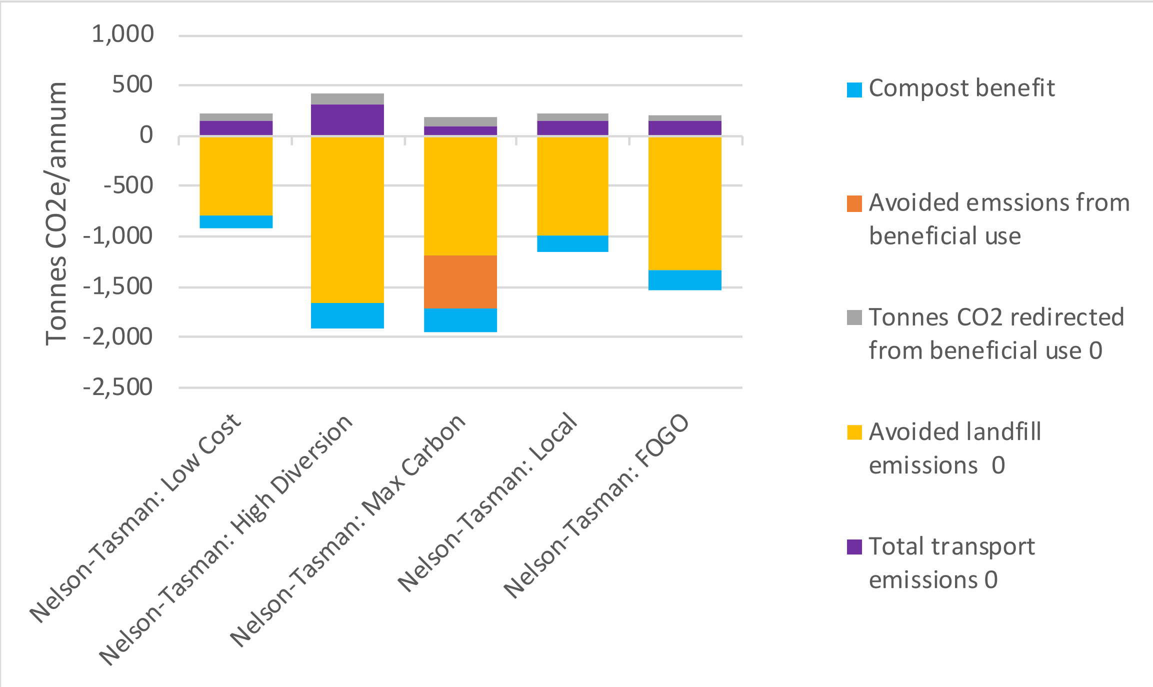
The table and chart below show how these benefits are achieved in each of the scenarios.

### Table 6: $CO_2$e Emissions Breakdown (Tonnes per Annum)

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| **Total transport emissions** | 157 | 307 | 95 | 158 | 155 |
| **Avoided landfill emissions** | -796 | -1,654 | -1,194 | -995 | -1,334 |
| **Tonnes CO2 redirected from beneficial use** | 57 | 119 | 86 | 72 | 57 |

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| **Avoided emissions from beneficial use** | | | -518 | | |
| **Compost benefit** | -129 | -268 | -238 | -161 | -194 |
| **TOTAL CO2 IMPACT** | **-710** | **-1,495** | **-1,769** | **-926** | **-1,316** |
| **kg/CO2 benefit per hh served** | 11.86 | 25.11 | 33.99 | 15.71 | 22.86 |

## Figure 7: $CO_2e$ Emissions Breakdown (Tonnes per Annum)




The collection vehicles generate emissions, with the High Diversion scenario generating roughly twice as many due to having twice weekly collections. In the Maximum Carbon Reduction scenario, the urban collection vehicles (but not those on rural routes) are assumed to be electric and so generate much lower emissions (but not zero as they are assumed to get electricity from the grid which is currently not zero emissions).

There are savings in emissions from avoiding sending the food waste to landfill where it will generate methane (a greenhouse gas approximately 32 times more powerful than carbon dioxide)[10]. Much of the methane generated in modern landfills is captured and flared or used to generate electricity. [11] For York Valley Landfill the gas capture used for the purposes of the Emissions Trading Schem is 90%, however there is some discussion around the correct rate to use to get a true picture of the carbon impact. For the default scenario above we have used a figure of 77% and modelled other capture rates as sensitivities. The reasons for this, and presentation of the impacts of changes in the gas capture rate and assumed beneficial use are discussed in section 4.1. The amount of avoided landfill emissions is a direct function of the tonnage of food waste/FOGO that is recovered.

The next component is the use of organic waste to create methane. In all scenarios it is assumed that the organic waste that goes to landfill generates methane and 98% of this is captured and destroyed. 25%- 30% of this used to replace coal in the Nelson Hospital boilers to generate heat, and the remainder is flared.[12] Not sending this organic waste to landfill therefore means that this benefit is not captured; so, there is a reduction in carbon benefit from this aspect of taking food waste out of landfill. However, this benefit is minimal under the default assumptions where landfill gas is assumed to be captured and used to generate electricity. Refer to section 5.7 for a discussion of the assumptions and the impact of different assumptions in the carbon benefits.

The final component of the carbon equation is the benefit from using the product (e.g. compost) as a soil amendment. This calculation includes both the potential sequestration (absorbing) of the carbon in the compost into the soil (i.e. increasing the carbon content of the soil), and the avoidance of the use of fossil fuel based fertilisers. In terms of the scenarios, this is a function of the tonnages assumed to be recovered, except for the Maximum Carbon Reduction scenario where the material that has been through the anaerobic digestion process sees a large portion of the carbon from the food waste used to generate gas. In the Maximum Carbon Reduction scenario, the benefit from this aspect is the lowest of the scenarios, while there is substantial benefit in the High Diversion scenario.

## 5.5 Logistics

A key aspect of the modelling exercise was to determine if there was any advantage to having multiple small local facilities or a single large facility for processing the collected food waste or some combination thereof.

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[10] The figure of 32 times is based on current IPCC figures of the impact over a 100 year timeframe. Because methane is a shorter-lived gas in the atmosphere than $CO_2$ the ratio used depends on the period over which the effect is discounted, and so this figure is subject to change. In other words over 100 years one tonne of methane is estimated to have the same impact as 32 tonnes of $CO_2$.

[11] The rate of gas capture and landfills is open to some debate. Refer to section 5.7.1 for further discussion.

[12] It is assumed the residual waste would go to York Valley landfill for disposal which does use the gas to generate electricity.

Each scenario had a different configuration of facilities. These are briefly noted in the table below:

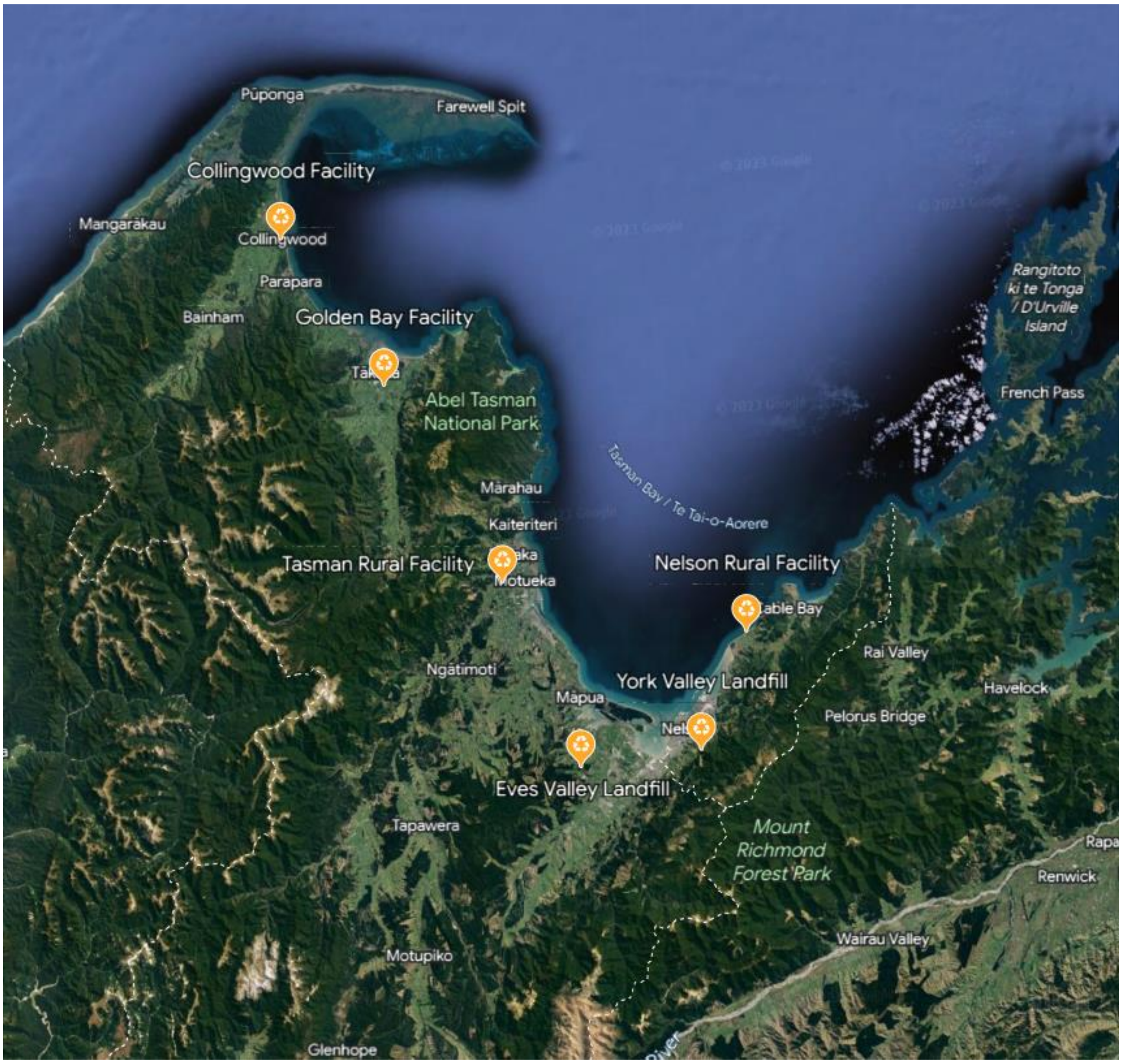
### Table 7: Facility Configuration by Scenario

| Scenario | Processing | Notes |
|---|---|---|
| **Low Cost** | Vermicomposting, 6 sub-regional sites. | Vermicomposting is chosen as it is flexible and can utilise multiple sites to reduce transport costs |
| **High Diversion** | 'Gore' type Composting<br><br>3 sub-regional facilities located near feedstock sources | The compostable liners ideally require an aerobic process to decompose. Additional feedstock sources are also sought to optimise plant sizes and maximise the overall amount of material diverted from disposal. |
| **Max Carbon Reduction** | AD Central location plus one small facility in Golden Bay (nominally vermicomposting) | AD is preferred as this provides significant carbon benefit where the gas generated offsets fossil fuel use. The economies of scale need to make the plant viable mean one centralised plant is specified that also seeks to attract other putrescible material. A small vermicomposting facility is also suggested to process food waste from Golden Bay.<br><br>Compostable liners are not able to be effectively degraded in an AD process. They are skimmed off as contamination before entering the process. As other contaminants are usually included in the skimmed material, the liners are landfilled. The weight of liners landfill will be negligible compared to the additional tonnage captured. |
| **Local Processing** | Vermicomposting / composting 6 local sites | The main driver for this option is to facilitate local processing. In this regard vermicomposting or small-scale composting is identified as the preferred processing technologies due to their scalability. Vermicomposting however will not effectively process compostable liners and so no liners are specified. |

| Scenario | Processing | Notes |
|---|---|---|
| **FOGO** | Covered windrow composting<br><br>2 sub-regional facilities located near feedstock sources. plus one small facility in Golden Bay (nominally vermicomposting) | This is the food and garden waste option. In this instance no compostable liners are specified as the garden waste in the bin usually provides sufficient aeration to reduce odour (compostable liners could be included however).<br><br>A composting process is specified to enable effective processing of garden waste. These facilities could be located sub-regionally to optimise access to other feedstocks and improve cost effectiveness. |

The map below shows the approximate assumed locations of the facilities.

## Figure 8: Assumed Approximate Processing Locations



Travel distances for collection vehicles were calculated using google maps. A set of collection logistics tables was constructed to estimate the total travel distances that might be involved under each of the scenarios.

A key assumption was that at the end of each collection day, collection vehicles would return to a vehicle base, nominally near the Richmond RRC in Beach Road, Richmond. Under this assumption it quickly became apparent that there would be no significant advantage in terms of logistics from having local processing sites. As each vehicle would be returning to the base in Richmond at the end of each day, it would pass in proximity to the probable location of a centralised facility (e.g. at the York Valley or Eve's Valley Landfill sites). Provided that the collection vehicles are sized appropriately to require only one empty per day (very likely in the case of food waste vehicles[13]), there would be no advantage to a local drop off. Basing a collection vehicle and operator in Golden Bay was considered, but there was no clear scenario where the vehicle would be fully employed. If used to collect other materials on other days when not collecting food waste, then these would need to be transported to processing or disposal outside of Golden Bay. It may be possible to construct a community focused option in Golden Bay utilising the vehicle and operator for a range of tasks (such as commercial food waste) and bulking recyclables locally, but development of this type of option is outside the scope of the present study.

## 5.6 Capital Costs for Processing

The processing options considered in this study were covered windrow composting, anaerobic digestion, and vermicomposting. A brief explanation of the key technical aspects of each of these methodologies is provided in Appendix A.1.0. It is beyond the scope of this report to comment in detail on the relative merits of each of the processing options from a technical perspective.

Rough order capital costs were developed to provide the Councils with an indication of the level of investment that might be required from each type of processing option. The costs were developed in reference to costs of existing facilities, commercial cost models we have access to, conversations with organic waste operators, and for site and building costs, we used QV Costbuilder[14].

The capital costs included all capital equipment, site development costs, buildings, ancillary equipment, weighbridges, and estimates of design and consenting cots. Land

[13] Discussions with operators have indicated that food waste collection vehicles operating in NZ virtually always have spare capacity at the end of their rounds.

[14] QV Costbuilder is an up-to-date database used by the construction and engineering sector to develop cost estimates. It contains unit pricing for NZ by geographic area. We used the nearest geographic unit which was Christchurch.

costs were excluded as it was assumed that the facilities would be on Council owned or leased land.

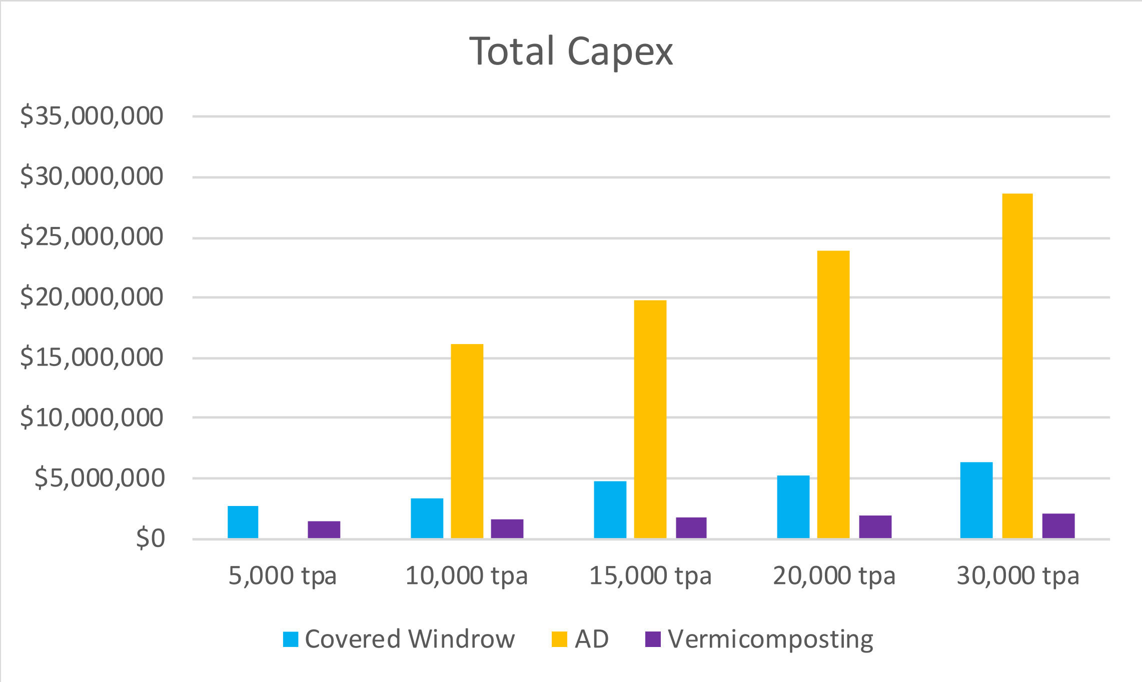
It should be noted that capital costs can vary significantly depending on the proprietary technology involved, the scale, project timescales, and how the facilities are procured and owned. The capital cost estimates provided should therefore be taken to be broadly indicative only.

Capital costs have been provided for 5,000, 10,000, 15,000, 20,000 and 30,000 tonne facilities (except for AD where the minimum viable facility size is considered to be 10,000 tonnes). As noted from the collection modelling above, it is unlikely that the total quantity of household food waste collected through kerbside will exceed 5,000 tonnes per annum, while a FOGO collection would potentially yield around 9,000 tonnes. For most facility size options above 5,000 tonnes therefore additional sources of organic waste would need to be secured. Also, as was clear from the logistics modelling, there is likely to be only minimal benefit in terms of logistics from multiple smaller facilities located throughout the districts, but potentially significant benefit from economies of scale. For this reason, we have not looked at smaller facilities than 5,000 tonnes.

As discussed in the Parameter Report (refer to section 4.2.1.6), an estimate of 30,000 tonnes of other organic material that may be available for processing in an organic waste facility was derived, although there is considerable uncertainty in regard to this figure, as data from different sources yielded very different estimates. Further, more detailed investigation in regard to potential additional tonnages is therefore strongly recommended.

Figure 9 and Table 8 below show the high-level expected capital costs for each of the different processing technologies considered.

### Figure 9: Estimated Total Capex by Processing Technology




### Table 8: Estimated Total Capex by Processing Technology

| Capacity | 5,000 tpa | 10,000 tpa | 15,000 tpa | 20,000 tpa | 30,000 tpa |
|---|---|---|---|---|---|
| **Covered Windrow** | $2,777,340 | $3,350,988 | $4,716,156 | $5,289,804 | $6,325,860 |
| **AD** | | $12,728,700 | $15,431,316 | $18,434,412 | $21,739,134 |
| **Vermi-composting** | $1,455,540 | $1,547,388 | $1,770,756 | $1,862,604 | $2,007,060 |

As can be seen from the above table and chart, AD technology represents the highest level of capital cost by some margin, while vermicomposting has a low capital cost.

As the facility sizes scale up, capital costs increase but become proportionately cheaper on a per tonne basis.

A breakdown of each of the processing technologies is provide in the tables below.

### Table 9: Estimated Capex for Covered Windrow by Facility Size

| IVC | 5,000 tpa | 10,000 tpa | 15,000 tpa | 20,000 tpa | 30,000 tpa |
|---|---|---|---|---|---|
| **Processing infrastructure and equipment** | $513,600 | $902,800 | $1,301,600 | $1,690,800 | $2,449,000 |
| **Ancillary equipment** | $1,000,000 | $1,000,000 | $1,650,000 | $1,650,000 | $1,650,000 |

| IVC | 5,000 tpa | 10,000 tpa | 15,000 tpa | 20,000 tpa | 30,000 tpa |
|---|---|---|---|---|---|
| **Site works** | $250,850 | $289,690 | $328,530 | $367,370 | $422,550 |
| **Weighbridge** | $250,000 | $250,000 | $250,000 | $250,000 | $250,000 |
| **Engineering and consenting** | $300,000 | $350,000 | $400,000 | $450,000 | $500,000 |
| **Contingency** | $462,890 | $558,498 | $786,026 | $881,634 | $1,054,310 |
| **TOTAL** | **$2,777,340** | **$3,350,988** | **$4,716,156** | **$5,289,804** | **$6,325,860** |

The largest proportion of costs for a covered windrow facility are the processing infrastructure and equipment costs, specifically the concrete pad with aeration, biofilter and breathable covers.  Ancillary equipment such as loaders, shredders and trommel screens are also a significant capital cost.

### Table 10: Estimated Capex for AD by Facility Size

| AD | 5,000 tpa | 10,000 tpa | 15,000 tpa | 20,000 tpa | 30,000 tpa |
|---|---|---|---|---|---|
| **Maturation infrastructure and equipment** | | $588,900 | $831,660 | $1,064,820 | $1,503,080 |
| **Buildings** | | $2,195,000 | $2,563,750 | $2,932,500 | $2,932,500 |
| **Processing infrastructure and equipment** | | $9,040,000 | $11,225,000 | $13,950,000 | $17,350,000 |
| **Ancillary equipment** | | $600,000 | $700,000 | $787,500 | $875,000 |
| **Site works** | | $263,350 | $289,020 | $314,690 | $330,360 |
| **Weighbridge** | | $150,000 | $150,000 | $150,000 | $150,000 |
| **Engineering and consenting** | | $650,000 | $700,000 | $750,000 | $800,000 |
| **Contingency** | | $2,697,450 | $3,291,886 | $3,989,902 | $4,788,188 |
| **TOTAL** | **$0** | **$16,184,700** | **$19,751,316** | **$23,939,412** | **$28,729,128** |

For an AD plant the largest element of capital cost is in the digestion equipment itself, including pulping and pre-treatment, digestion tanks, gas collection, pumps, and gas treatment systems. Buildings, including a waste reception area and building to house the plant, are also significant costs.

### Table 11: Estimated Capex for Vermicomposting by Facility Size

| Vermicomposting | 5,000 tpa | 10,000 tpa | 15,000 tpa | 20,000 tpa | 30,000 tpa |
|---|---|---|---|---|---|
| **Processing infrastructure and equipment** | $600,000 | $600,000 | $700,000 | $700,000 | $700,000 |
| **Site works** | $157,950 | $206,990 | $265,630 | $314,670 | $407,550 |
| **Buildings** | $155,000 | $157,500 | $160,000 | $162,500 | $165,000 |
| **Weighbridge** | $150,000 | $150,000 | $150,000 | $150,000 | $150,000 |

| Vermicomposting | 5,000 tpa | 10,000 tpa | 15,000 tpa | 20,000 tpa | 30,000 tpa |
|---|---|---|---|---|---|
| **Engineering and consenting** | $150,000 | $175,000 | $200,000 | $225,000 | $250,000 |
| **Contingency** | $242,590 | $257,898 | $295,126 | $310,434 | $334,510 |
| **TOTAL** | **$1,455,540** | **$1,547,388** | **$1,770,756** | **$1,862,604** | **$2,007,060** |

Vermicomposting facilities have low capital costs, with the main capital items being loaders to place and harvest material and screens for grading product. Other costs relate to site preparation, buildings, and weighbridge.

### 5.6.1 Comment on Capital Costs

As noted above, the above capital costs are indicative, high-level costs only, and are not provided with reference to specific sites or site characteristics. It may be possible to reduce some of the above cost elements, depending on the location. For example, if an AD plant was co-located near the York Valley landfill it may be possible to share gas collection and treatment infrastructure, as well as administration buildings, and weighbridges etc. Similarly, we understand that proposals have been put forward by Alimentary Systems to co-locate a digestion facility at the Wastewater Treatment Plant on Bell Island. There could be a number of synergies with that location as well. It is however, beyond the scope of the report to comment on specific proposals.

## 5.7 Sensitivities

### 5.7.1 Landfill Gas Capture Rate

The correct figure to use for landfill gas capture when calculating the impacts of diverting food waste from landfill is open to some debate.

The main source of debate is whether to use the current gas capture rate or the lifetime gas capture rate. The current gas capture rate represents the calculated amount of gas a landfill is expected to generate based on the waste going into it, minus the amount of gas captured in that period. This is the method used for calculating emissions under the NZETS. The lifetime gas capture rate takes account of the full lifecycle of the landfill and includes gas generated before gas capture systems are operating (they cannot operate until the pipes are installed, and cell has been capped), as well as after the landfill has closed and the gas capture systems have ceased operating. The lifetime gas capture rate is therefore lower than the current gas capture rate.

The lifetime landfill gas capture rate for York Valley is not possible to determine without significant additional information and modelling work which is outside the scope of this report. The Climate Change Commission estimates the average gas capture for landfills in NZ to be 68%, which is broadly in line with international estimates of lifetime landfill gas capture rates for well-run modern sanitary landfills.[15] We have therefore used a rate of 68% for the lifetime gas capture rate in the calculations. In our view this is likely to be closer to the true gas capture rate over time.

A further source of debate is whether to use the gazetted gas capture rate which is used to calculate liabilities under the NZETS. Under the ETS landfills are able to claim up to 90% gas capture rates. York Valley, which is the landfill where Nelson & Tasman household waste is assumed to be sent, currently has a published UEF of 0.091 equivalent to a capture rate of 90%.[16] However, as provided for in the regulations, the gazetted gas capture rate is based on a default waste composition.

Consultants Tonkin+Taylor have calculated that, based on the measured composition of waste going in to the landfill, the actual gas capture and destruction rate is likely to be approximately 77% over the remaining 10 year life of the landfill.[17] This figure is likely to most accurately represent the gas capture collection and destruction efficiency over the

[15] CCC - He Pou a Rangi the Climate Change Commission. Ināia tonu nei: a low emissions future for Aotearoa May 2021, p125

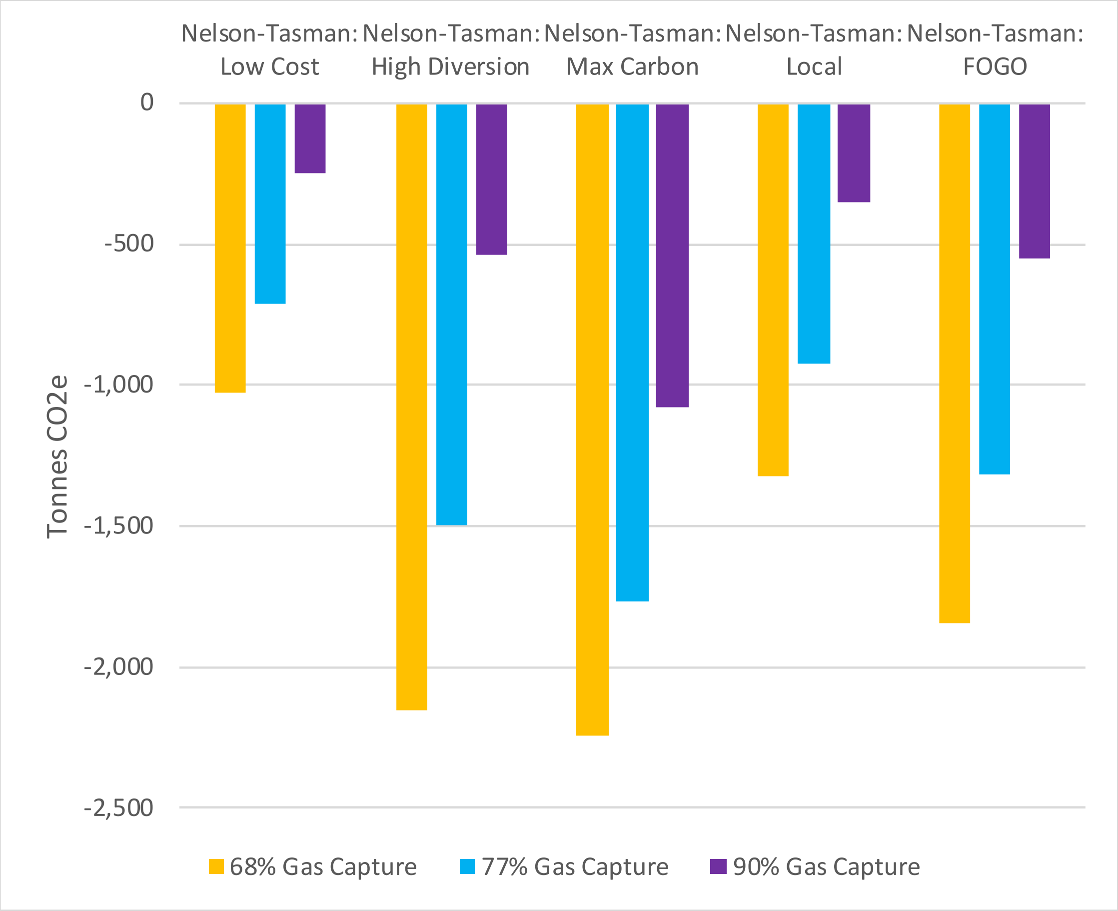
[16] Notice of Approval of Unique Emissions Factors - 2023-au3444 - New Zealand Gazette

[17] Email communication from Chris Hillman, Tonkin+Taylor 21 September 2023. The overall collection and destruction efficiency of 77% (i.e. approximately 77 % of the methane generated is destroyed) is based on 77% collection efficiency for 2022, plus 98/99% efficiency for the flares and 10% oxidation of methane through the cap.

remaining life of the landfill (estimated at approximately 10 years). This figure has been used as the default figure for the modelling.

The chart below shows the relative impact of the different assumed rates of gas capture on the potential $CO_2$ benefit against the default assumptions for use of landfill gas:

**Figure 10: $CO_2$ Impact under Different Landfill Gas Capture Rates**



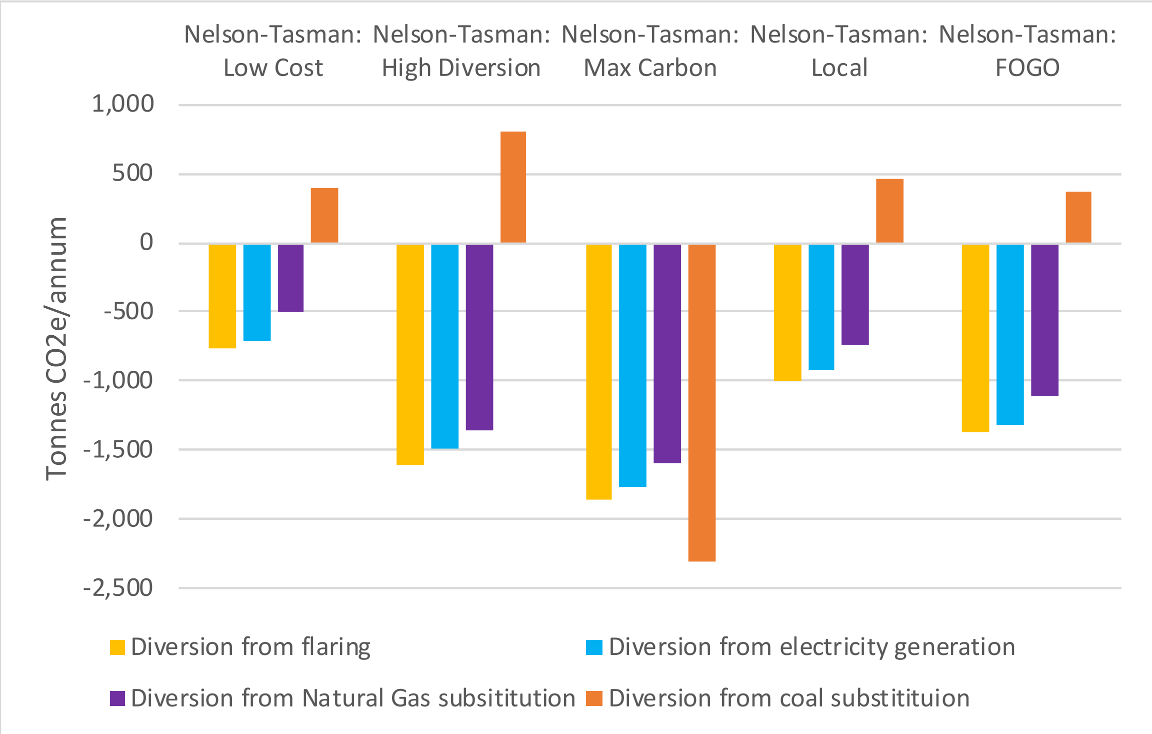

As can be seen the benefit is greatest when a low level of gas capture is assumed. This drops off quite significantly when a high level of gas capture is assumed. The Max Carbon Reduction scenario drops off the least as it assumes greater $CO_2$ benefit when the food waste is diverted from landfill and goes to anaerobic digestion.

### 5.7.2 Sensitivity – Use of Landfill Gas

Presently up to 30% of the landfill gas captured is utilised in heating Nelson Hospital. This use of the gas displaces the use of a coal boiler in heating the hospital. The remainder of the gas is currently flared and so is not going to beneficial use. We are advised that, in the future, beneficial use of landfill gas is planned, and so, as our default we have assumed that the gas not used at the hospital will be used to generate electricity.

In our modelling diverting food waste from landfill would not divert the landfill gas from use in the hospital, which is considered the highest value use, and which would therefore have priority.  Any gas diverted from the landfill would either be diverted from flaring (no $CO_2$ benefit) or from some beneficial use such as electricity generation or substituting for natural gas. The chart below shows the relative impacts of diverting gas from the landfill under different scenarios.

**Figure 11: Impact of Diverting Landfill Gas from Different Uses (77% Gas Capture Rate)**




As can be seen from the above chart, the impact of taking food waste out of landfill, and hence away from beneficial use of the landfill gas, varies according to the beneficial use to which the gas would be put.  Our calculations suggest that under most scenarios there is still positive benefit from diverting food waste from landfill even where the landfill gas would have been put to beneficial use.  The one exception to this is where all the gas is assumed to have been used to substitute for coal use.  In this instance use of the food waste to generate landfill gas would have a more positive benefit overall than diverting that material from landfill – except in the Max Carbon Reduction Scenario.  In this scenario the landfill gas that is captured (more efficiently) through AD is assumed to also substitute for coal, and so here the benefit would be greatest.

## 5.8 Implementation Costs

In addition to the modelled costs outlined above, the Councils will face additional costs of introducing and supporting the service. MfE also offers subsidies for communications and promotional marketing/education materials and related collateral — up to $5 per property or up to $7.50 per property where there are multiple councils jointly rolling out services.  This means that NCC and TDC could claim up to $7.50 and potentially have zero communications cost for the first year.

For the purposes of assisting with budgeting, estimates of these costs are provided below:

**Table 12: Estimated Council Overhead Costs**

| | Assumptions | Year One Costs | Ongoing Costs (PA) |
|---|---|---|---|
| **Communications** | Communications @$7.50/hh year 1 and $3/hh ongoing | $326,250 | $130,500 |
| ***Communications with MfE subsidy*** | *Communications fully subsidised* | *$0* | *N/A* |
| **Contract Management** | Full time role @$75,000 pa[18] | $75,000 | $75,000 |
| **Compliance** | Part of wider compliance role | $20,000 | $20,000 |
| **Total annual cost without MfE Subsidy** | | **$421,250** | **$225,500** |
| ***Total Year 1 cost with MfE Subsidy*** | | ***$95,000*** | |

# 6.0 Processing Procurement Options

There would be some advantages for the collection and processing of food waste to be combined under a single contract – in particular this gives the operator control over collection methodologies and allows them to best determine how resources are applied to control contamination.  However, if streams other than household food waste are to be processed then it may be sensible for the processing of organic wastes to be separated from collection.  This would enable the processing operator to source an appropriate mix of materials and would facilitate longer term arrangements as the investment of capital would not be tied to a limited term collection contract.  Outside of a collection contract, a plant may be able to be financed over 15 or even 20 years for example.

[18] https://www.trademe.co.nz/c/jobs/product/salary-guide

Any plant developed to process food waste and other organics on a Council site could be funded in a number of ways. Some of the key arrangements that might be considered include:

**Full Council Ownership.** Under this model the Councils would be responsible for the design and construction of the plant and would have full ownership. The Councils could elect to select an operator and seek their input on design elements, to help ensure the facility was fit for purpose.

**Design Build Operate (DBO):** Under this arrangement the Councils would own the plant and equipment and so would be responsible for the capital expenditure. This means the Councils hold all capital risk, however as the design construction and operation of the plant would reside with the contractor, they would hold the operational risk. This type of arrangement may make sense where the plant is constructed on Council land and has the advantage of Council being able to potentially access cheaper capital to finance the build and hence reduce opex costs[19]. It also allows the operator to specify the plant design to work the most effectively for their preferred methodology.

**Design Build Finance Operate. (DBFO)** This is essentially the same as the DBO option, but the contractor provides the finance – although they do not own the plant. This option makes sense in the event Council was not able to or did not wish to provide the capital for construction.

**Build Own Operate (BOO).** Under this scenario the contractor would own the plant and equipment and would in effect take full risk for the plant. This type of arrangement would require a long-term contract from the Councils to enable economic write-down of the capital investment. Variations on this type of arrangement include a split of the ownership. For example, the Councils might pay for and own the buildings, an immovable infrastructure, while the contractor owns the removable plant and equipment. This appropriately splits the risk and without having to have long contract timeframes.

**Build Own Operate Transfer (BOOT).** This is similar to the BOO arrangement except at the end of the contract the Council would purchase the plant from the contractor at its residual value. This reduces risk for the contractor and also avoids the need for long contract periods. Variations such as split ownership are also possible with this type of arrangement. This is a logical option where the plant is sited on Council land.

**Full Private Ownership.** Under this model the Councils would have no ownership or control over the facility and would simply purchase capacity on a commercial basis from an existing facility that was capable of managing the feedstock. A

[19] The larger waste operators may be able to access cheaper capital so this advantage may only apply if a more bespoke operators is awarded the contract.

medium to long term supply arrangement could be entered into to ensure things like access to the facility, operating standards, stability of pricing, quality of product etc.

It should be noted that this is not an exhaustive list. The type of ownership arrangement that is established will impact the amount of capital that council is required to invest, the risk each party takes on and ultimately the cost of processing. Different operators have different business models and preferences in respect of these types of arrangements and so in procuring organic waste processing capacity it will be necessary to negotiate the arrangement with the preferred supplier that will be best suited to the parties.

## 6.1 Assessment of Procurement Options for Each Technology

The matrix below sets out the key processing technology types considered in this report and evaluates how suitable each procurement option is likely to be for that type of technology.

| Description | Pros | Cons | Covered Windrow | AD | Vermicomposting |
|---|---|---|---|---|---|
| **Full Council Ownership.** | • The Councils have full control over the facility and facility design.<br>• There are no issues with residual value and there would be scope to change the operator if they are not performing.<br>• As the most appropriate sites are likely to be Council owned this also avoids issues of ownership and residual value at the end of the contract. | • There is risk of a disconnect between the facility preferred by Council and what the operators require.<br>• While this can be reduced through involving the operator in the design, there could be tension around upgrades and changes, and level of responsibilty for maintenance and wear and tear. | May be appropriate. The design requirements are not overly complex, and it would be simple enough to derive a split between the council and private capex required. For example, Council would own the hard infrastructure and the operator the operating equipment. | Not recommended as there is a high level of technical complexity to the design and the operators will want full control over the specifications. | Not recommended as the capex required is low and it is mostly operating equipment such as loaders and screens which are more appropriately owned by the operator. The operation could take place on Council land if an appropriate site is available. |
| **Design Build Operate (DBO)** | • The plant would be specified to exactly the operator's requirements.<br>• If the Council is able to obtain cheaper finance than an operator this could reduce the overall cost.<br>• As the facility is owned by the Council this avoids issues of ownership and residual value at the end of the contract | • As the facility is owned by the Council there could be tension around upgrades and changes, and level of responsibility for maintenance and wear and tear. | Appropriate. Helps ensure the facility is designed to meet operational requirements | May be appropriate, but as it is high capex with a specific use, Council would need to undertake careful technical evaluation to be satisfied it was fit for purpose | Not recommended as the capex required is low and it is mostly operating equipment such as loaders and screens which are more appropriately owned by the operator. The operation could take place on Council land if an appropriate site is available. |

| Description | Pros | Cons | Covered Windrow | AD | Vermicomposting |
|---|---|---|---|---|---|
| **Design Build Finance Operate. (DBFO)** | • This is the same as DBO but would be utilised where the contractor is able to access cheaper finance. | • This is the same as DBO but would be utilised where the contractor is able to access cheaper finance. | Appropriate. Helps ensure the facility is designed to meet operational requirements | May be appropriate, but as it is high capex with a specific use, Council would need to undertake careful technical evaluation to be satisfied it was fit for purpose | Not recommended as the capex required is low and it is mostly operating equipment such as loaders and screens which are more appropriately owned by the operator. The operation could take place on Council land if an appropriate site is available. |

| Description | Pros | Cons | Covered Windrow | AD | Vermicomposting |
|---|---|---|---|---|---|
| **Build Own Operate (BOO)** | • No capital expenditure required by the Councils.<br>• Appropriate where there is a long enough contract period for economic amortisation of capital (e.g. 15-20 years).<br>• A split ownership model with Council owning the buildings and hard infrastructure and the contractor owning movable plant is a good way of sharing risk and responsibility.<br>• Clear allocation of responsibility for upgrades, maintenance etc. | • Requires a long contract period. Council has limited say in the design and operation of the facility.<br>• Does not provide any incentive to ensure residual value in the asset - i.e. there may be issues with plant not being maintained in the final years of the contract. | A split ownership model is likely to be appropriate | A split ownership model is likely to be appropriate | Not recommended as the capex required is low and it is mostly operating equipment such as loaders and screens which are more appropriately owned by the operator. The operation could take place on Council land if an appropriate site is available. |
| **Build Own Operate Transfer (BOOT)** | • Similar to BOO but provides a mechanism to transfer residual value at the end of the contract.<br>• Provides an incentive to invest in and maintain the plant | • Council has limited say in the design and operation of the facility and could be left with having to purchase an asset at its residual value that may no longer be fit for purpose. | Appropriate. | Appropriate. | Not recommended as the capex required is low and it is mostly operating equipment such as loaders and screens which are more appropriately owned by the operator. The operation could take place on Council land if an |

| Description | Pros | Cons | Covered Windrow | AD | Vermicomposting |
|---|---|---|---|---|---|
| | | | | | appropriate site is available. |
| **Full Private Ownership** | • No capital expenditure is required by the Councils.<br>• Council carries no risk. Council is able to enter into shorter term arrangements which provides flexibility in the event that requirements change over time.<br>• Potential to make use of/enable the expansion/upgrading of existing facilities. | • Council has no say in the location, design and operation of the facility, or what happens to the product.<br>• Council may be a price-taker unless the tonnages offered are significant in the context of the facility. | May be appropriate if a facility that fully meets the Councils requirements is available | May be appropriate if a facility that fully meets the Councils requirements is available | Appropriate where a facility that meets the Councils requirements is available |

The above analysis suggests that Vermicomposting is likely to be best suited to a private ownership model, while DBO, DBFO, BOO and BOOT models are likely to be best for invessel composting facilities, and BOO or BOOT best for Anaerobic Digestion facilities. The actual model that is preferred will depend on a range of factors however, and there are likely to be circumstances where all models (including variations on the above or other models not considered here) may be appropriate.

#### 6.1.1.1 External Funding Sources

A further option that may be considered alongside the above is to apply for external funding to support capital investment – for example from the Waste Minimisation Fund. As noted earlier the Waste Minimisation Fund has specific funding set aside for supporting organic waste processing infrastructure. The MfE Website states that "Applications from multiple councils looking at shared services are encouraged and will be assessed favourably. We will consider the level of co-investment required on a case-by-case basis."[20]

The Bioresource Processing Alliance (BPA)[21] is an initiative funded by the Ministry of Business, Innovation and Employment. The BPA connects those developing value add processes in the bio-resource sector with researchers and development support. Funding for projects is available from $5,000 to around $800,000. The project must involve co-funding and developing innovative products or processes with interested organisations by using primary sector waste streams.

## 6.2 Creating Market Conditions

The other key aspect to promoting organic waste minimisation and recovery is taking a holistic and coordinated approach to creating the market conditions that will drive recovery activities. The desired outcome ultimately is for organic materials to be seen to have value and for there to be clear economic drivers for their recovery. While there are sufficient market drivers for recovery of substantial quantities of organic wastes, there are still some areas where the drivers are not sufficient. The key elements to create more conducive market conditions which the Councils can influence include:

- Landfill pricing – including differential pricing for organics
- Landfill acceptance
- Transfer station pricing – including differential pricing for organics
- Introduction and alignment of bylaw conditions including bans on materials, restrictions on domestic bin sizes etc.
- Tightening up and consistent enforcement of consent conditions in particular around industrial monofills

[20] https://environment.govt.nz/what-you-can-do/funding/waste-minimisation-fund/funding-for-councils-for-kerbside-organic-waste-collection-services/
[21] http://bioresourceprocessing.co.nz/

- Drawing links in regional plans between soil and water quality and the ability to improve soil structure and reduce nutrient runoff through application of organic soil amendments.

We note the work being done on opportunities for greater utilisation of organic wastes within the Nelson-Tasman area.

There are a range of processing options potentially available in proximity to Nelson & Tasman, that are either already in operation or expected to be in operation prior to Nelson & Tasman introducing a food waste collection. All of the facilities noted below are able to accept food waste from household collections.

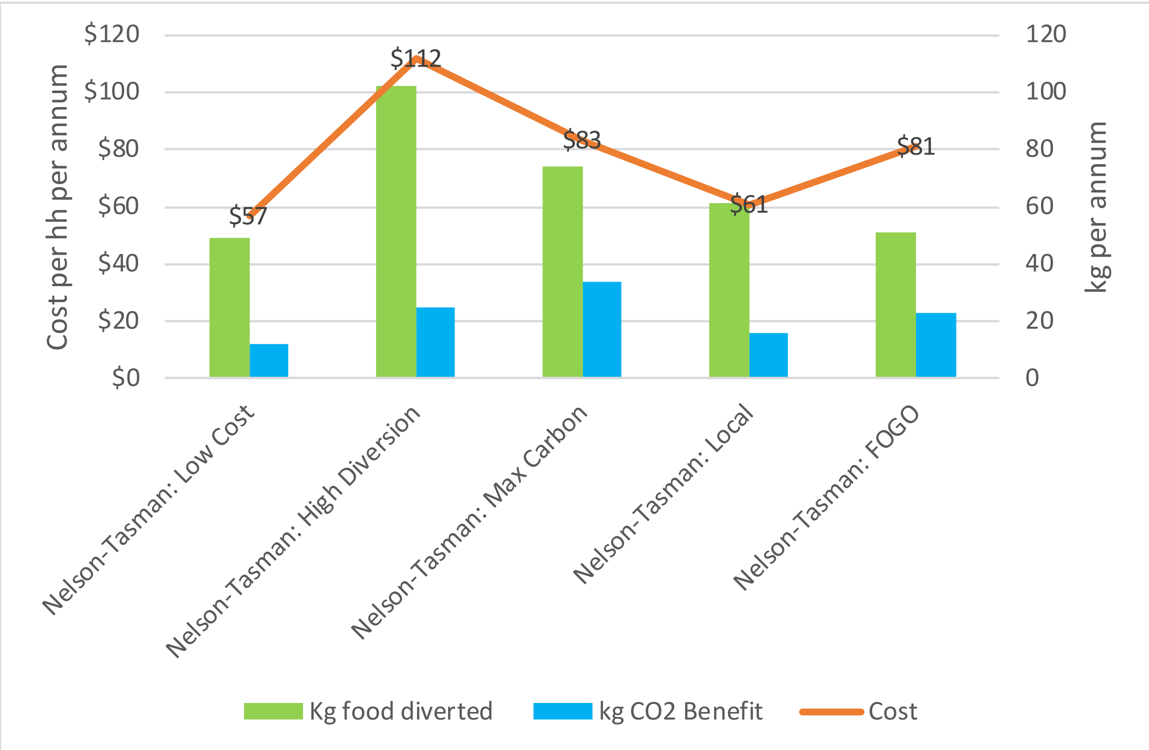
# 7.0 Summary

## 7.1 Cost Modelling

This section provides an overview of the outcomes of the modelling exercise and shows how the different results fit together.

The chart below summarises the cost and waste diversion performance the options modelled.

**Figure 12: Per Household Cost, Recovery and Carbon Reduction**




The key findings of the modelling are:

1. Collection costs make up the majority of costs across all the services.

2. The modelling suggests that services are likely to cost between $57 per household and $112 per household depending on the standard of service specified.
3. The Low Cost scenario has the lowest cost overall but also the lowest level of food waste recovery and carbon reduction.
4. The Local scenario costs around 7% more but also delivers 25% greater reduction in food waste to landfill and 32% more carbon savings.
5. The Maximum Carbon Reduction scenario costs 47% more than the Low Cost scenario but delivers 50% more food waste reduction and 187% more carbon savings.
6. The High Diversion scenario costs 97% more than the Low Cost scenario but delivers 108% more food waste diversion and 112% more carbon savings.
7. The FOGO scenario costs 43% more than the Low Cost scenario but delivers 4% more food waste diversion and 93% more carbon savings.

## 7.2 Indicative Capital Costs for Processing

As can be seen from the table below there is a wide variation in the expected capital costs between different processing technology options.

**Table 13: Summary of Indicative Capital Costs for Processing Facilities**

| Capacity | 5,000 tpa | 10,000 tpa | 15,000 tpa | 20,000 tpa | 30,000 tpa |
|---|---|---|---|---|---|
| Covered Windrow | $2,777,340 | $3,350,988 | $4,716,156 | $5,289,804 | $6,325,860 |
| AD | | $12,728,700 | $15,431,316 | $18,434,412 | $21,739,134 |
| Vermi-composting | $1,455,540 | $1,547,388 | $1,770,756 | $1,862,604 | $2,007,060 |

AD is by some distance the most expensive option in terms of capital cost, with covered windrow having moderate expenditure and vermicomposting relatively low capex requirements.

It should be noted that the capital requirements do not necessarily result in significantly different processing costs. While AD would be expected to be the most expensive option, followed by Covered Windrow, and then vermicomposting, the operating costs and the value of the product tend towards the inverse of the capital costs and result in the gate fees being broadly competitive.

Our analysis of the different procurement arrangements highlights and number of different advantages for each approach. It is likely that some level of Council capital investment and control will be advantageous for AD and covered windrow technologies, but for vermicomposting, because capital requirements are low, the best option could simply involve provision of a site.

# A.1.0 Organic Waste Processing Technologies Considered

This Appendix provides a brief overview of the key aspects of the technologies considered in this report.

## A.1.1 Aerated Static Pile Composting

Aerated Static Pile composting involves forcing air into windrows to maintain oxygen levels and help control temperature and moisture. This can be done by laying the compost over pipes that have holes along their length or over a concrete pad which has aeration holes in the base.

Static composting (as opposed to regular turning) in piles and rows requires mechanical aeration, and the windrows or piles are also usually covered with dry organic matter or with an artificial cover. Aeration and covering increases the cost of processing; however, a covered, static, aerated process is more suitable for putrescible wastes than standard windrow composting, as odour issues are more easily controlled, and the composting process can be faster. Negative pressure can also be used to capture air flows, which can then be treated to remove any odours.

Aerobic methods usually require a mix of at least 50% garden waste or similar bulking agent (such as woodchips) to achieve the correct Carbon-Nitrogen balance and moisture content, but to avoid operational issue most operators would aim for a much higher ratio of garden waste (e.g. 70%). It there is too much food waste the not enough air can get into the middle of the piles and the composting can become anaerobic and be very odorous.

### A.1.1.1 Example processors:

- Waste Management (Timaru)
- EnviroWaste (Hampton Downs)

## A.1.2 Anaerobic Digestion

### A.1.2.1 Description

Anaerobic digestion (AD) involves the biological degradation of organic material in the absence of oxygen, often with the addition of water to turn the waste into a slurry. ‘Biogas’ is generated, which is a mixture of carbon dioxide and methane, with trace amounts of less pleasant compounds. Methane can be used to generate energy. It can either be used directly, for the production of electricity and/or heat, or it can be purified and compressed to power vehicles. When the gas is burned, methane is converted to carbon dioxide, and some acid gases (sulphur dioxide and nitrogen). Newer applications include its use in stationary fuel cells.

There are a number of options for the design of digesters; they can be either:

- Mesophilic (35 - 40 °C) or thermophilic (50 - 55°C);
- Dry (> 15 % dry solids) or wet (< 15 %);
- Two phase (acidification + methanisation) or single phase (combined);
- Codigestion (solid waste + other substrate) or solid waste digestion (only waste);
- Mixed/residual waste (no separate collection) or biowaste only (separate collection of organics), though the rest of this section concentrates on the latter only.

After the digestion process has finished, a residue remains which can either be:

- Spread directly on land; though there may be good reasons for caution in this respect (related to the activity in the remaining material, and its potential to be phytotoxic);
- Pressed to separate the liquid and solid, with the liquid being used as fertiliser and the solid being further 'matured' (composted) to stabilise the product for use as compost; and
- Pressed to separate the liquid and solid, with the liquid being treated (as waste water) and the solid being further 'matured' (composted) to stabilise the product for use as compost.

Some of the liquid can usually be usefully recirculated in the process.

Anaerobic digestion processes require some energy input. However, they can also generate energy on-site, meaning that the heat generated by combustion of biogas can be used to power the process (which requires elevated temperatures to operate). Generally, studies highlight the benefits of anaerobic digestion relative to composting, but digestion processes are not so well suited to treating lignin-rich biowastes, such as most woody materials and some types of paper and board.

### Table 14: Typical Composition of Biogas

| Compound | Formula | % |
|---|---|---|
| **Methane** | $CH_4$ | 50–75 |
| **Carbon dioxide** | $CO_2$ | 25–50 |
| **Nitrogen** | $N_2$ | 0–10 |
| **Hydrogen** | $H_2$ | 0–1 |
| **Hydrogen sulfide** | $H_2S$ | 0–3 |
| **Oxygen** | $O_2$ | 0–0 |

Source: *www.kolumbus.fi, 2007*[95]

Traditionally, digestion processes have been considered as more expensive than composting processes. However, the gap between the two appears to be converging with improvement in process controls, and the introduction of tighter process control measures for facilities processing putrescible wastes.

#### A.1.2.2 Example suppliers

- EcoGas (Reporoa)
- Alimentary Systems

#### A.1.2.3 Waste stream suitability

**Food wastes.** Highly suitable. The high moisture and nitrogen content means this stream is well suited to digestion. Contamination with plastic bags and solids (e.g. bones) can create operational difficulties in some processes. The high salt content of food waste can lead to issues in the use of outputs if these are not diluted.

**Mixed waste**. International facilities are operating successfully as part of a broader MBT operation.

**Wood wastes**. Notwithstanding the particle size and moisture content of wood falling far outside the acceptance criteria of AD facilities, the lignin within wood's cellular structure means this material is particularly slow to degrade and not of use for such an application.

**Organic sludges**. Highly suitable; good track record with large number of facilities operating internationally on a wide range of organic wastes and sludges from domestic, commercial and industrial sources. Organic waste types include biosolids, dairy shed effluent, manures, and food processing wastes.

### A.1.3 Vermicomposting

Vermicomposting uses special worms (usually Tiger Worms, *Eisenia foetida*) to process organic material (mainly softer organic wastes) and produce a high-quality soil amendment product. When the waste material passes through the worms' gut the nutrients become more bio-available, with many times more (for example) nitrogen and phosphorous available than normal topsoil. Where the product is of high quality the output can be sought after by farmers and market gardeners who may pay a significant premium[22]. Worm composting is also a promoted option for home composting, particularly suited to households with small sites or limited amounts of green waste.

Worms used for commercial vermicomposting are housed in beds which can be either enclosed or set up as open windrows. The worms feed on a layer of slightly decomposed

[22] Personal communication with Colin McPike, Organic Waste Solutions; a vermicomposting operation within the Bay of Plenty, New Zealand currently charges up to NZ$350 per tonne.

material 5 to 10cm below the surface, leaving behind the 'castings' which are a rich soil-like substance.  Most worm farms are fed with layers of material at the top and worm castings are harvested at the bottom (although there are variations on this theme such as a horizontal continual flow system).  Worm farms can also produce a liquid (vermi-liquid or worm tea) which can be diluted about 1:8 and used as a direct application plant food.  Many medium-scale commercial operators carefully balance the inputs to their vermicomposting systems to minimise liquid outputs and may add liquid back to the system to be fully processed by the worms.

Vermicomposting produces a higher nutrient value product than standard composting processes as described above.  It also reduces the volume of the waste by up to two thirds, compared to composting which can reduce volume by one third.

New Zealand is among those at the forefront of using vermicomposting at commercial scale, largely led by Waikato based Noke.  Vermicomposting is most suitable for high nutrient value waste streams, such as sewage sludge, primary processing wastes, and kitchen wastes; where it is desirable to add value to the materials.  Worm farms are also used in on site commercial and institutional applications such as restaurants, schools, community gardens, kennels, stables, and zoos.

A potential issue with vermicomposting is pathogens, particularly if biowastes are included in the feedstock.  Conventionally killing pathogens that may be contained in organic wastes requires temperatures of at least 55°C for three days, which cannot be achieved in normal vermicomposting (as this would kill the worms).  Trials and research indicate however that when material is passed through the worm's gut this is sufficient to kill pathogens and acceptable rates of pathogen destruction can be achieved through vermicomposting without needing to heat treat material.

High temperatures are also required to kill many weed seeds and some plant seeds.  To resolve this issue, some kind of heat treatment process may be required to ensure that the highest value product can be realised.  Normally this would increase the cost of vermicomposting as an overall process.

Odour can be an issue with vermicomposting if the process and mix is not carefully controlled.  This depends on the feedstock to a large extent, ensuring proper aeration through the use of bulking agents, and the ideal mix of nitrogen and carbon in the feedstock minimises this risk.  Other options for odour control include covering the waste with dry organic matter or an artificial cover and ensuring that there is sufficient distance between the processing site and any sensitive receptors.

Vermicomposting reduces waste going to landfill, improves soil fertility and productivity and avoids the production of methane.  However, worms produce Nitrous Oxide (NOx) which as a greenhouse gas is up to 300 times more powerful than CO2.[23]  While this is

[23] James Frederickson, Graham Howell (2002) *Large-scale vermicomposting: emission of nitrous oxide and effects of temperature on earthworm populations:* The 7th international symposium on earthworm ecology · Cardiff · Wales ·

potentially of concern from a greenhouse gas perspective, indications are that emissions to the atmosphere of NOx from within a vermicomposting ecology are not of concern as the layers of mulch on the top of the vermicomposting beds act as a biofilter, and that vermicomposting may even reduce NOx emissions compared to composting.[24]

#### A.1.3.1 Example Suppliers

- Noke
- Revital
- EnviroWaste

#### A.1.3.2 Waste Stream Suitability

Organic waste streams most suitable to vermicomposting include biosolids, food wastes, sludges, and some pre-consumer food processing waste; although these wastes are usually combined with a bulking and carbon-rich material to ensure best operation. Worms are relatively sensitive to the types of feedstock and careful blending of materials is required to avoid stressing or killing the worms, or ending up with retained unprocessed organic waste. Small quantities of bulking agents (up to 30 percent) are required for food waste to avoid the process becoming anaerobic. Worms are usually fed a pre-processed mixture of organic materials – either pre-composted material or raw material that has been blended to ensure the right pH and moisture balances, aeration structure and carbon to nitrogen ratio (20-25:1).

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24 https://www.researchgate.net/publication/306128308_Vermicomposting_as_a_technology_for_reducing_nitrogen_losses_and_greenhouse_gas_emissions_from_small-scale_composting

# A.2.0 Specialist Organic Waste Operators

## A.2.1Noke

Noke specialises in processing organic wastes through vermicomposting.  The company operates several large-scale vermicomposting operations around New Zealand alongside a number of smaller sites.  These sites process food waste, industrial processing waste, and/or sludges/biosolids.  It is under.

Noke is actively pursuing new locations around New Zealand and has established a detailed evidence base for the quality of its end product as a soil amendment product. The product has also been shown to meet the highest WaterCare testing standards, even when sewerage sludges/biosolids are incorporated.

Vermicomposting is a type of aerobic composting process, which is accelerated by the use of large populations of two specific types of worms which naturally specialise in breaking down putrescible organic wastes with high nitrogen content (as opposed to carbon-heavy organic wastes, such as green waste).  Vermicomposting is able to accept virtually all food wastes including cooked food, dairy, meat, bones, and fish.

Vermicomposting in general is a fairly low-cost operation, with the exception of land.  As the vermicomposting process takes time, and the end product benefits from maturation, processing large quantities of organic wastes requires significant space.

The end product however is a very nutrient-dense product, and the types of nutrients (particularly nitrogen) are provided in bio-available forms that are not water soluble, meaning that nitrogen can be added to the soil in a form that can readily be used by plants and will not be lost in the next rainfall.

Unless the product is taken through a hot aerobic composting stage (see below for description), the process is not capable of processing organic wastes that are not a natural part of the worm’s diet.  This includes compostable caddy liners, which would be removed as a contaminant and would either be landfilled or would need to be sent to another site for processing.

The process benefits from the addition of some bulky carbon-heavy wastes to provide structure to the vermicomposting windrows such as shredded cardboard or greenwaste.

The estimated processing cost per tonne for the purposes of this project is $100 per tonne, excluding transport.

## A.2.2EcoGas

EcoGas is a partnership between Pioneer Energy and EcoStock.  EcoGas have recently opened the first large-scale AD plant in New Zealand.  This facility, located in Reporoa, accepts food waste collected in Auckland (currently rolling out).

EcoGas is actively investigating other locations around New Zealand; however, anaerobic digestion plants require highly engineered plant and equipment to operate effectively and so are usually constructed as large-scale regional facilities rather than smaller local facilities to take advantage of economies of scale.

In an AD facility, a wide range of organic wastes are encouraged to degrade anaerobically (without oxygen) in contained systems. This enables the methane and other gases produced during anaerobic decomposition to be captured and used to create electricity and/or heat. For this reason, AD facilities are usually co-located with high users of one or both outputs. In the case of Reporoa, the facility is located next to a large Turners & Growers greenhouse. The biogas produced will be used to heat the greenhouses, and the $CO_2$ from the combustion process will be used in the greenhouses to stimulate plant growth.

The other output from AD is a solid and/or liquid by-product known as 'digestate'. This contains a lot of nutrients from the organic waste and can be used as a soil amendment; although it can benefit from some further processing to maximise the quality of the product (such as windrow composting). At present there is limited experience using digestate on soils in NZ (although there is significant experience internationally), and the digestate is not at this time considered to have a commercially viable market. However, it is understood that EcoGas is working with local farmers to test product and develop local markets.

# A.3.0 Carbon Calculations

## A.3.1 Emissions from Transport

Emissions from transport were based on the numbers of kms travelled per annum for each vehicle multiplied by the total number of vehicles (non-integer) to derive total kms travelled per annum. Per kilometre carbon emission factors for vehicles were obtained from Ministry for the Environment's summary of emission factors.[25] The following factors were used:

| | Vehicle | $kgCO_2$ per km |
|---|---|---|
| **Collections** | Post 2015 7.5t -10t HGV diesel vehicles | 0.583 |
| **Collections (EV)** | Post 2015 7.5t -10t HGV BEV (battery electric vehicle) | 0.062 |
| **Bulk transport** | Post 2015 15t -20t HGV diesel vehicles | 0.955 |

## A.3.2 Avoided Landfill Emissions

Avoided landfill emissions were calculated by multiplying the tonnes of avoided disposal by the landfill emission factor. Food waste to landfill has a Unique Emissions Factor (UEF) of 1.26.[26] That is, every tonne of food waste landfilled generates the equivalent of 1.26 tonnes of $CO_2$. This figure was calculated based on an assumed global warming potential (GWP) of methane of 25. That is, a tonne of methane has the same impact over 100 years as 25 tonnes of $CO_2$. However, the GWP of methane has recently been revised upwards by the IPCC to 28-36.[27] To account for this upward revision we assumed a mid-point GWP of 32 and adjusted the UEF of food waste to 1.61[28].

However, landfills can capture much of this gas. We used three figures in the modelling:

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[25] Ministry for the Environment. 2022. Measuring emissions: A guide for organisations: 2022 summary of emission factors. Wellington: Ministry for the Environment. Table 26.

[26] https://www.legislation.govt.nz/regulation/public/2009/0286/latest/whole.html#DLM3515125

[27] Methane and climate change – Methane Tracker 2021 – Analysis - IEA

[28] (1.26/25 x 32)

- 77% which is the actual landfill gas capture for York Valley based on current landfill composition and gas capture rates[29];
- 90% which is the gazetted landfill gas capture figure in 2023 by York Valley Landfill[30], and;
- 68% which is the figure used by the climate change commission for landfill gas capture in NZ and is used here as a proxy for lifetime gas capture.[31]

In addition to estimating the landfill gas capture we also took into account that the landfill can use the captured methane to generate electricity, flare it, or use it for other beneficial use. We allowed for a 40% efficiency in the generators, where gas is being used for electricity generation (as opposed to being flared), and for this to offset electricity from the grid which has a carbon intensity of 0.1kg/$CO_2$ per kWh[32]. For natural gas substitution and figure of 0.195kg $CO_2$/kWh was used[33] For coal a figure of 2.01kg $CO_2$/kg coal as used.[34]

### A.3.3 Energy Generation from Biogas

We assumed that for food waste sent to AD the biogas captured would be put to use as a substitute for natural gas in heating greenhouses.  Based on an assumed biogas methane content of 65% and approximately 123$m^3$ of gas being generated per tonne of food waste in the order of 80$m^3$ of methane would be generated per tonne of food waste.  Each cubic meter of methane was assumed to generate approximately 37Mj of heat energy.  A figure of 54 kg/$CO_2$ per GJ of energy for natural gas was used[35] to calculate the avoided $CO_2$ emissions from natural gas.

[29] Figure of 77% net gas capture and destruction provided by Tonkin + Taylor via e-mail 21 September 2023.

[30] Notice of Approval of Unique Emissions Factors - 2023-au3444 - New Zealand Gazette

[31] CCC - He Pou a Rangi the Climate Change Commission. Ināia tonu nei: a low emissions future for Aotearoa May 2021, p125

[32] Ministry for the Environment. 2022. Measuring emissions: A guide for organisations: 2022 summary of emission factors. Wellington: Ministry for the Environment. Table 9

[33] Ministry for the Environment. 2022. Measuring emissions: A guide for organisations: 2022 summary of emission factors. Wellington: Ministry for the Environment. Table 3

[34] Ministry for the Environment. 2022. Measuring emissions: A guide for organisations: 2022 summary of emission factors. Wellington: Ministry for the Environment. Table 3

[35] Ministry for the Environment. 2022. Measuring emissions: A guide for organisations: 2022 summary of emission factors. Wellington: Ministry for the Environment. Table 3

### A.3.1 Carbon Benefits from Use as Soil Amendment

A figure of 60 kg $CO_2$e benefit per tonne of food waste for compost and 74kg per tonne of food waste was used to calculate the benefit of use as a soil amendment.[36] This calculation takes into account the benefits from carbon sequestration in soil as well as avoided use of fertilisers.

[36] Eunomia (2019). Waste Strategic Options Development – TECHNICAL APPENDICES Prepared for Darebin City Council

# A.4.0 Cost Modelling Detail

## A.4.1: Total Costs

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| Collection | $1,925,080 | $3,685,407 | $2,716,534 | $2,021,610 | $2,257,612 |
| Containers | $294,844 | $736,819 | $527,316 | $364,106 | $365,867 |
| Processing | $257,454 | $445,851 | $386,181 | $268,181 | $910,664 |
| **TOTAL** | **$2,477,378** | **$4,868,077** | **$3,630,031** | **$2,653,898** | **$3,534,143** |
| | | | | | |
| **Food waste cost per hh served** | **$56.95** | **$111.91** | **$83.45** | **$61.01** | **$81.24** |
| Cost per collection | $1.10 | $1.08 | $1.60 | $1.17 | $1.56 |
| Cost per tonne food scraps | $1,154.71 | $1,091.86 | $1,127.98 | $989.59 | $1,647.27 |

## A.4.2: Tonnages

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| Food Waste Tonnes | 2,145 | 4,459 | 3,218 | 2,682 | 2,145 |
| Garden Waste Tonnes | 0 | 0 | 0 | 0 | 6,961 |
| **TOTAL Tonnes** | **2,145** | **4,459** | **3,218** | **2,682** | **9,107** |
| | | | | | |
| **Food scraps kg/hh served** | **49** | **102** | **74** | **62** | **51** |
| | | | | | |
| Cost per kg per hh | $1.15 | $1.09 | $1.13 | $0.99 | $1.59 |

## A.4.3: Carbon Emissions (77% Landfill Gas Capture)

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| Total transport emissions | 157 | 307 | 95 | 158 | 155 |
| Avoided landfill emissions | -796 | -1,654 | -1,194 | -995 | -1,334 |
| Tonnes CO2 redirected from beneficial us | 57 | 119 | 86 | 72 | 57 |
| Avoided emssions from beneficial use | | | -518 | | |
| Compost benefit | -129 | -268 | -238 | -161 | -194 |
| **TOTAL CO2 IMPACT** | **-710** | **-1,495** | **-1,769** | **-926** | **-1,316** |
| kg/CO2 benefit per hh served | 11.86 | 25.11 | 33.99 | 15.71 | 22.86 |

## A.4.1Carbon Emissions (LFG Replaces Coal)

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| Total transport emissions | 157 | 307 | 95 | 158 | 155 |
| Avoided landfill emissions | -796 | -1,654 | -1,194 | -995 | -1,334 |
| Tonnes CO2 redirected from beneficial us | 1,396 | 2,902 | 2,094 | 1,745 | 2,104 |
| Avoided emssions from beneficial use | | | -2,720 | | |
| Compost benefit | -129 | -268 | -238 | -161 | -194 |
| **TOTAL CO2 IMPACT** | **629** | **1,288** | **-1,963** | **748** | **731** |

## A.4.2: Capex

### A.4.2.1 Covered Windrow Composting (by facility - size tonnes per annum)

| | **5,000** | **10,000** | **15,000** | **20,000** | **30,000** |
|---|---|---|---|---|---|
| **Capex** | | | | | |
| Concrete pad | $76,500 | $153,000 | $229,500 | $306,000 | $459,000 |
| Aeration equipment (blowers, piping, installatior | $25,000 | $50,000 | $75,000 | $100,000 | $150,000 |
| Covers | $250,000 | $500,000 | $750,000 | $1,000,000 | $1,500,000 |
| Biofilter | $100,000 | $125,000 | $150,000 | $175,000 | $200,000 |
| Bunkers for storage | $24,000 | $24,000 | $33,600 | $33,600 | $38,400 |
| Paving and roading | $10,800 | $14,400 | $18,000 | $21,600 | $28,800 |
| Fencing | $27,300 | $36,400 | $45,500 | $54,600 | $72,800 |
| | | | | | |
| **Ancilarly Equipment** | | | | | |
| Loader | $350,000 | $350,000 | $700,000 | $700,000 | $700,000 |
| Shredder | $400,000 | $400,000 | $600,000 | $600,000 | $600,000 |
| Trommel screen | $250,000 | $250,000 | $350,000 | $350,000 | $350,000 |
| | | | | | |
| **Site works** | *500* | *700* | *900* | *1,100* | *1,500* |
| Site preparation | $8,350 | $11,690 | $15,030 | $18,370 | $25,050 |
| drainage | $57,500 | $80,500 | $103,500 | $126,500 | $172,500 |
| Leachate collection and treatment | $30,000 | $40,000 | $50,000 | $60,000 | $60,000 |
| Truck wash | $5,000 | $5,000 | $5,000 | $5,000 | $5,000 |
| Equipment shed (3 sided) | $51,250 | $51,250 | $51,250 | $51,250 | $51,250 |
| Admin building | $83,750 | $83,750 | $83,750 | $83,750 | $83,750 |
| Power | $5,000 | $5,000 | $5,000 | $5,000 | $5,000 |
| Water and services | $10,000 | $12,500 | $15,000 | $17,500 | $20,000 |
| | | | | | |
| Weighbridge | $200,000 | $200,000 | $200,000 | $200,000 | $200,000 |
| Weighbridge installation | $50,000 | $50,000 | $50,000 | $50,000 | $50,000 |
| | | | | | |
| Design and engineering | $100,000 | $125,000 | $150,000 | $175,000 | $200,000 |
| Consenting | $200,000 | $225,000 | $250,000 | $275,000 | $300,000 |
| | | | | | |
| **CAPEX SubTOTAL** | **$2,314,450** | **$2,792,490** | **$3,930,130** | **$4,408,170** | **$5,271,550** |
| **Ancillary and contingency** | **$462,890** | **$558,498** | **$786,026** | **$881,634** | **$1,054,310** |
| **CAPEX TOTAL** | **$2,777,340** | **$3,350,988** | **$4,716,156** | **$5,289,804** | **$6,325,860** |

## A.4.2.2 Anaerobic Digestion (by facility - size tonnes per annum)

| | 10,000 | 15,000 | 20,000 | 30,000 |
|---|---|---|---|---|
| **Capex** | | | | |
| **Maturation composting** | | | | |
| Concrete pad | $153,000 | $229,500 | $306,000 | $459,000 |
| Aeration equipment (blowers, piping, installatior | $50,000 | $75,000 | $100,000 | $150,000 |
| Covers | $200,000 | $300,000 | $400,000 | $600,000 |
| Biofilter | $125,000 | $150,000 | $175,000 | $200,000 |
| Bunkers for storage | $24,000 | $33,600 | $33,600 | $38,400 |
| Paving and roading | $9,600 | $10,800 | $12,000 | $12,000 |
| Fencing | $27,300 | $32,760 | $38,220 | $43,680 |
| | | | | |
| **Buildings** | | | | |
| Reception shed | $360,000 | $360,000 | $360,000 | $360,000 |
| Plant building | $1,475,000 | $1,843,750 | $2,212,500 | $2,212,500 |
| Dewatering building | $360,000 | $360,000 | $360,000 | $360,000 |
| | | | | |
| **Equipment** | | | | |
| Decontamination | $100,000 | $100,000 | $100,000 | $100,000 |
| Pulper | $1,920,000 | $2,400,000 | $3,000,000 | $3,750,000 |
| Digester | $3,840,000 | $4,800,000 | $6,000,000 | $7,500,000 |
| Scrubber and ventilation | $1,280,000 | $1,600,000 | $2,000,000 | $2,500,000 |
| Storage tanks | $960,000 | $1,200,000 | $1,500,000 | $1,875,000 |
| Dewatering | $300,000 | $325,000 | $350,000 | $375,000 |
| Energy recovery | $640,000 | $800,000 | $1,000,000 | $1,250,000 |
| | | | | |
| **Ancilarly Equipment** | | | | |
| Loader | $350,000 | $350,000 | $437,500 | $525,000 |
| Shredder | | | | |
| Trommel screen | $250,000 | $350,000 | $350,000 | $350,000 |
| | | | | |
| **Site works** | *500* | *600* | *700* | *800* |
| Site preparation | $8,350 | $10,020 | $11,690 | $13,360 |
| drainage | $57,500 | $69,000 | $80,500 | $92,000 |
| Leachate collection and treatment | $40,000 | $50,000 | $60,000 | $60,000 |
| Truck wash | $5,000 | $5,000 | $5,000 | $5,000 |
| Equipment shed (3 sided) | $51,250 | $51,250 | $51,250 | $51,250 |
| Admin building | $83,750 | $83,750 | $83,750 | $83,750 |
| Power | $5,000 | $5,000 | $5,000 | $5,000 |
| Water and services | $12,500 | $15,000 | $17,500 | $20,000 |
| | | | | |
| Weighbridge | $100,000 | $100,000 | $100,000 | $100,000 |
| Weighbridge installation | $50,000 | $50,000 | $50,000 | $50,000 |
| | | | | |
| Design and engineering | $125,000 | $150,000 | $175,000 | $200,000 |
| Consenting | $525,000 | $550,000 | $575,000 | $600,000 |
| | | | | |
| **CAPEX SubTOTAL** | **$13,487,250** | **$16,459,430** | **$19,949,510** | **$23,940,940** |
| **Ancillary and contingency** | **$2,697,450** | **$3,291,886** | **$3,989,902** | **$4,788,188** |
| **CAPEX TOTAL** | **$16,184,700** | **$19,751,316** | **$23,939,412** | **$28,729,128** |

### A.4.2.3 Vermicomposting (by facility - size tonnes per annum)

| | 5,000 | 10,000 | 15,000 | 20,000 | 30,000 |
|---|---|---|---|---|---|
| **Capex** | | | | | |
| Concrete pad | | | | | |
| Aeration equipment (blowers, piping, installation) | | | | | |
| Covers | | | | | |
| Biofilter | | | | | |
| Bunkers for storage | $24,000 | $24,000 | $33,600 | $33,600 | $38,400 |
| Paving and roading | $10,800 | $14,400 | $18,000 | $21,600 | $28,800 |
| Fencing | $27,300 | $36,400 | $45,500 | $54,600 | $72,800 |
| | | | | | |
| **Equipment** | | | | | |
| Loader | $350,000 | $350,000 | $350,000 | $350,000 | $350,000 |
| Shredder | | | | | |
| Trommel screen | $250,000 | $250,000 | $350,000 | $350,000 | $350,000 |
| | | | | | |
| **Site works** | *500* | *700* | *900* | *1,100* | *1,500* |
| Site preparation | $8,350 | $11,690 | $15,030 | $18,370 | $25,050 |
| drainage | $57,500 | $80,500 | $103,500 | $126,500 | $172,500 |
| Leachate collection and treatment | $30,000 | $40,000 | $50,000 | $60,000 | $70,000 |
| Truck wash | $5,000 | $5,000 | $5,000 | $5,000 | $5,000 |
| Equipment shed (3 sided) | $51,250 | $51,250 | $51,250 | $51,250 | $51,250 |
| Admin building | $83,750 | $83,750 | $83,750 | $83,750 | $83,750 |
| Power | $5,000 | $5,000 | $5,000 | $5,000 | $5,000 |
| Water and services | $10,000 | $12,500 | $15,000 | $17,500 | $20,000 |
| | | | | | |
| Weighbridge | $100,000 | $100,000 | $100,000 | $100,000 | $100,000 |
| Weighbridge installation | $50,000 | $50,000 | $50,000 | $50,000 | $50,000 |
| | | | | | |
| Design and engineering | | | | | |
| Consenting | $150,000 | $175,000 | $200,000 | $225,000 | $250,000 |
| | | | | | |
| **CAPEX SubTOTAL** | **$1,212,950** | **$1,289,490** | **$1,475,630** | **$1,552,170** | **$1,672,550** |
| **Ancillary and contingency** | **$242,590** | **$257,898** | **$295,126** | **$310,434** | **$334,510** |
| **CAPEX TOTAL** | **$1,455,540** | **$1,547,388** | **$1,770,756** | **$1,862,604** | **$2,007,060** |

## A.4.3: Collection Data

| | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|
| km travelled per vehcile | 28,220 | 29,234 | 48,621 | 27,039 | 28,916 |
| vehicles | 7.1 | 13.4 | 2.2 | 7.5 | 6.8 |
| Total km | 200,274 | 391,162 | 106,966 | 201,537 | 196,995 |
| | | | | | |
| EV Kms | | | 130,606 | | |
| EV vehicles | | | 6.4 | | |
| Km per vehicle | | | 20,407 | | |

## A.4.4: Container Capex Detail

| | Nelson-Tasman Baseline | Nelson-Tasman: Low Cost | Nelson-Tasman: High Diversion | Nelson-Tasman: Max Carbon | Nelson-Tasman: Local | Nelson-Tasman: FOGO |
|---|---|---|---|---|---|---|
| | | | | | | |
| Household numbers | 43,500 | 43,500 | 43,500 | 43,500 | 43,500 | 43,500 |
| Bin Costs | | | | | | |
| 23 Litre Roadsde Bin | $22 | $957,000 | $957,000 | $957,000 | $957,000 | |
| Kitchen Caddy | $8 | | $348,000 | $348,000 | $348,000 | $348,000 |
| 80L Wheeled bin | $45 | | | | | $1,957,500 |
| | | $957,000 | $1,305,000 | $1,305,000 | $1,305,000 | $2,305,500 |
| MfE Subsidy | | | | | | |
| 23 Litre Roadsde Bin | $15 | $652,500 | $652,500 | $652,500 | $652,500 | |
| Kitchen Caddy | $5 | | $217,500 | $217,500 | $217,500 | $217,500 |
| 80L Wheeled bin | $40 | | | | | $1,740,000 |
| Roll out Cost | | $50,000 | $50,000 | $50,000 | $50,000 | $50,000 |
| Net Capex | | $254,500 | $385,000 | $385,000 | $385,000 | $298,000 |
| | | $702,500 | $920,000 | $920,000 | $920,000 | $2,007,500 |