GRAMPIANS ORGANICS FEASIBILITY STUDY

Prepared for:

Northern Grampians Shire Council
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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Northern Grampians Shire Council (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

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610.30578-R01-v3.0	12 May 2022	Emerson Helmi Patch, Bithi Roy	Andrew Quinn	Chani Lokuge

EXECUTIVE SUMMARY

Project Drivers

The Grampians Central West region comprises 12 councils in Victoria, encompassing an area of over 50,000 km. The region covers about 21% of the state. In 2013-2014, the region generated approximately 492,000 t of waste, of which 66% was recovered and 34% was sent to landfill. The diversion of organics from landfill is a significant opportunity for the region to reduce the quantities of material going to landfill, which would help to increase the life of landfills and to reduce the greenhouse gas emissions that are generated from landfill by the decomposition of organics in particular.

The Victorian Government's *Recycling Victoria: a new economy* policy requires all local councils in Victoria to implement kerbside food and garden organics (FOGO) collections by 2030. The key driver is for the local government groups, like the Grampians Central West Waste and Resource Recovery Group, to come up with solutions that makes sense for their communities, that are financially and environmentally sustainable and provide a really clear direction for commercial players, local or otherwise, to understand what is required to be be provided and allow them to identify opportunities to align with the direction and required outcomes.

Northern Grampians Shire Council, on behalf of eight Grampians councils, Horsham Rural City Council, Yarriambiack Shire Council, Hepburn Shire Council, West Wimmera Shire Council, City of Ballarat, Central Goldfields Shire Council, Pyrenees Shire Council, and Northern Grampians Shire Council, commissioned SLR Consulting Australia Pty Ltd to investigate high level options for processing kerbside food organics and garden organics (FOGO) that the participating councils will be collecting. It describes the current landscape of organic material waste generation in the region, processing, current and potential future disposal pathways.

Research, Consultation, and Data Analysis

After undertaking research and consulting with stakeholders, data was analysed to establish quantities and sources of organics to estimate future waste generation trends. These were modelled over 20 years to 2040.

The data showed that 1,215,867 t of organics were generated in the region in 2020-2021. This included 29,101 t of FOGO, 2,187 t of biosolids, 6,107 t of forestry plantation from Central Highlands Water (CHW) and 1,178,472 t of commercial organics. Currently around 59% of FOGO is generated from the City of Ballarat. The analysis also forecast the total amount of waste generation in 2039-2040, which is estimated to be 1,506,812 t, and around 67% of potential FOGO is expected to come from the City of Ballarat.

The processing technologies for processing FOGO in the region are discussed in this report. These technologies include open windrow composting (OWC), in-vessel composting (IVC), vermicomposting, anaerobic digestion (AD), and thermal treatment. A high-level SWOT analysis was also conducted for the FOGO treatment technologies.

The potential markets for organics products, waste-to-energy and refuse derived fuel in the Grampians region were also investigated. The organic products could be compost, mulch, soil conditioner, or other products. Based on the estimated organics data for the region, it is predicted that the amount of composted materials is likely to increase over the next few years, thereby potentially creating an oversupply in the local market. Councils would need to closely monitor the demand for compost in the local region and adjust supply to meet the expected demand. Councils might also need to encourage agriculture and horticulture authorities to switch over into the new compost materials from traditional fertiliser / soil amendments.

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Options Assessment

One of the objectives of this project is to narrow down the options for further analysis. A 'long list' of 14 options was presented to Council during a workshop at the conclusion of the feasibility and market research stages. Further discussion on the long list can be found in Table 17. From these options, those selected for further analysis by the Client were:

- **Option 1**: Business as usual
- **Option 2**: FOGO composted at a large IVC near Ballarat. Three smaller IVCs at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 4**: FOGO composted at a new dry AD facility near Ballarat. Three smaller IVCs at other councils, such as, Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 5**: FOGO and biosolids composted at a new wet AD facility near Ballarat. Three smaller IVCs at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 8**: FOGO processed at one large pyrolysis facility near Ballarat and seven transfer stations for bulk haulage from other councils at Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort and Stawell.
- **Option 11**: FOGO composted at large OWC facility near Ballarat. Three smaller OWC facilities at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 13**: FOGO from all councils and a small proportion (approximately 2-5%) of the potentially available commercial organics, processing at a new IVC facility near Ballarat. Potential sources of commercial organics are McCains, Mars, and HPV plantation. All organics aggregated then bulk transported from other councils, near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell, to the facility at Ballarat.

Table 1 below shows the estimated total costs and benefits for each option over 20 years, from 2021-2022 to 2040-2041, and the net present value (NPV) based on 7% real discount rate. These figures take into account the construction and operating costs, and potential income.

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Table 1 Project life costs, benefit, and net present value

Item Description	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13*
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)
Total cost over 20 years	$94.2 m	$147.8 m	$211.8 m	$140.2 m	$169.1 m	$116.8 m	$262.8 m
Total capital costs over 20 years	$0.0 m	$22.9 m	$45.9 m	$29.3 m	$33.9 m	$9.7 m	$36.5 m
Total operational costs over 20 years	$94.2 m	$124.9 m	$165.9 m	$110.9 m	$135.2 m	$107.0 m	$226.2 m
Total income over 20 years	$28.1 m	$82.6 m	$86.0 m	$90.3 m	$28.5 m	$82.6 m	$315.3 m
Total value of landfill savings over 20 years	$133.7 m	$181.2 m	$174.5 m	$188.0 m	$185.0 m	$181.2 m	$345.1 m
Total benefit NPV	$31.2 m	$43.4 m	$1.3 m	$50.6 m	$4.6 m	$64.0 m	$196.8 m

* Option 13 includes commercial organics, along with kerbside FOGO, as feedstock for this option.

The table shows that Option 13 has the best net benefit among all the options. This is due to the inclusion of commercial organics, along with kerbside FOGO, as feedstock for this option. No agreements for the supply of commercial organics have been established. To make this option viable, access to the estimated quantities of commercial organic will need to be confirmed.

A multi-criteria assessment was undertaken for each of the short-listed options using a range of assessment criteria, discussed in Section 11. Scores were awarded based on relevant data provided to SLR throughout the project, augmented by publicly available information, SLR's internal databases and performed calculations.

Some of the key features considered for the assessment are:

- IVC is a proven mature technology. Compared to the other technologies, costs and emissions are relatively low for IVC. Moreover, there are no significant regulatory barriers for this technology.
- Although OWC is a proven mature technology, and cost is relatively low, this technology has some public health and environmental risks due to odour and leachate issues when processing food waste. It is unlikely that the EPA will approve OWC for food waste.
- Emissions are relatively low in anaerobic digestion, but it would take more planning and construction time than for pyrolysis and composting facilities. Dry anaerobic digestion is unproven for FOGO, while wet anaerobic digestion is not suitable for processing green organics.
- Thermal treatment, like pyrolysis, is an unproven technology for food organics processing. There are also some public health and environmental risks associated with emissions from the pyrolysis process.

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Table 2 and **Figure 1** below show the summary of multi-criteria analysis results.

Table 2 Multi-Criteria Analysis Summary

Criteria		Facility and Technology Criteria	Technical and General	Financial	Social	Environmental	Total	Rank
Weighting		20%	20%	25%	10%	25%	100%	
Option 1	Business as usual	0.52	0.59	0.75	0.18	0.38	2.41	6
Option 2	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	0.70	0.96	0.83	0.47	0.53	3.48	2
Option 4	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	0.63	0.84	0.65	0.46	0.53	3.10	5
Option 5	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	0.53	0.68	1.00	0.46	0.53	3.20	3
Option 8	7 Transfer stations, 1 Pyrolysis plant (FOGO)	0.43	0.59	0.65	0.24	0.48	2.38	7
Option 11	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	0.68	0.80	1.00	0.24	0.43	3.14	4
Option 13*	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	0.74	0.98	1.25	0.43	0.63	4.02	1

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* Option 13 includes commercial organics, along with kerbside FOGO, as feedstock for this option.

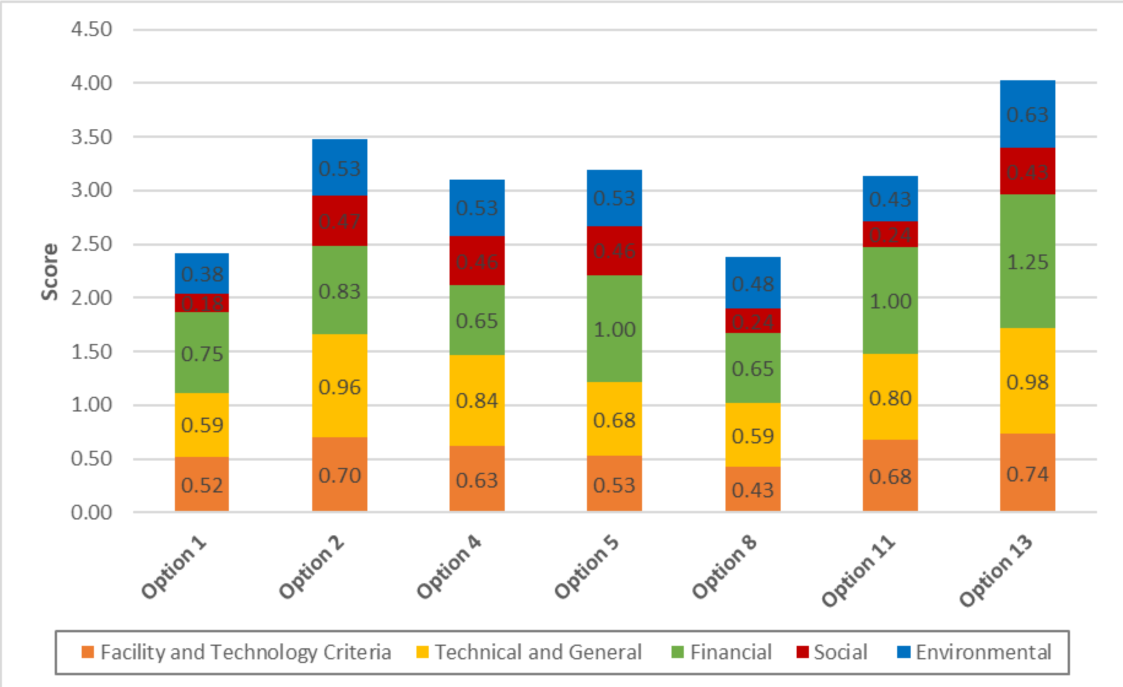

Figure 1 Multi-Criteria Analysis Summary Scores

Based on the assessment, Option 13, with one large IVC and seven transfer stations, has the highest score of all the short-listed options, followed by Option 2, with one large IVC, three small IVCs, and two transfer stations. The result for Option 13 is primarily due to the inclusion of commercial organics, along with kerbside FOGO, as feedstock. No agreements for the supply of commercial organics have been established. To make this option viable, access to the estimated quantities of commercial organic will need to be confirmed.

Next Steps

- Prepare a detailed timeline for future tasks
- Prepare a more detailed business case with more accurate costs and income
- Develop a community engagement strategy
- Investigate potential assistance from State Government and Office of Co-ordinator-General
- Undertake further investigations into the selected sites
- Undertake pre-lodgement discussions with councils and state agencies to choose an approvals pathway.
- Councils to take action to support development of markets for new compost products.

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Glossary

Term or Acronym	Definition
ACCUs	Australian carbon credit units
AD	Anaerobic digestion
ATT	Advanced thermal treatment
BaU	Business as usual
BNR	Biological Nutrient Removal
BOLT	Build, operate, lease and transfer
BOM	Build, own and maintain
BOO	Build, own and operate
BOOT	Build, own, operate and transfer
BSWWTP	Ballarat South Wastewater treatment plant
C&D	Construction and Demolition
C&I	Commercial and Industrial
Capex	Capital expenditure
CGSC	Central Goldfields Shire Council
CHW	Central Highlands Water
CPI	Consumer price index
D&C	Design and construct
DBFO	Design, build, finance and operate
DBMO	Design, build, maintain and operate
DCM	Design, construct and maintain
DCMO	Design, construct, maintain and operate
EfW	Energy from waste
EPA	Environment Protection Authority
EPAV	Environment Protection Authority Victoria
EPC	Engineering procurement and construction
FAST	Finance and Accounting Support Team
FOGO	Food organic and garden organics
GCWWRRG	Grampians Central West Waste and Resource Recovery Group
GHG	Greenhouse gas
GO	Garden organics
GWP	Global warming potential
IVC	In-vessel composting
JV	Joint venture
LCA	Life cycle assessment
LDO	Lease, develop and operate
LGCs	Large Scale Generation Certificates

Term or Acronym	Definition
LPG	Liquefied Petroleum Gas
MBT	Mechanical biological treatment
MCA	Multi-criteria analysis
MSW	Municipal Solid Waste
MWOO	Mixed waste organic output
NGSC	Northern Grampians Shire Council
NPV	Net present value
Opex	Operating expense
Organics	All organic materials arising from households and gardens, including food scraps as well as lawn clippings and garden prunings
OWC	Open windrow composting
PFAS	Per- and poly-fluoroalkyl substances
PPA	Power purchase agreement
PPP or P3	Public private partnership
RDF	Refuse derived fuel
Residual Waste	Non-recyclable waste
ROOT	Rehabilitate, own, operate and transfer
SPV	Special purpose vehicle
SRF	Secondary recovered fuel
SWRRIP	Statewide Waste and Resource Recovery Infrastructure Plan
WtGas	Waste to Gas
WWTP	Wastewater treatment plant

1 Introduction

1.1 Grampians Region

The Victorian Government's *Recycling Victoria: a new economy* policy requires all local councils in Victoria to implement kerbside food and garden organics (FOGO) collections by 2030. Northern Grampians Shire Council, on behalf of eight Grampians councils (the client) commissioned SLR Consulting Australia Pty Ltd (SLR) to investigate high level options for processing kerbside food and garden organics that the participating councils will be collecting. The participating councils are:

- Horsham Rural City Council,
- Yarriambiack Shire Council,
- Hepburn Shire Council,
- West Wimmera Shire Council,
- City of Ballarat,
- Central Goldfields Shire Council,
- Pyrenees Shire Council, and
- Northern Grampians Shire Council.

This report describes the current landscape of organic material waste generation in the region, existing processing infrastructure and potential future beneficial reuse pathways. The benefits of addressing organic waste material management through such an approach are myriad, including reducing greenhouse gas (GHG) emissions, conserving resources, easing pressure on ecological systems, lowering household and business costs, reducing food insecurity, conserving dwindling landfill space, creating new sustainable industries and jobs, and improving soil quality to enhance the agricultural lands that produce food in the first place.

Introducing FOGO without careful, holistic planning risks not only squandering many of these opportunities, but locking in less sustainable organic material management pathways.

1.2 Approach and Report Structure

The main steps undertaken to prepare this report are illustrated in **Figure 2**.

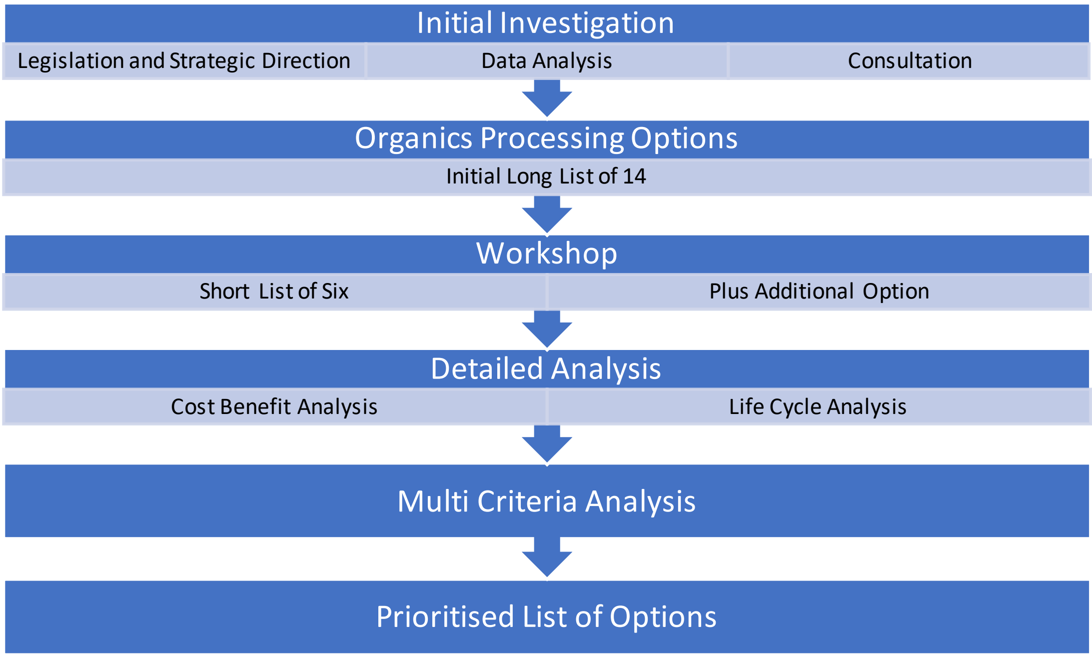

Figure 2 Process Flow Chart

The results from the initial investigation were used to develop the organics processing options. The findings of the legislation, policy, and guidelines (discussed in Section 2), council and industry conultation (discussed in Section 3 and Section 4), and data analysis (presented in Section 5) were used to prepare a 'long list' of 14 options for processing available organics (presented in Section 8). This long list was presented to Council during a workshop from where six options (including business as usual) were short listed and an additional option was subsequently selected for further detailed analysis. The life cycle assessment (discussed in Section 9) and cost benefit analysis (discussed in Section 10) were performed on the selected options. Multi-criteria analysis (MCA) was performed considering several factors including the results of LCA and cost benefit analysis. The results of MCA are presented in Section 11. The preferred list of options were recommended based on the outcome of the MCA.

2 Legislation, Policy, and Guidelines

2.1 Introduction

SLR has undertaken a review of current regional waste strategies and policies on waste collection, recycling, and disposal in the Grampians region. The purpose of these reviews was to identify key factors that are relevant to this study. This section contains an outline of the relevant legislation, policies, and guidelines.

2.2 National Legislation and Guidelines

2.2.1 National Waste Policy 2018

The National Waste Policy provides a national framework for waste and resource recovery in Australia. The latest National Waste Policy was published in 2018 and outlines roles and responsibilities for collective action by businesses, governments, communities, and individuals.

While the National Waste Policy provides guidance for collaboration among states, territories, businesses, and industry, it does not preclude these parties from implementing tailored waste and resource recovery solutions that respond to local and regional conditions.

The 2018 National Waste Policy refers to the Waste Hierarchy, recognises the need for Australia to shift towards a circular economy, and provides a framework for businesses to embrace innovation and adopt technologies that create new opportunities.

The objective of the National Waste Policy Action Plan 2019 is to guide investment and national efforts to 2030 and beyond by setting targets and actions to implement the 2018 National Waste Policy.

These targets include:

- Ban the export of waste plastic, paper, cardboard, glass and tyres from the second half of 2020
- Reduce total waste generation in Australia by 10% per person by 2030
- 80% average resource recovery rate from all waste streams following the waste hierarchy by 2030
- Significantly increase the use of recycled content by government and industry
- Phase out problematic and unnecessary plastics by 2025
- Halve the amount of organic waste sent to landfill for disposal by 2030
- Make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions.

The national waste policy framework prompts businesses and organisations to re-evaluate their waste management practices, pursuant to a growing need to increase domestic recycling and increased resource recovery to minimise environmental impacts. Accordingly, significant investment in developing new and modernising current waste infrastructure is required. This requires collective action from national, state, and local government, businesses, and the community. The potential diversion of organics made possible by this feasibility study can contribute to the targets set by the policy.

2.2.2 Federal budget 2021

In its 2021 budget, the Australian government committed $67 million to FOGO, including establishing the Healthy Soils Fund to divert 3.4 million tonnes of organics from landfill, including the establishment of the Food Waste for Health Soils Fund, aimed at diverting organic material from landfill to productive use in agricultural soils. Together with co-contributions from participating state and territory governments and industry, the Fund will leverage more than $170 million of investment to build new and improve existing organic waste recycling infrastructure to divert organic waste into nutrient-rich compost and soil enhancers. Funded facilities will increase the quantity and quality of recycled organic waste available for use especially in the agricultural industry.

The intake for funding will close on the 31 March 2022. Jurisdictions must partner with industry organisations to apply. Councils are considered to be an industry for the purposes of the funding. It is expected a similar round of funding will be available in the 2022 budget released in the week of 31 March. This will need to be confirmed.

Applications must:

- relate to a project to build processing capacity or improve product quality of processing recovered organic waste that is either:
  - a proposed new facility, or
  - an improvement or expansion of an existing facility.
- relate to a proposed project that is expected to be economically viable over its operational life.
- have the written support of the responsible state or territory minister, and industry partner(s) (evidence of this to be attached to the application).
- request Commonwealth funding for of less than or equal to one-third of the total cost of the projects with the remaining costs met by the state or territory government and industry partner(s) on a minimum 1:1:1 basis.
- relate to a project(s) that had a confirmed investment decision made after 15 April 2021 and will be commissioned and operational by 30 June 2025.

2.3 Victorian Legislation and Guidelines

Victoria recently released a suite of new legislation, regulations and guidelines which overhauled its environmental laws. On 1 July 2021 the amended *Environment Protection Act 2017* came into effect.

The following legislation and guidelines are reviewed below and have been listed in chronological order:

- *Environment Protection Act 2017*
- Victorian Environment Protection Authority (EPA) Energy from waste guideline 2017
- Statewide Waste and Resource Recovery Infrastructure Plan 2018
- Recycling Victoria - a new economy 2020
- Victorian Government waste to energy framework (Draft for consultation) June 2021.

2.3.1 Environment Protection Act 2017

The *Environment Protection Act 2017* (the Act) came into effect on 1 July 2021. Key to the new regime in Victoria is the introduction of the general environmental duty, which requires persons engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste, to minimise those risks, so far as reasonably practicable.

The Act allows for greatly increased fines, compared to the previous Act. This brings Victoria into line with other Australian jurisdictions. It also presents an overhaul of the waste regime, including a new system of priority and reportable priority wastes and changes to disposal categories and premises authorised to receive industrial waste. In relation to waste licences and operating licences, the Act contains transitional arrangements in relation to permissions held under the predecessor legislation which remain valid until 30 June 2022.

2.3.2 Recycling Victoria - a new economy 2020

The Victorian Government released the *Recycling Victoria: a new economy policy* in 2020 (The Policy). The Policy overhauls household recycling services, introduces a four stream service,[1] a container deposit scheme, rollout of FOGO service across all of Victoria by 2030 and establishes the new Waste Authority. The purpose of the Policy is to improve the value captured from the materials in Victoria and provides the opportunity to transition Victoria to a circular economy and provide long-term economic, social, and environmental benefits for the state.

The Policy sets the following targets:

- Divert 80% of waste from landfill by 2030, and an interim target of 72% by 2025.
- Cut total waste generation by 15% per capita by 2030.
- Halve the quantity of organic material going to landfill between 2020 and 2030, with an interim target of 20% reduction by 2025, through the following actions:
  - Mandatory rollout of food and garden organics recovery services to households that don't already have access will commence in 2026-2027, with all Victorians to have access to a bin or service by 2030. According to the Policy, the introduction of FOGO collection services could divert up to 650,000[2] t of organic waste from landfill each year[3]. It is inherently difficult to predict how successful FOGO will be in reducing the quantity of organics in kerbside residual municipal solid waste (MSW). The level of diversion depends on a number of factors such as future government initiatives and policy changes, commitment to recycling, cultural influences on cooking habits, home composting rates, amount of food left in packaging and others. Based on SLR's Australian and international experience, it can be expected that only a proportion, not all, of the organic waste from the residual stream will be captured in a FOGO collection.
  - Ensure every Victorian household has access to food and garden organic waste recycling services or local composting by 2030.

Section 6.1 of the Policy outlines forecasted price increases to the waste levy to bring it into line with other states like NSW and SA[4].

The waste levy rates are based on fee units, the value of which are set by the Treasurer of Victoria each financial year. The Victorian government uses fee units to index increases in fees and fines across all Victorian government departments. The fee unit rate for the 2020-2021 financial year is $14.81[5]. The waste levy fees for 2023-2024 are currently only expressed in fee units by the EPA to allow for further increases. To show the likely increase in the waste levy for the 2023-2024 year, SLR has provisionally allowed for the fee unit to increase with CPI[6], however, this is subject to change.

[1] Four stream service includes combined food and garden organics, glass, combined paper, plastic and metals, and residual waste.
[2] This figure is based on the organics going to landfill in 2017-18 from the SV Waste projection model, available at https://www.sustainability.vic.gov.au/Government/Victorian-Waste-dataportal/Interactive-waste-data-mapping/Wasteprojection-model
[3] SLR is aware that SV is currently preparing a new waste projection model that takes into account policies including the rollout of FOGO
[4] For reference, the waste levy for metropolitan Adelaide was $146 per tonne and $147.10 per tonne for metropolitan Sydney as of 6 October 6, 2021
[5] EPA Victoria *How we calculate fees and fines* https://www.epa.vic.gov.au/for-business/fees/calculate-fees-and-fines
[6] Over the twelve months to the June 2021 quarter, the CPI rose 3.8% https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/consumer-price-index-australia/latest-release

2.3.1 Statewide Waste and Resource Recovery Infrastructure Plan 2018

The Statewide Waste and Resource Recovery Infrastructure Plan (SWRRIP) is the roadmap to guide planning and investment decisions for waste and resource recovery infrastructure in Victoria for 30 years from 2018. The SWRRIP is designed to guide the waste and resource recovery industry and local and state governments in their decision-making process as well as to provide guidelines for land use planning, transport, and broader environmental policy.

Some sections of the report have been superseded by new documents and government policy including the *Recycling Victoria - a new economy 2020.*

The SWRRIP gives an overview of the current waste and resource recovery infrastructure at the state level and models projections for future trends in waste generation, recovery and landfilling over the next 30 years. For each of the main material streams, the SWRRIP summarises current recovery scenarios, as well as future opportunities and potential barriers to increasing recovery.

2.3.2 Recycling and resource recovery infrastructure Evidence base report – 2019

This report prepared by infrastructure Victoria, looked at the waste sector from an infrastructure lens. It examines how the industry as a whole has been operating, what has been working and what hasn’t, and advises how infrastructure and government action can create a better recycling sector. This evidence-based report sets out the done work and key findings to date.

As part of the key early findings, the report suggests support for high levels of resource recovery for organics, particularly food organics. The report lists some options and barriers to increase recovery of organics including:

- Increased separation and processing of organic materials would require supporting processing infrastructure to enable value added product and viable end market for organics. Current infrastructure is likely to be insufficient.
- Supporting processing infrastructure closer to the source of waste or end market for recycled materials is likely to be important, particularly for food organics. High transport costs are often cited as a barrier to greater recovery and recycling of organics. This is particularly true for regional and rural areas where transport distances are often large.

The report also developed a range of possible scenarios for waste materials in future. Each scenario has implications for the amount and type of infrastructure required, ranging from kerbside collections, sorting, and processing. The report indicates that compost processing using open windrow technology and in-vessel technology, mulch processing for garden and timber wastes, and biochar for boutique applications could be some potential processing options for organics.

2.4 Grampians region

2.4.1 GCWWRRG

The Grampians Central West Waste and Resource Recovery Group (GCWWRRG) is a Victorian statutory organisation responsible for facilitating a co-ordinated approach to the planning and delivery of waste infrastructure and services in the Grampians Central West region of western Victoria.

The GCWWRRG has a range of documents detailing the production and fate of organic waste in the region

2.4.1.1 Grampians Central West Waste and Resource Recovery Waste to Energy Framework

This establishes the framework for economically viable and environmental sound waste to energy projects that reduce waste to landfill and provide alternative energy sources for local communities and businesses.

2.4.1.2 Grampians Central West Waste and Resource Recovery Implementation Plan 2017

The purpose of the plan is to set out how the waste and resource recovery infrastructure needs of the Grampians Central West region will be met over 10 years from 2017. The plan has been prepared to assist stakeholders, including councils, industry and the community, to continue to participate in the planning and infrastructure implementation to meet the regional waste and resource recovery needs.

The plan aims to work on the following nine priority actions:

1. Assess and, where viable, support the development of solutions and systems to increase the recovery of priority materials
2. Facilitate the development of regional partnerships to produce efficiencies in resource recovery, materials transport, and disposal
3. Work across all levels of government, industry, and investors to explore innovative and technological advancements that could inform future infrastructure development and investment
4. Work with councils and industry to upgrade and rationalise infrastructure, improve operations and engage communities
5. Facilitate work between councils and/or industry and the EPA to progress any rehabilitation assessments and requirements for closed landfills
6. Work with councils and relevant state planning authorities to site new infrastructure appropriately and protect existing facilities and hubs from encroachment
7. Contribute to the development and application of a reliable state and regional integrated data system to inform waste and resource recovery decisions
8. Share information across government on regional infrastructure and market development needs and priorities
9. Continue to work with relevant agencies, councils, industry, schools and the community on waste and resource recovery education and engagement.

The data used for analysis in the plan is out of date; residual waste quantities are from the 2013-2014 financial year, for example. The plan notes some difficulties with data in the region, as well as the opportunity for improved data collection for continuous improvement in resource recovery decisions.

While MSW accounts for about one quarter of all waste generated in the region, it represents a large proportion (42%) of the material that is sent to landfill each year. With the introduction of kerbside collection of garden organics in some councils, it is anticipated that the MSW resource recovery rate will increase, as will the overall regional, and ultimately the state, recovery rate.

Assuming current resource recovery rates continue and, based on further economic development and expected population increases, by 2026, waste generated is projected to increase to almost 666,000 t. By 2046, it is expected to have increased by more than 36 % to approximately 768,000 t.

Detailed analysis has established that the region will not require additional landfill capacity within the next 10 years. Moreover, the strategic objective to recover materials and reduce waste to landfill will further lessen the reliance on landfill.

According to the Plan, there are currently five organics processors processing approximately 30,000 t annually. This included food organics (around 50%), garden organics (around 11%), wood and timber (around 9%) and other organics (around 31%, which included biosolids, grease trap waste, sludges, and others).

Kerbside garden organics collections commenced in Ballarat in July 2016 for the urban areas, which covers a total of over 33,000 residences. This leaves 75% of councils and a significant number of households in the region without an organics garden waste collection service. This results in a considerable quantity of a viable waste material being sent to landfill. The gap in kerbside organics recovery is an opportunity for the region.

There are at least five facilities in the region accepting, aggregating and/or reprocessing organics. Castlegate James, which manages around 40–50% of the organics total and is the only facility which accepts food waste, and Calleja Transport (40–45% of the organics total) are the major reprocessors of organic materials.

The Horsham Garden Recycling Centre, Davos Worm Farms, and the Garden Recycling Centre (Ballarat) manage significantly smaller quantities. Central Goldfields Shire Council currently operates an in-vessel composting facility, which manages the garden waste from its voluntary kerbside organics collection. The facilities produce a range of composts, soil conditioners and biodiesel. Special considerations have been given for resource recovery activities that improve the environment, community amenity and human health, while stimulating markets for the use of recovered materials for positive economic return.

A number of resource recovery centres, transfer stations and landfills stockpile garden organic waste, which is not included in data on the quantity of organics managed in the region as it does not leave the site where it is deposited. This organic material is either mulched and used by councils for horticultural applications at parks and reserves, or occasionally offered to the community, used for daily cover or rehabilitation of landfills. Consequently, there are higher amounts of this material available for reprocessing than is accounted for in the data.

The plan notes that many industries are significant generators of organic material and accurate organics data may never be captured as the material may be used for economic benefit without further reprocessing.

The plan further lists current and future resource recovery and reprocessing infrastructure.

2.4.1.3 Grampians Region Organics Review 2018

A review of organics recovery and processing for the Grampians Central West (GCW) region was conducted by Frontier Ag & Environment. The main purpose of this review was to:

- Review past work on organics in the region, as well as recent developments in other regions and states
- Summarise the existing organics situation in the region
- Identify and summarise recent organics developments, or likely future developments, that might provide insight to future prospects for the region
- Identify information, knowledge and data gaps where appropriate
- Recommend options for future work in organics for the region.

The Grampians Region Organics Review 2018 summaries the current estimate of the quantity of organics managed in the region, drawing on the 30,000 t estimated from the 2017 GCWWRRG Implementation Plan (see Section 2.4.1.2) and notes the following:

- The range of organic waste to energy projects already developed in the Grampians such as Berrybank Farm and Pyrenees Straw to Energy among others
- Estimates of the quantities and sources of organics waste in the region
- Details of the garden organics and FOGO services currently implemented in the region.

2.4.2 Ballarat

Ballarat has a range of documents covering organic waste management in its council area, including:

- City of Ballarat, Resource Recovery and Waste Management Strategy 2018-22
- A Greener More Vibrant and Connected Ballarat. The Ballarat Strategy, Today Tomorrow Together, Our Vision for 2040
- City of Ballarat, Carbon Neutrality and 100% Renewables Action Plan 2019–2025
- City of Ballarat, Good Food for All - Food Strategy 2019-2022.

Relevant details are summarised below:

- The introduction of a kerbside garden organics collection service in Ballarat in July 2016 saw more than 9,300 t of green waste collected in the first year of operation, resulting in an increase in the diversion rate of municipal solid waste from 38% to almost 50%. These bins also showed very little contamination (around 1%). However, waste audits indicate that just under 30% of the contents of kerbside garbage bins contained potentially divertible waste.
- Ballarat is pursuing a policy of zero recoverable waste to landfill by 2040. Part of the actions developed to achieve this is the development a business case for organic diversion options for MSW and commercial and industrial (C&I) waste sectors. This study should be able to feed into this business case.
- A fleet of 14 trucks and 17 full-time equivalent staff are employed annually to collect 44,251 garbage bins and recycling bins and 33,680 green waste bins. In addition to kerbside collection, there are 325 public place waste and recycling bins in the City of Ballarat.

2.4.3 Hepburn Waste Management and Resource Recovery Strategy 2014

The most recent Hepburn Waste Management and Resource Recovery Strategy was published in 2014. This means some data from the strategy is relatively out of date including costs of waste disposal and quantities of waste cited in the study.

The strategy notes that the residual waste sent to landfill contains a number of resources which could be recovered for beneficial reuse, including organic material (food and garden waste) which could be converted to either compost or energy and recyclables which could be recovered through the existing recycling system.

A number of options for decreasing the amount of waste generation and/or increasing the amount of recycling through the kerbside system are considered as part of this strategy, including:

- Reducing the bin size for residual waste
- Encouraging the use of compost bins and worm farms for food and garden waste

- Getting more recyclables into the recycling bin
- Extending the kerbside collection system to the more households
- Implementing a kerbside collection for household garden and food waste.

2.4.4 Horsham Rural City Council Waste Strategy Project Update 31 July 2017

In consideration of feedback received from constituents, the project's steering committee identified the following set of priority issues which will be addressed in a series of discussion papers at the Committee's next meeting in mid-August, the initial priorities being:

- Green waste collection
- Hard waste collection
- Extension of garbage and recycling services to more rural areas
- A review of bin sizes and collection frequency
- Provision of services for people with limited abilities
- Services provided at transfer stations
- Design of Kenny Road transfer station
- Managing commercial food waste.

The strategy notes that one key area where costs can be reduced is by reducing the quantities of materials going to landfill. Not only are the costs of constructing and rehabilitating new landfills high, but Council is also required to pay a levy for disposal of material to the landfill. In 2016-2017 the levy amounted to more than $700,000.

2.4.5 Northern Grampians Waste Management Strategy 2020-2030

This waste management strategy includes updates in response to the *Recycling Victoria: A new economy* which guided the Waste Management Strategy objectives and goals.

Waste generation in Northern Grampians Shire is currently 380 kg per person per year, which is 10% more than regional average and 5% more than the state average. This demonstrates improvements are needed to reduce per capita waste generation in the Shire. Council participates in a range of waste initiatives such as DrumMUSTER, Mobile Muster and collection of e-waste. In 2019-2020 Council collected more than 4.2 t of e-waste and 3,095 chemical drum containers.

Council's goals for the strategy are:

- Divert 50% of FOGO from landfill
- Reduce per person waste by 5%
- Reduce transfer station general waste by 15%
- Increase recyclables by 20%.

Currently council faces challenges due to location and issues with the lack of infrastructure for waste streams regionally and locally, but recognises opportunities for future developments. The strategy also notes that a large portion of Northern Grampian Shire Council is farming and vacant land. There could be some local opportunities to support innovative technology in organic processing for FOGO material.

2.4.6 Pyrenees Shire Council Review of Council Municipal Waste Services and Waste Management Plan 2015

The Plan provides an overview of existing waste management services while providing details of opportunities for these services to be made more efficient and economical for the Pyrenees Shire community.

The plan notes that Pyrenees shares, along with most municipalities, the difficulty in establishing a sustainable and economic program for the disposal or reuse of green and organic waste. The strategy notes the current organics processing operations. The Council operations involve the collection of green and garden waste monthly from kerbside and provides facilities at Beaufort, Avoca, and Snake Valley Transfer Stations for the disposal of garden organics.

All non-garden waste, including food waste and other bio waste materials, is mainly disposed to Stawell landfill. Monthly kerbside garden waste collections are disposed of at Beaufort or Avoca Transfer Stations. Green waste management costs approximately $62,000 per year.

The sole treatment of this waste is 'shredding' by occasional contract, with no product end use, aside from landfill rehabilitation. Although landfill rehabilitation in the short term is an effective disposal arrangement, it is not sustainable in the long term when rehabilitation is complete.

The current issues of Pyrenees Green Waste Practice are stated below:

- Contamination with non-organic materials
- No capture of other organics
- No sustainable end use
- Not part of any regional initiative
- Requires Pyrenees Council staff to manage the waste stream
- No encouragement to reduce green or organics waste disposal.

2.4.7 Council Plan 2017 – 2021 Yarriambiack Shire Council Revised 2018

Strategic objective 3.3 of the Council plan is to develop and implement further strategies to minimise waste.

The waste objectives include:

- Promote sustainable waste management practices.
- Support sustainable development of the mineral sands mining industries and the provision of the required infrastructure.
- Review operations of transfer stations and landfills.
- Consider the impact of climate change and provide education to the community to ensure sound environmental practice.
- Construction of levee for flood protection.

Upgrade of the Warracknabeal Transfer Station including the closure of the unlicensed hard waste landfill and rehabilitation of the site.

2.4.8 Central Goldfields Shire Council - Waste Management Strategy 2020-2030

Waste Management Vision:

> *We will be a low waste community that has equitable and affordable waste services with minimal impact on the environment and public health.*

Waste Management Goals:

In order to achieve this vision, the following goals for Council were also developed:

- Reduced volume of waste
- Diverse waste collection and recovery options
- Council leads by example
- Council manages waste infrastructure in ways that minimise impacts on the environment and public health
- All people in the Shire community understand their role in waste management.

Waste Management Focus Areas:

Areas of Council's waste management responsibility and/or influence were determined. These correspond to the focus areas:

- Waste service models
- Waste management infrastructure
- Creating an evidence base for planning and investment
- Advocacy
- Industry and community engagement.

A set of actions for Council and the Shire Council community have been developed for each focus area and are detailed in the *What Will We Do* section of this Strategy.

3 Council Consultation

3.1 Council's current waste services

3.1.1 Central Goldfields Shire Council

Central Goldfields Shire Council (CGSC) currently services urban properties with a weekly 80 L residual waste service and 240 L fortnightly recycling service. Rural properties are serviced with a fortnightly service for both residual and recycling in 140 L and 240 L bins respectively. Waste goes to the Stawell (Cleanaway) landfill in the Northern Grampians council area. The collection service is provided by Waste Recyclers Victoria.

Council has an optional twice monthly kerbside FOGO service introduced in 2016 which services approximately 1600 households. A small number, not more than 10, small commercial business premises also receive the FOGO service.

FOGO waste is currently processed at an in-vessel composting (IVC) facility at the Carisbrook Transfer Station, however, the facility is nearing capacity. The IVC facility's construction was funded by Council. The composted material is screened and bagged and given back to the community. Everyone who has a FOGO organic waste service is entitled to one bag of composted material each month, however, no data is available on how much compost is produced or distributed.

The IVC facility is above ground in small, enclosed sheds which have temperature and moisture probes throughout which are monitored by a third party offsite. Veolia, as part of their contract for running the transfer station, loads and empties the facility but does not do the monitoring. The process from receival of organic waste to the production of a composted material ready for distribution takes three to four months. The produced material is not produced to Australian Standard 4454–2012 for compost, soil conditioners and mulches.

Transfer station green waste is mulched and screened, and used for site rehabilitation like the decommissioned Carisbrook landfill.

The Carisbrook transfer station is the main transfer station in the region and is operated by Veolia. The transfer station is on Crown land the responsibility of the Department of Environment, Land, Water and Planning. Council pays a fee for use of the land.

3.1.2 Yarriambiack Shire Council

Yarriambiack Shire Council provides a weekly 120 L kerbside residual waste collection service and a fortnightly 240 L kerbside recycling collection service for all towns in the municipality. Residual waste goes to the Dooen Landfill in Horsham. The collection service is provided by Wimmera Mallee Waste as part of a collaborative procurement with four other councils in the region. There is currently no kerbside organics service.

Some waste may be shredded and used as cover on decommissioned landfills like the recently closed landfill at Warracknabeal. The transfer stations are staffed and operated by Yarriambiack Shire Council.

3.1.3 Pyrenees

Pyrenees Council provides a weekly 120 L kerbside residual waste collection service and a 240 L fortnightly kerbside recycling collection service. Council also provides a 240 L garden organics collection service in the townships of Avoca and Beaufort collected every four weeks. The material collected as part of the kerbside service is converted into a chipped mulch that is used for either rehabilitating old landfill sites or for council purposes. Residual waste goes to the Stawell Landfill in Northern Grampians Council. The collection service is provided by SUEZ.

Transfer station green waste is converted into chipped mulch by Green Care. The transfer stations themselves are operated by Four Seasons Waste. A specific area is provided at each of the transfer stations for residents to drop off green waste such as tree branches, pruning, grass and leaf litter. The chipped mulch is used by Pyrenees Council in horticultural applications at playgrounds and parks or rehabilitation of decommissioned landfills in the Council area.

3.1.4 Northern Grampians Shire Council

Northern Grampians Shire Council (NGSC) provides a weekly 120 L kerbside residual waste collection service and a 240 L fortnightly kerbside recycling collection service. Residual waste goes to the Stawell Landfill. The collection service and bulk haulage are all provided by Wheelie Waste. There is no kerbside organics service.

Green waste can be disposed of at any of the transfer stations throughout the shire. NGSC has been storing green waste since 2018. It has previously mulched this material which was then used as cover for the rehabilitation of the neighbouring landfill into the St Arnaud Transfer Station which closed in 2017-2018.

3.1.5 City of Ballarat

City of Ballarat provides a weekly 140 L kerbside residual waste collection service and a 240 L fortnightly kerbside recycling collection service to all residents. Residual waste goes to the Smythesdale Landfill in the Golden Plains Council area. Ballarat is the only council area in the study that is subject to the metropolitan waste levy.

City of Ballarat has its own fleet of collection vehicles and staff for all types of kerbside collections.

Properties between 250 m^2 and 4000 m^2 with a detached house also have 240 L garden organics bins. This material is collected and taken to the Pinegro facility at Mt Wallace and processed into a high-grade compost. Green waste from the transfer stations is also processed by Pinegro using open windrow composting.

3.1.6 West Wimmera Shire Council

West Wimmera offers a weekly 120 L kerbside residual waste collection service and a fortnightly 240 L kerbside recycling collection service. Residual waste goes to the Dooen Landfill in Horsham. The main transfer station is Edenhope through which all waste passes.

Green waste has been burnt in the past, but Council will now be looking to shred the material with builders timber. Council is about to advertise for the shredding service. Council has in the past mulched this material and it was used by Council for rehabilitation of the decommissioned landfill at Kaniva.

3.1.7 Hepburn Shire Council

Hepburn Council provides a weekly kerbside residual waste and fortnightly recycling collection service to the townships of Clunes, Creswick, Daylesford, Hepburn Springs, and Trentham. SUEZ provides the kerbside services. Kerbside residual waste is collected using 120 L bins weekly (green or red lid), while township recycling is collected fortnightly using 240 L bins (yellow lid). Council also provides a fortnightly waste and recycling collection to some rural areas. Waste from rural areas is collected fortnightly in 240 L bins. Commercial properties can elect to have collection through Council in inner township zones.

Council is currently trialling a 120 L FOGO bin in the Clunes township which includes a free kitchen caddy. Accepted materials for the organic bins are found in a guide.[7] The bin is collected weekly. A separate contractor, Gekko and Gaia enviro tech, are providing contractor services at the Creswick Transfer station through a rapid composting in-vessel composting system. The rapid composter takes around 10-20 days, depending on input materials. No material is currently distributed from this service after processing. The compost is undergoing testing to determine possible uses or if it can match a standard.

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[7] Organics bin A-Z guide, https://www.hepburn.vic.gov.au/wp-content/uploads/2021/03/Organics-Bin-A-Z.pdf

Green waste is collected at transfer stations in the Council area. The garden organics are usually stored at transfer stations for some time before Green Care Mulching from Geelong comes to grind it and transport the material off-site. Woody weeds are not accepted at the transfer stations.

3.1.8 Horsham

Horsham Council is currently undertaking consultation to change its services. In urban areas, 240 L bins are used for both residual waste and recycling collected fortnightly. Glass is collected monthly using 80 L bins. In rural areas, 240 L bins are collected fortnightly for both residual waste and recycling materials.

Council provides a weekly kerbside residual waste and 240 L fortnightly recycling collection service in urban areas. The residual waste service is either a 120 L or 240 L bin. About two thirds of services are in a 240 L bin.

Council also provides a fortnightly residual waste and recycling collection in some rural areas. Residual waste is currently sent to the Dooen Landfill in the Council area. Residual waste collection is undertaken by Council staff and vehicles. Co-mingled recyclables are collected by the contractor Wheely Waste. Transfer station staffing and operation is by Wastebusters Recycling.

Green waste from transfer stations is chipped or shredded into a mulch and then retained on site. The mulch is occasionally sold to a local motorcycle club. Mulched green waste has been used as landfill cover in the past. This has been less than 100 t per year, however, this practice is not continuing at this stage.

3.1.9 Council collection services

Table 3 below shows the kerbside collection services operating in each council. For some Councils the stated system operates in urban areas, and may not be operating in rural areas.

Table 3 Kerbside collection systems

Council name	Residual waste		Recycling		Green waste		Glass		Note
	Bin size	Collection frequency	Bin size	Collection frequency	Bin size	Collection frequency	Bin size	Collection frequency	
Horsham Rural City Council	240L	Weekly	240 L	Fortnightly					
Yarriambiack Shire Council	120L	Weekly	240 L	Fortnightly					
Hepburn Shire Council	120L	Weekly	240 L	Fortnightly	120 L	Weekly			
West Wimmera Shire Council	120L	Weekly	240 L	Fortnightly	NA	NA			
City of Ballarat	140L	Weekly	240 L	Fortnightly	240 L	Fortnightly			
Central Goldfields Shire Council	80L	Weekly	240 L	Fortnightly	240 L	Twice a month, opt in additional cost.			Details are for urban areas only. Rural areas may differ
Pyrenees Shire Council	120L	Weekly	240 L	Fortnightly	240 L	Four weekly	120 L	Four weekly	Details are for Avoca and Beaufort only.
	140L	Fortnightly	140 L	Fortnightly	NA	NA			Rural areas
Northern Grampians Shire Council	120L	Weekly	240 L	Fortnightly	NA	NA	NA	NA	

3.1.10 General notes

Operating a network of transfer stations is commonly done in regional towns and cities where population centres are spread out geographically and/or where rural residents are not provided with a kerbside service. It is also not unusual to limit the operating hours of these facilities to certain days of the week or certain hours of the day or both. Many councils in this study operate this type of model for regional transfer station operation.

4 Industry consultation

4.1 Hancock Victorian Plantations

Hancock Victorian Plantations Pty Limited (HVP) operates large pine plantations and in Creswick, Daylesford, and Ballarat among other areas. HPV is not producing any material that it is trying to dispose of at no cost. Woodchips are produced which are sold overseas to China and Japan for paper manufacture. HPV is currently part of a joint venture in Geelong which exports about 90,000 t of woodchip material to Japan for use in a biomass combustion plant for heat and power.

This materials could potentially be redirected to a site in Ballarat or Geelong for approximately $70 a tonne for woodchip radiata pine. HPV has a facility in Geelong that collects sawmill woodchips and forest pulpwood which is chipped. There is potential to collect the residue that remains on harvest sites; however, research indicates that the cost of collecting and delivering the remaining material would likely be as much as the value of the woodchips themselves.

4.2 Central Highlands Water

CHW is an urban water corporation responsible for water and sewerage in the Central Highlands region of Victoria. CHW has 6000 ha of land in the Grampians region. Approximately half of the area is leased to farmers, 1500 ha is pine plantations, 1500 ha is bushland conservation for water catchment. CHW produces green waste through servicing its pine plantations.

Over a 35-year rotation per plantation, waste is generated by thinning out processes and general felling. When thinning, any trunks that are able to be sold, are sold. Other material, such as branches, is left on site. For the felling period, once all saleable material has been transported offsite, the remaining green waste is pushed together and burnt. CHW is potentially willing to supply this material as a feedstock. The CHW service region includes City of Ballarat, Hepburn Shire Council, Pyrenees Shire Council and Central Goldfields.

CHW operates 11 lagoon-based wastewater treatment plants (WWTPs) near Avoca, Ballan, Beaufort, Cardigan, Clunes, Daylesford, Gordon, Maryborough, Snake Valley, Skipton and Waubra. These plants produce sludge periodically, based on desludging frequencies required for maintenance anywhere from once per year to once per 20 years, depending on size of plant and drivers. Maryborough and Daylesford are the biggest of these plants and might produce a couple of hundred tonnes of material per year, on average.

CHW operates the Ballarat South wastewater treatment plant (BSWWTP) in Mount Clear, the plant is a biological nutrient removal (BNR) plant with 'daily production' of sludge (not biosolids) from the belt press and wasting. In 2020-21 a total of 12,415 wet tonnes were produced. Using monthly moisture content results, this was converted to 1,797 dry tonnes of material. This sludge is currently transported to Clunes for further treatment in accordance with Environment Protection Authority Victoria (EPAV) Publication 943. The final quality is T1C2 biosolids (~60% total solids). Due to the costs of transport and processing at Clunes, CHW would preferentially propose that the untreated sludge from BSWWTP is used as feedstock, rather than the treated biosolids at Clunes. Biosolids are shipped out to Clunes, where they are dried. End use is stockpiling at Clunes for future beneficial reuse as agricultural soil ameliorant.

Veolia Water Services operates the Ballarat North WWTP located at Mount Rowan, the plant is a BNR plant with 'daily production' of biosolids on site from the centrifuge and thermal dryer system, which produces pelletised T1C2 biosolids in accordance with EPAV Publication 943, with <5% moisture content. In 2020-2021 a total of 895.8 dry tonnes of 95% dry biosolids were produced. Biosolids were transported to the Pinegro facility at Mt Wallace. The Pinegro site has an EPA license for receiving biosolids. The biosolids are composted with green waste from Ballarat and the final product returned into the Ballarat garden industry.

4.3 Gekko

Gekko, and its subsidiary Gaia Enviro Tech, is an organic-specific waste management business based in Ballarat. Both are currently operating the trial IVC composting facility in Creswick in Hepburn Council which handles waste for Clunes. This facility would need to expand to accept FOGO for all townships. In this trial, a lot of time was spent on education. If any material comes through that has a higher contamination rate than 3%, this is then sent to landfill.

Gekko are also running an anerobic digestion (AD) facility at Trigg Farm near Ballarat which is currently undergoing trials. The company is waiting for grant funding to complete the trial. The facility will probably have a capacity of around 10,000-20,000 t per year. Gekko, currently services a dairy farm which produces about 7,500 t of liquid organic waste per year which is fed into the AD. It has permission to use the digestate as a soil conditioner. The solids from the AD system can possibly go back to the composter units to aid the composting process.

Based on a preliminary discussion, Gekko has expressed interest in accepting FOGO from Ballarat at this facility. However, there may be regulatory issues in order to use that facility.

The Gekko AD system is modular and can scale up from 2,500 t to 30,000 t. Gekko is based in Ballarat and is one of the few facilities that has laboratory and pilot plants. It characterises waste prior to processing with assistance of an in-house biochemist.

As with many other stakeholders, Gekko believes contamination will be a significant issue and would look to work with councils at the early stages to work on contamination and pre-processing issues together.

Gekko would be looking to reduce the amount of waste that is transported by road and has put forward the idea of installing distributed composters in each locality but bringing any liquid putrescible waste to a central facility. In addition, after processing of compost at each facility, it could use the liquid output to transport to a centralised facility.

4.4 Gaia Enviro Tech (Subsidiary of Gekko)

Hepburn Council is looking to expand the Clunes facility in 2022. The site is currently using a rapid composter made and serviced by Gaia. The feedstock at Clunes is quite pure, with some plastic contamination. It needs to make sure that it is shredded to the right density and moisture. Airflow is used to manage temperature and heat. Originally Council was considering AD but the results were not satisfactory so IVC was used.

Gaia Enviro Tech makes modular AD facilities and some IVC. Other councils and private clients are looking at combining rapid composters and modular facilities based in Ballarat.

4.5 Davos worm farm

Davos worm farm takes about 100 t per month of food waste from McCains and Mars food manufacturing plants and from Ballarat Base Hospital. However, the capacity at the facility is much larger.

A major issue is getting EPA approval for the business. Council originally advised that no permit would be needed but the EPA advised that a permit would be needed if Council was planning to sell the compost. Devos also tried to process timber packing crates into biochar, but the EPA classified this as industrial waste.

At one stage Davos was collecting food organics from 30 business, but the contamination rate was too high to be viable. Davos does not know of any recycler that can make money by selling the end product. The only viable method is by taking the gate fee. Davos charges a gate fee of about $100 per tonne. A small amount of the output is sold to home gardeners and the excess is put onto its own farms. A pre-treatment system is needed at the source to keep contamination down.

Council advises that because of the low numbers of businesses taking up the offer, the collection company'cost per bin was very high. More than one company tried it but couldn't get the costs lower.

4.6 Bioplant Energy

Bioplant Energy produces biochar through a pyrolysis process. It is building its first plant in Manuvatu south of Gisborne in New Zealand for processing MSW and some woodchips and tyres. Construction was expected to start on 1 January 2022. Bioplent Energy expressed its interest in the organics project if it proceeds down the thermal treatment route.

4.7 Pinegro

Pinegro operates an OWC facility at Mt Wallace near Ballarat. This facility has an EPA license to take 60,000 t per year of organic waste. Of this 45,000 t are green waste from kerbside and transfer stations, and 15,000 t are biosolids from Western Water. All the green waste collected is composted together. The end product is sold as compost to agricultural customers and some landscapers.

Pinegro has a mass mobile aerated floor. It is looking to get funding for a new version which will be able to process FOGO. It is also looking to get a license for FOGO processing.

4.8 Calleja

Calleja Group has a system that could process contaminated FOGO and is currently undergoing a trial to prove the concept. The system uses an industrial press to breakdown the waste to a cellular level. The liquid extract is then put into an AD facility. The residual dry mass is put through an energy from waste (EfW) combustion process.

For the EfW process, Calleja is looking at processing unrecyclable timbers and soft plastics. The current facility is likely to be around 100,000 t per year capacity.

For AD, Calleja would look to supplement the FOGO feedstock with other organic sources in the region. The likely capacity of the AD facility would be around 20,000-50,000 t per year.

Calleja claims that its process is 'net energy positive', unlike composting which requires energy input. The site is located in Maddingly, Victoria. Calleja is working with Federation University to get funding for a trial of the AD technology.

4.9 Sacyr

Sacyr has technology for IVC and AD, but is not aligned to any particular technology or provider. Globally, it has undertaken about 50 municipal waste projects, eight of which were AD facilities. Some of the larger facilities processed 140,000 t per year. The delivery and ownership model is a public private partnership model which includes a gate fee mechanism. To make this type of system work, there needs to be guarantee of a fixed amount of waste per month.

Sacyr noted the issues with including compostable plastics in the waste and the and the longer processing and cycle times that are required if these are included. It is involved in a gasification project but on a much bigger scale than the amounts of waste available in the Grampians region. Sacyr is in discussions with other parties to process FOGO with dry AD in other regions.

Sacyr hs a new FOGO facility in Dandenong South which has a capacity of around 100,000 t per year. Nine metro Melbourne councils send their FOGO waste to the facility. The IVC output is a compost of around 80,000-100,000 t per year. This compost is sold to industrial Sacyr customers. These companies include processors, who will blend it, and market gardeners. They are not involved in any bagging of product on site.

The site has 12 tunnels. The facility has been in operation for two years. The composition of incoming FOGO is mostly garden organics with some food. Sacyr has some commercial companies that deliver feedstock including Woolworths, however, the feedstock is predominantly council waste. Bio-degradable and compostable plastics and things like bamboo were not really a consideration when it was designed and these have become a a problem. For example, some of these materials have about a 12-week processing time, while garden organics normally requires only four weeks. This means there are certain conditions and specification in the contract about contamination. The facility is planned to operate for 20 years.

4.10 ResourceCo

ResourceCo is not interested in processing organics. Currently it deals with non-putrescible organics.

4.11 Bio-gro

Bio-gro is a South Australian-based company with a large composting facility at Mount Gambier. The facility uses OWC and the incoming feedstock takes FOGO, abattoir waste, food waste, paper pulp, timber residue, pine bark saw dust, liquid waste and whey from dairies. The facility is surrounded by pine plantations so, according to Bio-Gro there are no issues with odour. However, it did note that the Victorian EPA is more risk-averse than the South Australian EPA.

Bio-gro also has a transfer facility in Dandenong where organics are decontaminated and shredded before being transported offsite. The organics are mostly bulk hauled to the facility in Mount Gambier, however, some waste is also taken to Gippsland Water for further processing.

Bio-gro's specialty is large OWC facilities, and it is looking to bring more of these facilities online in Victoria in the next couple of years. It is developing new site to the west of Melbourne and open to setting up new facilities.

The option of installing a transfer facility to transport organics to a bio-Gro facility was also discussed.

The output from the Mount Gambier facility is organic growing substrates, soil conditioners, mulching mediums, and biological growth stimulants for a range of applications. These are sold to nursery, cut flower, fruit and orchard, turf growing, viticulture, and broad acre industries. Some material is also packaged for private label soil products for Australia's gardening and landscaping retailers. About 700,000 m^3 of product is produced per year.

4.12 Sustainability Victoria

Sustainability Victoria has provided funding for various organic waste management initiatives in the region. It is not clear whether future rounds of grants would include organics capacity. SV has targets for capacity statewide which have probably been reached but this may not prevent further grants in the future.

There is standardised assistance for councils for waste education. There are lots of materials available from Sustainability Victoria that the councils can use.

5 Data analysis

5.1 Introduction

Data is critical to well-targeted, evidence-based, and planned waste management. Data is also crucial for measuring performance of key indicators, progress, and impact. Yet waste data is difficult and expensive to collect, and in the absence of a national standard, waste data collection and reporting methods vary by jurisdiction and waste types. Similar to other jurisdictions in Australia, the Grampians Region faces inconsistencies in the quality, collection, storage, analysis and sharing of waste and resource recovery data.

5.2 Data Gaps

This project used a wide range of data available in the public domain and collected through consultation. SLR has reviewed the waste data supplied by Council. Data has been provided that extends back ten years. Residual quantities were obtained from weighbridge data from landfills and supplied by individual councils.

The most recent data at the time of the project was from a variety of sources and from a variety of financial years. For example, data from the Australian Biomass for Bioenergy Assessment project were from a variety of years and sources.[8] For the purposes of this project, we have assumed that these quantities are still available in the agricultural sector even though the most recent data may be from 2015.

We also note that no significant data gaps have been discovered in this study. When raw waste generation data is not available or has not been provided for some streams, several assumptions based on industry practice and previous knowledge were applied to extrapolate the generation rate. If data is not available for 2020 for a particular waste stream, the most recent available data from the previous years for that stream were used in this data analysis.

5.3 Findings and assumptions from Data Analysis

The key findings and associated assumptions of this data analysis are listed below:

- The food organics capture rates for all councils are around 44%.[9]
- The proportion of organics in kerbside residual waste is as follows for each council:
  - Horsham Rural City Council - 47.09%.[10]
  - Yarriambiack Shire Council - 35.60%.[11]
  - Hepburn Shire Council - 45.41%.[12]
  - West Wimmera Shire Council - 40.49%.[13]
  - City of Ballarat - 33.79%.[14]

[8] Australian Biomass for Bioenergy Assessment Project, Department of primary Industries; https://www.dpi.nsw.gov.au/forestry/science/forest-carbon/abba
[9] Analysis of NSW kerbside green lid bin audit data report, 2020
[10] Kerbside Waste & Recycling Bin Audit, Horsham Rural City Council, 2019
[11] Regional Waste Facility Audit, Resource Recovery Centre, Transfer Stations and Landfills, EC Sustainable, 2020
[12] Regional Waste Facility Audit, Resource Recovery Centre, Transfer Stations and Landfills, EC Sustainable, 2020
[13] Regional Waste Facility Audit, Resource Recovery Centre, Transfer Stations and Landfills, EC Sustainable, 2020
[14] Ballarat organics data, 2019

- Central Goldfields Shire Council - 46.06%.[15]
- Pyrenees Shire Council - 44.46%.[16]
- Northern Grampians Shire Council - 54.53%.[17]

- The green organics capture rate for all councils is 98%.[18]
- The proportion of organics in kerbside green waste is 99.1% for
    - Horsham Rural City Council
    - Yarriambiack Shire Council
    - Hepburn Shire Council
    - West Wimmera Shire Council
    - Central Goldfields Shire Council
    - Pyrenees Shire Council and
    - Northern Grampians Shire Council.[19]
- The proportion of organics in kerbside green waste for City of Ballarat is 99.65%.[20]
- The transfer station organics capture rates for all councils are 98%.[21]
- The proportion of organics in transfer station drop-off is 99.1% for
    - Horsham Rural City Council
    - Yarriambiack Shire Council
    - Hepburn Shire Council
    - West Wimmera Shire Council
    - Central Goldfields Shire Council
    - Pyrenees Shire Council and
    - Northern Grampians Shire Council.[22]
- The proportion of organics in transfer station drop-off for City of Ballarat is 99.65%.[23]
- It was assumed that the
    - commercial organics capture rates and proportion of organics in commercial residual waste for all councils are 100%.
    - the capture rates for wastewater treatment plant organic biosolids for all councils are 100%.
- The proportion of organics in biosolids for all councils is 80%.[24]

[15] Regional Waste Facility Audit, Resource Recovery Centre, Transfer Stations and Landfills, EC Sustainable, 2020
[16] Regional Waste Facility Audit, Resource Recovery Centre, Transfer Stations and Landfills, EC Sustainable, 2020
[17] Regional Waste Facility Audit, Resource Recovery Centre, Transfer Stations and Landfills, EC Sustainable, 2020
[18] Analysis of NSW kerbside green lid bin audit data report, 2020
[19] Regional Residential Kerbside Bin Audit, EC Sustainable, 2019
[20] Ballarat organics data, 2019
[21] Analysis of NSW kerbside green lid bin audit data report, 2020
[22] Regional Residential Kerbside Bin Audit, EC Sustainable, 2019
[23] Ballarat organics data, 2019
[24] Fertilizing with Biosolids

5.4 Base-Line Data

This section provides an overview of all organic waste streams and their management for 2020.

5.4.1 Mass balance

The tables in this section show a mass balance of materials entering each council's waste management system from residents, the public and commercial customers and leaving it to landfill or other waste management facility.

The quantities of total kerbside residual organic waste from each council are shown in **Table 4**. The table shows that a total of 7,925 t of kerbside residual organics could be available in 2020-2021, with most of the organics coming from the City of Ballarat.

Table 4 Kerbside Residual Organic Waste Quantity for 2020

Council name	Kerbside residual waste (t)	Proportion of organics in residual waste (%)	Kerbside residual organic waste (t)	Food organics capture rate (%)	Potential available kerbside residual organic waste (t)
Horsham Rural City Council	7,994	47.1%	3,764	44%	1,656
Yarriambiack Shire Council	2,255	35.6%	803	44%	353
Hepburn Shire Council	2,255	45.4%	1,024	44%	451
West Wimmera Shire Council	965	40.5%	391	44%	172
City of Ballarat	23,706	33.8%	8,010	44%	3,524
Central Goldfields Shire Council	2,228	46.1%	1,026	44%	452
Pyrenees Shire Council	1,797	44.5%	799	44%	352
Northern Grampians Shire Council	4,022	54.5%	2,193	44%	965
TOTAL	**45,221**		**18,010**		**7,925**

The quantities of total kerbside green organic waste from each council are shown in **Table 5**. The table shows that a total of 10,884 t of kerbside green organics could be available in 2020-2021, with almost all organics coming from the City of Ballarat. Based on the available information, we note that Horsham Rural City Council, Yarriambiack Shire Council, Hepburn Shire Council, West Wimmera Shire Council, and Northern Grampians Shire Council do not have kerbside green waste collection facility separately.

Table 5 Kerbside Green Organic Waste Quantity for 2020

Council name	Kerbside green waste (t)	Proportion of organics in green waste (%)	Kerbside green organic waste (t)	Green organics capture rate (%)	Potential available kerbside green organic waste (t)
City of Ballarat	10,254	99.7%	10,218	98%	10,013
Central Goldfields Shire Council	657	99.1%	651	98%	638
Pyrenees Shire Council	240	99.1%	238	98%	233
TOTAL	**11,150**		**11,106**		**10,884**

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https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw508_0.pdf#:~:text=In%20biosolids%20produced%20by%20anaerobic%20digestion%20and%20dewatering,percent%20organic%20N%20and%20a%20trace%20of%20ammonium-N.

The quantities of total transfer station garden organics drop-off from each council are shown in **Table 6**. The table shows that a total of 10,292 t of transfer station organics drop-off could be available in 2020-2021, with most of the organics coming from the City of Ballarat.

Table 6 Transfer Station Garden Organics Drop-Off Quantity for 2020

Council name	Transfer station drop-off (t)	Proportion of organics in drop-off (%)	Transfer station garden organics drop-off (t)	Transfer station organics capture rate (%)	Potential available transfer station garden organics drop-off (t)
Horsham Rural City Council	860	99.1%	852	98%	835
Yarriambiack Shire Council	491	99.1%	487	98%	477
Hepburn Shire Council	1,829	99.1%	1,812	98%	1,776
West Wimmera Shire Council	460	99.1%	456	98%	447
City of Ballarat	3,873	99.7%	3,860	98%	3,782
Central Goldfields Shire Council	1,402	99.1%	1,390	98%	1,362
Pyrenees Shire Council	161	99.1%	160	98%	156
Northern Grampians Shire Council	1,500	99.1%	1,487	98%	1,457
TOTAL	**10,576**		**10,502**		**10,292**

The quantities of total commercial residual organic waste from each council are shown in **Table 7**. Most of the commercial residual waste data was collected from the Australian Biomass for Bioenergy Assessment project from a variety of years and sources.[25] C&I manufacturing, primary production, forestry- sawmills and forestry plantations data were collected from an interactive dashboard available at Sustainability Victoria.[26] It was assumed that Sustainability Victoria used the data from the Australian Biomass for Bioenergy Assessment Project, which ran from 2015 to 2020. The same quantities, unless otherewise indicated, were used throughout the years from 2015 - 2020 in this calculation. As mentioned in the assumptions, we have assumed that these quantities are still available in the agricultural sector even though the most recent data is from 2015.

For the City of Ballarat, additional commercial organics data sources include landfilled C&I and C&D bags organics data, landfilled receival separated C&I organics data, and food waste data from Mars and McCains in Ballarat.

[25] Australian Biomass for Bioenergy Assessment Project, Department of primary Industries; https://www.dpi.nsw.gov.au/forestry/science/forest-carbon/abba
[26] Victorian Biomass Residue Generation Estimates by LGA, Sustainability Victoria, https://www.sustainability.vic.gov.au/research-data-and-insights/waste-data/interactive-waste-data/biomass-data

Table 7 Commercial Residual Organic Waste Quantity for 2020

Council name	Commercial residual waste (t)	Proportion of organics in commercial waste (%)	Commercial residual organic waste (t)	Commercial organics capture rate (%)	Potential available commercial residual organic waste (t)
Horsham Rural City Council	191,595	100%	191,595	100%	191,595
Hepburn Shire Council	13,010	100%	13,010	100%	13,010
West Wimmera Shire Council	200,005	100%	200,005	100%	200,005
City of Ballarat	136,463	100%	136,463	100%	136,463
Central Goldfields Shire Council	56,162	100%	56,162	100%	56,162
Northern Grampians Shire Council	581,236	100%	581,236	100%	581,236
TOTAL	**1,178,472**		**1,178,472**		**1,178,472**

The table shows that a total of 1,178,472 t of commercial residual organics could potentially be available in 2020-2021, with majority of the organics coming from Northern Grampians Shire Council. We note that no commercial organic data was available for Yarriambiack Shire Council and Pyrenees Shire Council. Only a small proportion (2-5%) of these commercial organics would be used for the options assessment, for example, Option 13.

Based on the available data, a total of 2,187 t of organic biosolids could be available for 2020, which only came from the wastewater treatment plant and CHW at Ballarat.

As well as the organic waste streams described above, there are a total of 6,107 t of forestry plantation that could be available from CHW for 2020.

Table 8 Organic Waste Quantity Summary for 2020

Council name	Source	Waste type	Waste quantity (t)
Horsham Rural City Council	Kerbside	Residual organic waste	1,656
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	835
	Commercial	Residual organic waste	191,595
		Sub-total	**194,087**
Yarriambiack Shire Council	Kerbside	Residual organic waste	353
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	477
	Commercial	Residual organic waste	-
		Sub-total	**830**
Hepburn Shire Council	Kerbside	Residual organic waste	451
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	1,776
	Commercial	Residual organic waste	13,010

Council name	Source	Waste type	Waste quantity (t)
		Sub-total	**15,237**
West Wimmera Shire Council	Kerbside	Residual organic waste	172
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	447
	Commercial	Residual organic waste	200,005
		Sub-total	**200,624**
City of Ballarat	Kerbside	Residual organic waste	3,524
	Kerbside	Green organic waste	10,013
	Transfer Station	Garden organics drop-off	3,782
	Commercial	Residual organic waste	136,463
		Sub-total	**153,783**
Central Goldfields Shire Council	Kerbside	Residual organic waste	452
	Kerbside	Green organic waste	638
	Transfer Station	Garden organics drop-off	1,362
	Commercial	Residual organic waste	56,162
		Sub-total	**58,613**
Pyrenees Shire Council	Kerbside	Residual organic waste	352
	Kerbside	Green organic waste	233
	Transfer Station	Garden organics drop-off	156
	Commercial	Residual organic waste	-
		Sub-total	**741**
Northern Grampians Shire Council	Kerbside	Residual organic waste	965
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	1,457
	Commercial	Residual organic waste	581,236
		Sub-total	**583,658**
Sub-total			**1,207,573**
Additional waste	Central Highlands Water (CHW)	Forestry Plantation	6,107
	Wastewater Treatment Plant	Organic Biosolids	2,187
		Sub-total	**8,294**
TOTAL			**1,215,867**

A summary of all waste streams from all councils is provided in **Table 8**. As shown in the table, the total waste generation in 2020 was 1,215,867 t.

Considering only FOGO from kerbside residual organic, kerbside green organic, and transfer station garden organics drop-off, **Figure 3** shows the proportion and potential FOGO quantities for each council.

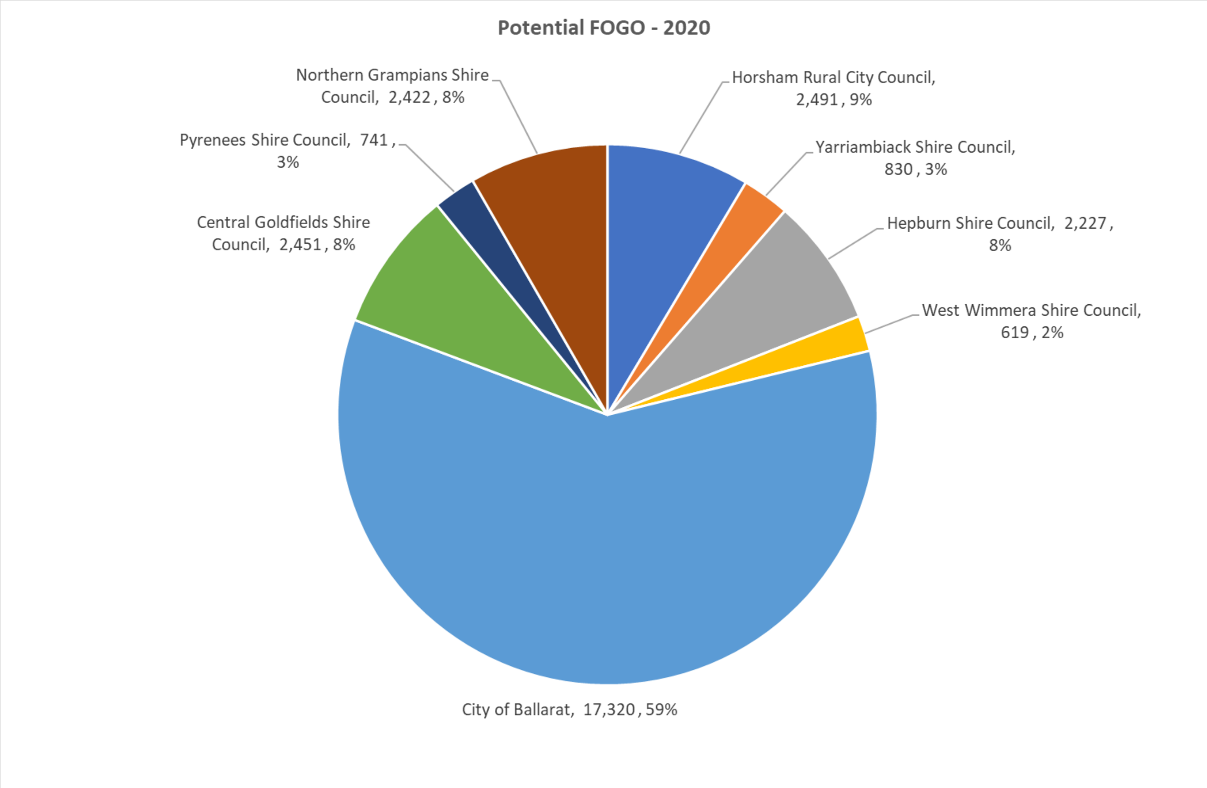


Figure 3 Potential FOGO - 2020

The charts shows that around 59% of potential FOGO is expected to come from the City of Ballarat.

5.4.2 Pathway mapping

Appendix A shows a mass balance flow chart of total organic waste under the considered eight councils for 2020. The waste streams include kerbside residual organic waste, kerbside green organic waste, transfer station garden organics drop-off, commercial residual organic waste, and some additional waste from CHW, forestry plantation and WWTP organic biosolids.

A mass balance flow chart of FOGO from kerbside residual organic waste, kerbside green organic waste, and transfer station garden organics drop-off for the eight councils for 2020 is showed in **Appendix B**.

These figures also show the quantities, sources, and end destinations of each waste stream.

5.5 Modelling to 2040

The expected organic waste quantities from 2020 to 2040 are shown in **Figure 4**, and are based on the available quantities trends over the past ten years.

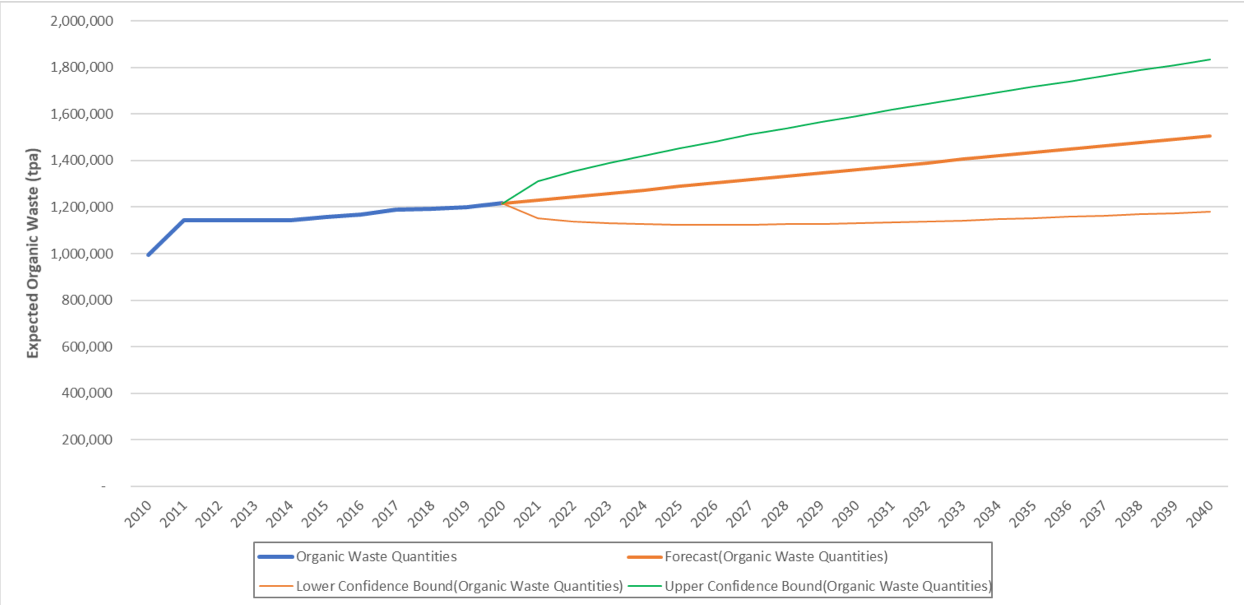


Figure 4 Projected Organic Waste Estimates from 2010 to 2040

Table 9 shows a summary of all waste streams from all councils for 2040. Based on the baseline model forecasting, the total amount of predicted waste generation in 2040 is estimated to be 1,506,812 t.

Table 9 Estimated Organic Waste Quantity in 2040

Council name	Source	Waste type	Waste quantity (t)
Horsham Rural City Council	Kerbside	Residual organic waste	1,476
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	3,103
	Commercial	Residual organic waste	192,803
		Sub-total	**197,382**
Yarriambiack Shire Council	Kerbside	Residual organic waste	461
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	695
	Commercial	Residual organic waste	-
		Sub-total	**1,156**
Hepburn Shire Council	Kerbside	Residual organic waste	187
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	2,589
	Commercial	Residual organic waste	18,593
		Sub-total	**21,369**

Council name	Source	Waste type	Waste quantity (t)
West Wimmera Shire Council	Kerbside	Residual organic waste	183
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	651
	Commercial	Residual organic waste	288,014
		Sub-total	**288,849**
City of Ballarat	Kerbside	Residual organic waste	3,680
	Kerbside	Green organic waste	35,602
	Transfer Station	Garden organics drop-off	5,513
	Commercial	Residual organic waste	285,104
		Sub-total	**329,899**
Central Goldfields Shire Council	Kerbside	Residual organic waste	311
	Kerbside	Green organic waste	1,401
	Transfer Station	Garden organics drop-off	3,115
	Commercial	Residual organic waste	59,052
		Sub-total	**63,878**
Pyrenees Shire Council	Kerbside	Residual organic waste	455
	Kerbside	Green organic waste	528
	Transfer Station	Garden organics drop-off	1,024
	Commercial	Residual organic waste	-
		Sub-total	**2,007**
Northern Grampians Shire Council	Kerbside	Residual organic waste	1,513
	Kerbside	Green organic waste	-
	Transfer Station	Garden organics drop-off	4,261
	Commercial	Residual organic waste	582,765
		Sub-total	**588,539**
Sub-total			**1,493,078**
Additional waste	Central Highlands Water (CHW)	Forestry Plantation	6,107
	Wastewater Treatment Plant	Organic Biosolids	3,334
		Sub-total	**9,441**
TOTAL			**1,506,812**

Considering only FOGO from kerbside residual organic, kerbside green organic, and transfer station garden organics drop-off, **Figure 5** shows the proportion and potential FOGO quantities for each council for 2040. As shown in the figure, around 67% of potential FOGO is expected to come from the City of Ballarat.

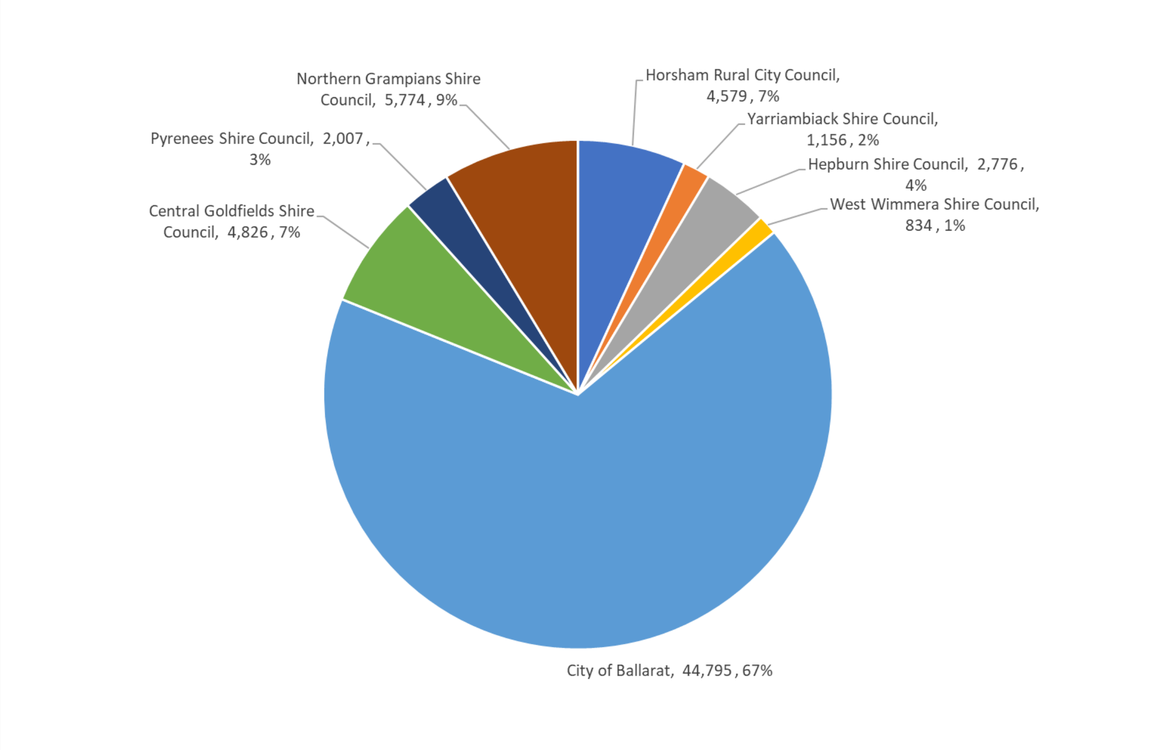


Figure 5 Potential FOGO - 2040

5.6 Summary

Table 10 provides a summary of potential quantities of all organic waste streams, including FOGO, WWTP biosolids, and commercial organics, for 2020 and 2040 from the eight councils. As indicated before, the growth of the volume is purely based on the waste quantities trend.

Table 10 Organic Waste Streams Summary for 2020 and 2040

Waste streams	Council name	2020 (t)	2040 (t)
FOGO	Horsham Rural City Council	2,491	4,579
	Yarriambiack Shire Council	830	1,156
	Hepburn Shire Council	2,227	2,776
	West Wimmera Shire Council	619	834
	City of Ballarat	17,320	44,795
	Central Goldfields Shire Council	2,451	4,826
	Pyrenees Shire Council	741	2,007
	Northern Grampians Shire Council	2,422	5,774
	Subtotal	**29,101**	**66,747**
WWTP biosolids		2,187	3,334
CHW forestry plantation		6,107	6,107
Commercial organics		1,178,472	1,426,331
TOTAL		**1,215,867**	**1,506,812**

The next stages of the project, including cost-benefit analysis, life cycle assessment (LCA) and multi-criteria analysis (MCA) were developed based on the waste streams and projected figures shown in this section.

6 Organics Processing Technologies

6.1 Technology Review

The opportunities for avoiding, reusing, recycling, or processing FOGO include a wide range of options of varying complexity. The processing options can be either biological, such as OWC, IVC and AD, or thermal, including incineration, gasification and pyrolysis.

Biological processing of organics involves harnessing the natural decomposition processes in a controlled environment to convert organic waste materials to useful and valuable products. Decomposition can either take place in aerobic conditions, when oxygen or air is present, or anaerobic conditions, when no oxygen or air is present.

In aerobic conditions, the degradable carbon in the organic matter is oxidised to carbon dioxide gas, with heat released in the process. Under anaerobic conditions, a different set of micro-organisms converts the carbon in the organic matter into a mixture of methane and carbon dioxide gases. By facilitating this decomposition in a controlled environment with optimised conditions including temperature, moisture, oxygen levels and nutrient balance, it occurs more rapidly and consistently, providing a predictable and manageable process to convert organic waste into valuable products.

In the case of anaerobic processes, the biogas, mainly methane and carbon dioxide, is also harvested and used for its energy value. Each technology is best suited to different types of organic feedstocks and products environments.

Aside from combustion, there are a number of newer thermal technologies that have been developed over recent decades to process waste feedstocks. These are collectively termed advanced thermal treatment (ATT) technologies, which includes various forms of gasification and pyrolysis.

This section provides the descriptions of the organics handling and processing technologies possible for processing FOGO in the region.

6.2 Waste treatment technologies

6.2.1 Open windrow composting

OWC, or turned windrow composting, is the most common and simple form of organics recovery and is often used to treat garden waste at a commercial scale. It can also be applied at a small scale such, as on-farm composting, which has the same operating principles and risk management approaches, regardless of size.

On a large open outdoor pad, the prepared feedstock is formed into long uniform prism-shaped ‘piles’ of material known as windrows. The windrows at commercial processing sites are typically up to 2-3 m high and 5-7 m wide at the base.

The windrows are then left for typically 8-12 weeks to compost. The exact duration is a function of the feedstock mix, turning frequency and local climate. Aeration in this case is passive – the air flows through the voids in the material, so it is important that the particles are not too small, wet, or compacted. Aeration is also provided through occasional mixing and turning. For small scale operations, turning may be undertaken by a front-end loader or tractor-drawn turning machine. Larger facilities are likely to use a specialised self-propelled compost-turning machine which drives along the windrow lifting and mixing the compost and reforming the windrow behind it.

Being an open process there is an increased risk of odour release, which is heightened whenever composting material is being moved, for example, during initial forming of the windrows or during turning operations. Open windrowing is generally not suitable for processing more odorous waste streams, including domestic and commercial food waste. It is also more difficult to control vermin and to ensure the material is evenly subjected to the sustained high temperatures that are required for pasteurisation. Victorian EPA guidance indicates that open windrow composting may not be appropriate in locations where there are insufficient separation distances for upset conditions. Hence, open facility may need to enclose operations and build suitable odour control equipment to minimise odours.[27]

Windrow composting is a low-cost method of processing organics and can be established with relatively low capital investment, including at small scales. However, it requires a large land footprint to accommodate the windrows and can be labour intensive. The uncovered windrows may produce leachate, both seepage from the compost and contaminated runoff, which needs to be captured and managed.

It is noted that there have been regional areas that are pursuing this based on buffers and surrounding industries, and at the moment the regulations apply the same level of requirements to a facility builit in the city to one in the regions.

6.2.2 In-vessel composting

IVC is a group of more advanced composting systems where the process is fully contained within a vessel or building, and closely controlled to accelerate the composting process.

IVC is particularly suited to more odorous waste streams such as food waste. Under the Victorian EPA composting guidelines, enclosed composting is likely to be required where the feedstock contains higher risk feedstock such as food waste, food processing waste, unsterilised biosolids, grease trap waste, fresh manure, and liquid organics. Under the guidelines, feedstocks containing FOGO is considered medium-high risk (category 3) and requires composting in an enclosed or a covered system that provides a level of engineered control and some level of control over odour emissions. The guidelines give some flexibility in that, in some situations, a 'covered environment' may include material covers over windrows (see section 4.1.3) or an appropriate layer of mature compost. However, for facilities which have sensitive receptors nearby, an in-vessel system is likely to be required. The guidelines do not specifically encompass AD, but it would likely be considered in the same way as IVC.

The containment 'vessel' may come in many forms including:

- Bays or beds within a building
- Rectangular tunnels
- Rotating horizontal drums

[27] Designing, constructing and operating composting facilities_EPA Victoria, 2017

- Plug flow composters
- Vertical flow silos or towers.

Most processes provide optimal and automated monitoring and control of composting conditions by providing:

- Mechanical agitation
- Controlled forced aeration to control oxygen supply
- Containment of heat to maximise pasteurisation
- Temperature and moisture monitoring
- Containment of process air which can then be treated to remove odours.

IVC can be an energy intensive process, predominantly for the power to provide the forced aeration. Typically, temperatures between 55°C and 65°C are achieved by IVC processes because the heat is contained in the vessel. Higher sustained temperatures have the advantage of destroying potentially pathogenic organisms in the waste and can also be used to dry material if desired (bio-drying).

IVC is a more intense form of composting but is often used to partially decompose and pasteurise the waste, followed by a secondary open composting and/or maturation phase. Hence the duration of the in-vessel phase will typically be between two and four weeks. This reduces the capacity requirement of the more expensive IVC phase but also adds to the overall site footprint requirement when the open windrow phase is included.

Odours are contained and captured by ensuring vessels are sealed and air is continuously extracted to maintain the vessel under negative pressure. The extracted process air is usually treated through a bio- filter. The waste is also contained from vermin and protected from weather conditions, including rainfall which might produce excessive leachate. Any leachate that does seep out during the composting process is captured and recirculated back into the compost.

Aeration is provided in a variety of ways:

- In most tunnel systems, the compost is static, and aeration is provided from a blower through a network of perforated pipes in the tunnel floor, either positive or negative
- In rotating drum systems, aeration is provided through the constant mixing and turning of the rotating waste
- In hall systems, a variety of mechanical turning equipment is used including bucket wheels, augers and windrow turning machines.

IVC systems generally can either operate in batch mode, as in tunnel systems, or in continuous processing mode, as in hall composting and rotating drum systems where fresh feedstock is regularly added at one end, and compost removed from the other.

Plug flow and vertical flow systems are usually small scale, suitable for commercial premises, institutions, or precinct solutions. Plug flow systems are continuous flow and provide mixing by way of paddles or tynes on a rotating axle within a horizontal cylinder. Vertical silos have no mixing, but passive aeration is encouraged by the varying temperature profile within the tower.

6.2.3 Vermicomposting

Vermicomposting, or vermiculture, involves the biological decomposition of organic waste, generally food waste, biosolids, manures or nitrogen-rich garden waste, by worms and other microorganisms. It is generally suitable for high moisture, softer organics, or materials such as food waste, commercial and industrial organics, manures and biosolids. The worms can be sensitive to chemical contaminants in the feedstock or changes in conditions.

Vermicomposting can be used with other materials such as garden waste, if they have been pre-composted to be more digestible by the worms. Unless the materials have been pasteurised through a composting process, vermicomposting may not destroy weed seeds and pathogens.

There are three basic types of vermicomposting systems:

- Windrows - batch or continuous
- Beds or bins - batch or continuous
- Flow-through reactors - continuous.

The worm castings, also called vermicompost, are generally superior in quality and soil benefits to that of conventionally produced compost. They can be used without further stabilisation, however, may be pelletised to improve handling. Excess worms can be harvested and are a valuable protein source for fish and animal feeds. Liquid fertiliser can also be produced by diluting and stabilising the castings.

In general, the process requires more labour, space and time for decomposition and harvesting of the worms. It is more sensitive to environmental conditions than composting including temperature and acidic feedstocks. As such, its uptake on a commercial scale has been limited. There is a small number of operators using the process with a primary focus on producing castings and worms. An example is Australian Vermiculture based in Mildura, with a facility in South Australia supplying products to farmers.

Vermiculture is normally a specialised or tailored approach, and it is not common in large scale operations.

6.2.4 Anaerobic digestion

AD involves the biological decomposition of organic waste in the absence of oxygen, which results in the production of methane-rich biogas. It involves a complex system of different microbe groups, which must be carefully controlled to produce an optimal output of biogas. Like composting, AD still results in an organic residue (called digestate) which has value as a soil conditioner product. The benefit over aerobic processing, is the opportunity to also extract energy during the process. This comes with additional cost and complexity, which needs to be balanced against the potential revenues from energy sales.

AD is an established technology in Australia for treating:

- sewage sludge from municipal wastewater treatment plants
- wet agricultural waste - piggery waste and
- food and beverage processing residues - brewery waste.

It has also been used to process commercial food waste and food processing waste at dedicated facilities such as EarthPower in Sydney, Richgro in Perth and more recently, Yarra Valley Water's facility digesting commercial food waste.

AD is common internationally, particularly Europe and UK, as a treatment technology for food and/or garden waste, which may be blended with other streams including biosolids and manure. AD processes can be more sensitive to feedstock and environmental changes, compared with composting.

There are two principal approaches to the anaerobic digestion of organic waste:

- 'Wet' AD processes – are most common and typically used to treat materials which are in, or can be made into, a liquid or slurry phase, usually with a solids content of no more than around 15%
- 'Dry' AD processes – are used to treat materials which are solid, stackable, not easily soluble and with solids content of more than 20%.

A high-level comparison of wet and dry AD systems is provided in **Table 11**.

Table 11 Comparison of wet and dry AD systems[28]

Comparison Criteria	Wet AD	Dry AD
Input material	Maximum 20% total solids, based on continuously stirred tank wet AD systems	20 – 40% total solids
Water consumption	Dilution may be necessary	Percolate recirculation
Digestate	Pumpable prior to solid or liquid separation	Removed with loader or specially designed discharge equipment
Manpower need	Typically operated automatically with minimum manual intervention	Manpower required for loading or unloading
Biogas production	Sustained production	Sequenced production over time

The existing AD systems in Australia and most of the systems globally are 'wet' systems. 'Dry' systems are usually applied where the feedstock includes larger solids contents including garden waste or other materials that are insoluble or difficult to macerate, for example, plantation residues. This makes the dry AD process much more suitable for FOGO waste.

6.2.4.1 Wet anaerobic digestion

In wet AD, the digestion takes place in a liquid or wet slurry phase. The feedstocks are typically wet and soft such as food waste, food processing waste, manures, biosolids or organic rich industrial slurries. Wet AD systems use organic material with consistency of 5-20% total dry solids (DS). Digestion takes place in enclosed tanks which are continuously stirred to enhance contact between microbes and the waste. Retention times are in the order of 15-30 days. Feedstock is typically diluted to form a pumpable slurry, between 5-10% DS. Heating is achieved through the use of heat exchangers to heat the feed material which is pumped into the digester.

Wet AD systems can be operated at mesophilic temperatures, between 35-40°C, and thermophilic temperatures (between 55-60°C). In some agricultural situations, digestion takes place in a covered pond with no mixing, which is cheaper to install and run, but less efficient.

There have been many, mostly unsuccessful, attempts to apply wet AD processes to the organic fraction separated from mixed waste. In most cases, the higher rates of chemical and physical contaminants have been detrimental to the process.

[28] State-of-the-art dry and wet anaerobic digestion systems for solid waste, https://www.biogasworld.com/news/dry-wet-anaerobic-digestion-systems/

6.2.4.2 Dry anaerobic digestion

Dry AD systems are designed for drier feedstocks including woody materials or feedstocks that have higher lignin content (the woody or fibrous structural material of plants) and are generally not soluble. Dry AD systems treat organic material with consistency of 20-40% total dry solids. The digestion reactions still occur in the liquid phase, through the constant recirculation of leachate over the waste mass. Dry AD systems can operate at both mesophilic and thermophilic conditions, although more commonly operate in the higher temperature range, due to the higher solids content and greater heat production from microbial activity.

Digestion in a dry AD plant can take place in an enclosed horizontal cylinder or concrete tunnels. It can either be a continuous plug flow process or a batch process. ‘Garage’ style digesters are similar in appearance and construction to concrete composting tunnels whereby batches of waste are placed in the tunnel by a front-end loader and then the doors are closed to seal the vessel for batch processing. This modular approach provides a high degree of flexibility in scale and future expansion options. A minimum of four tunnels is usually required to allow the batch process to act as a pseudo-continuous process in terms of both waste loading and gas production.

The digestate is usually in solid phase with the liquid retained in the process. A further phase of aerobic composting and maturation of the solid digestate will be required to fully stabilise the residues and make them suitable as a soil conditioner. The digestate can be composted on its own or co-composted with garden waste. This should be allowed for in the space and cost allocations for the project, or alternatively the digestate could be composted off-site.

Dry AD technologies have been used extensively in Europe and increasingly in North America, to process co-collected domestic kerbside food and garden waste, as an alternative to in-vessel composting. At medium to large scales, it can be cost competitive with IVC. It could also be used to process the organic fraction separated from mixed waste, being more robust than wet AD systems in this respect, but care will still be required to manage chemical contaminants.

6.2.5 Thermal treatment

Thermal treatment technologies primarily comprise technologies employing pyrolysis and/or gasification to process solid waste feedstock. Historically, the processes of gasification and pyrolysis of solid non-waste materials have been used extensively to produce fuels such as:

- charcoal by pyrolysing wood
- coke by pyrolysing coal and
- town or producer gas by gasification of coke in the presence of air and steam.

In recent years gasification has been commercially applied to the treatment of municipal solid waste, although on a limited scale in comparison to conventional incineration. Funabashi City, Japan, commissioned a commercial scale pyrolysis facility treating mixed residual waste in 1983, but this was subsequently closed in 1990 ‘due to insoluble technical problems’.

Pyrolysis processes involve the exposure of organic materials to temperatures in excess of 400°C in the complete absence of oxygen. Gasification is the partial thermal degradation of a substance in the presence of oxygen but with insufficient oxygen to oxidise, or combust, the fuel completely. The gasification process itself typically takes place at temperatures of approximately 800°C.

Pyrolysis and gasification processes usually take place in two chambers – the first chamber is where the waste feedstock is gasified or pyrolysed to produce a combustible gas, referred to as 'syn-gas', which is then transported to a secondary chamber for combustion to produce energy.

Syn-gas contains varying proportions of hydrocarbons, carbon monoxide and carbon dioxide and either be converted into energy using gas or steam turbines, or alternatively used as a feedstock for synthesis of new chemicals.

As with conventional incineration, these processes include four main stages:

- Waste reception or processing
- Pyrolysis and/or gasification
- Energy recovery (steam) or generation of electricity (turbo-generator) and
- Air pollution control.

Unlike conventional incineration, the pyrolysis and gasification processes are not ideally suited to treating residual waste without being pre-processed to remove metals and unsuitable items and then shredded to homogenise the material. Pre-processing is often done off-site at a separate location but can also be undertaken in-situ by expanding the waste reception stage. The pre-processing plant would normally contain a system of shredders, trommels and separation equipment for metals. These technologies can also be used to treat the refuse derived fuel (RDF) or solid recovered fuel (SRF) output from mechanical and biological treatment (MBT) plants. A further segregation of metals that remain in the RDF or SRF feedstock can also occur during the process.

Gasification or pyrolysis technologies can be further characterised by the means of energy generation. For example, gas turbine rather than steam turbine and the position of the gas clean-up section either before or after energy generation.

6.3 High-level SWOT

This section provides a high-level analysis of options of the inherent strengths and weaknesses and external opportunities and threats of each of the options based on our industry experience and information in the public domain seen in **Table 12**.

Table 12 SWOT analysis of FOGO treatment technologies

Technology	Strengths	Weaknesses	Opportunities	Threats
Open windrow Composting Processing site: Static aerated pile, mobile aerated floor, reverse aeration, covers. Targeting feed streams: Garden waste, FOGO waste, primary industry and manufacturing by-products, coir waste, biosolids, digestate). Notably, can process compostable packaging.	- Can be a relative low-cost option that can produce quality product that is of environmental and economic value to the agricultural producers and the consumers (soil health, environmental benefits) - Proven technologies that can be adapted in most areas using existing human and technological resources - Well-established and proven, with multiple plants operating across Australia - Produces quality mature compost which improves soil health, reduces irrigation needs and improves farming productivity, can be nutrient-rich, depending on feedstock - Off-the-shelf solutions exist - Produces large quantities of valuable product - Can be pelletised or granulated with customised nutrient additions - Can handle a wide variety of waste streams as well as compostable packaging. - Can handle contamination with technological fittings and processes.	- Without aeration control (such as static piles or loader based operation), anerobic conditions can result in poor product and environmental impacts - Requires large area, sealed surfaces and setbacks from sensitive receptors - Microplastics, PFAS and other contaminants can be found in compost from organic waste.	- Develop agricultural or horticultural market for compost and compost products - Develop an urban market for FOGO compost which can also function as an education tool for 'quality in, quality out' - Pelletisation or granulation of compost to increase value and market opportunities - Farmers can earn carbon credits for using compost on farms - Developing market(s) with customised quality products for agricultural and urban use (landscaping, domestic).	- Lack of market demand for end products (however, this can be mitigated by developing the market with quality products for agricultural and urban use) - Operators that under design capacity may undertake pre-shredding making it difficult to remove contaminants. - Transport costs may be prohibitive - Farmers may find spreading compost time consuming and complicated as it requires special equipment. - Potential to create glut of product.

Technology	Strengths	Weaknesses	Opportunities	Threats
In-vessel composting Processing site: Tunnel, geofabric covers, vertical, screw Target feed streams: FOGO, garden waste, manure, sludges, timber.	- Highly controlled odour and leachate management capability with no outside influences - Ability to be located in more sensitive areas with less buffer due to the highly controlled management of environmental risks - Well-established and proven, with multiple plants operating across Australia - Off-the-shelf solutions exist - Other benefits as per 'Composting'.	- Inherent high capex and opex results in high gate fees - Compostable packaging may be problematic since in practice many facilities do not allow adequate time for these items to decompose - Likely to involve substantially higher capital costs and be more expensive to operate than OWR composting facility - Lower value product ($/tonne) compared to some other high-cost processing options - Limited scalability given fixed equipment - Requires large areas for maturation - The initial composting processing in the vessel is short (2-3 weeks) and produces an immature product. Once it is exposed to the environment and cools, the product can be sensitive to regrowing a bacterial load, such as, faecal coliforms and salmonella).	- As above for OWR compost.	- High difficult to compete with OWN facility gate fees - Potentially unable to compete with low landfill costs - Compostable packaging becomes widespread and may not be accepted by in-vessel composting facilities - Lack of market demand for end products if expensive - Remainder as above for OWR composting. - Potential to create glut of product.

Technology	Strengths	Weaknesses	Opportunities	Threats
Vermiculture Target feed streams: FOGO, garden waste, bulking agent (paper/ cardboard, wood and timber).	- Can be set up in buildings and near households, scalable - Can be a low-tech option - Produces vermicast or vermicompost (brown soil-like material that is produced after organic materials have passed through the digestive system of a worm) which is a valuable soil conditioner - Various types of facilities or methods (windrows or beds, stackable trays, batch-flow containers, and continuous flow containers), so it may be possible to match the vermiculture equipment with the limitations of a site - Helps reduce waste as worms consume some of the organics and the vermicast is used which is a small proportion of the original feedstock quantity - A liquid output from the process is a valuable soil amendment - Soil and plant health improvements.	- Does not accept high-nutrient organics such as seafood, fish, and dairy products - A reasonably complex and hands-on process; consideration of temperature, moisture, oxygen levels, feedstock, protection from other pests, etc., are all important - Pre-processing of feedstock may be required (size reduction, mixing, adding bulking agent, and others)	- May be appropriate for certain applications or co-locate with food manufacturers or other sites that have suitable feedstock for vermiculture - Could be used as a training or learning tool (teaching school or university students, and others, about organics processing and nature).	- Contamination of feedstock - Worm death, for example, due to disease.

Technology	Strengths	Weaknesses	Opportunities	Threats
Anaerobic Digestion Target feed streams: FOGO, garden, timber, straw, and other organic streams with high total solids (>15%).	- Proven technology for dry AD (but not in Australia yet) - Generates renewable biogas which can displace fossil fuels - Suited to a range of streams - Lower risk of odour issues due to biofilter and negative air pressure - Digestate has potential fertiliser value.	- Higher capital and operating costs than lower tech solutions - Financial viability may be challenging without renewable energy subsidies (which help make them viable in Europe) - Digestate likely to require further processing before it is suitable to use as a product - Limited scalability given fixed equipment - Wet AD is not suitable for green organics	- Increase landfill levy to make technology more viable - Co-locate with manufacturing plant and/or other energy-intensive facility - Co-locate with composting facility and send digestate to composter for secondary processing into nutrient-rich product - Convert biogas into biomethane for transport fuel or gas grid.	- Potentially unable to compete with low landfill costs - Finding suitable sites, with adequate buffers, that are close to both waste sources and end markets - Market options or demand for digestate may be limited - Sensitive to the price of electricity fed into the grid, which can be low, if not used by associated industry - Cost of technology and compliance.
Advanced Thermal Treatment (Gasification or Pyrolysis) Target feed streams: Timber and oversized materials sent to composting facilities.	- Produces biochar and energy (syngas) - Carbon credits possible when land applied - Can take oversized items from compost processors - High value ($/tonne), stable output, easy to transport - Can be part of a process leading to hydrogen production.	- High capital cost compared to low-tech solutions - Some feedstock limitations (items should not be too moist/large).	- Developing markets in blended products e.g., biochar and compost and carbon sequestration.	- Finding suitable sites, with adequate buffers, that are close to both waste sources and end markets - Uncertainty on financial viability due to emerging market.

6.4 Details of facilities in Australia and overseas

This section also provides details of facilities in Australia and overseas that use these technologies, elements of them or combinations of them.

The details of Australian facilities with the types of technology and other information including risks can be found in **Appendix C**. **Appendix D** shows details of international facilities, for which different information is available. This includes the technology type, capacity, and costs where available.

7 Market analysis

7.1 Waste Facilities in the Grampians Region

The Grampians Central West (GCW) region comprises 12 councils in Victoria, covering an area of over 50,000 km^2. This is about 21% of the state.[29] In 2013-2014, the region generated approximately 492,000 t of waste, of which 66% was recovered and 34% was sent to landfill.[30]

The diversion of organics from landfill is a significant opportunity for the region to reduce the quantities of material going to landfill, which would help to increase the life of landfill and to reduce the greenhouse gas emissions that are generated in landfill. There are currently three landfills operating in the GCW region. The details are shown below in **Table 13**.

Table 13 Landfills in Grampians Central West region[31]

Landfill	Operated by	Waste from
Stawell (Cleanaway) landfill	Cleanaway.	• Ararat Rural City Council • Central Goldfields Shire Council • Northern Grampians Shire Council • Pyrenees Shire Council
Dooen (Horsham) landfill	Horsham Rural City Council	• Hindmarsh Shire Council • Horsham Rural City Council • West Wimmera Shire Council • Yarriambiack Shire Council
Smythesdale (Ballarat) landfill	City of Ballarat	• Ballarat City Council • Hepburn Shire Council

Transfer stations operating in the Grampians councils that are subject to this project are shown in **Table 14** below.

Table 14 List of transfer stations in Grampians region

Council	Transfer Station Name	Address or Location
City of Ballarat	Gillies Street Transfer Station	119 Gillies Street South, Alfredton.
Central Goldfields Shire Council	Carisbrook Transfer Station	125 Williams Road Carisbrook
	Talbot Transfer Station	Rocky Flat Road, Talbot
	Dunolly Transfer Station	1656 Maryborough-Dunolly Road, Dunolly
	Bealiba Transfer Station	White Hills Road, Bealiba
Hepburn Shire Council	Daylesford Transfer Station	Ajax Road, Daylesford
	Creswick Transfer Station	Ring Road, Creswick
	Trentham Transfer Station	Cosmo Road, Trentham
Horsham Rural City Council	Horsham Transfer Station	93 Kenny Road Horsham

[29] Grampians Region Organics Review, 2018
[30] Snapshot: Grampians Central West Waste and Resource Recovery Implementation Plan, 2017
[31] Review of Council Municipal Waste Services and Waste Management Plan 2015, Pyrenees Shire Council

Council	Transfer Station Name	Address or Location
	Toolondo Transfer Station	Telangatuk East, Rocklands Road, Toolondo
	Mt Zero Transfer Station	Wonwondah, Dadswells Bridge Road, Laharum
	Quantong Transfer Station	497 Lanes Avenue Quantong
Northern Grampians Shire Council	Stawell Transfer Station	36 Lavett Road, Stawell
	St Arnaud Transfer Station	329 Old Wedderburn Road, St Arnaud
	Halls Gap Transfer Station	4300 Ararat Halls Gap Road, Halls Gap
Pyrenees Shire Council	Avoca Transfer Station	71 Russell Street, Avoca
	Beaufort Transfer Station	2 Tip Road, Beaufort
	Landsborough Transfer Station	2161 Ararat -St Arnaud Road, Landsborough
	Snake Valley Transfer Station	298 Snake Valley -Morchup Road, Snake Valley
Southern Grampians Shire Council	Balmoral Transfer Station	55 Horsham Road, Balmoral
	Branxholme Transfer Station	92 Branxholme-Byaduk Road, Branxholme
	Cavendish Transfer Station	2478 Henty Highway, Cavendish
	Coleraine Transfer Station	42 Robertson Street, Coleraine
	Dunkeld Transfer Station	7 Bellicourt Road, Dunkeld
	Glenthompson Transfer Station	Boundary Road, Glenthompson
	Hamilton Transfer Station	Elijah Street, Hamilton
	Penshurst Transfer Station	5408 Hamilton Highway, Penshurst
Yarriambiack Shire Council	Speed/Tempy Transfer Station	Sunraysia Highway, Tempy
	Patchewollock Transfer Station	Hopetoun - Walpeup Road, Patchewollock
	Yaapeet Transfer Station	Rainbow - Yaapeet Road, Yaapeet
	Hopetoun Transfer Station	Hopetoun - Yapeet Road, Hopetoun
	Beulah Transfer Station	Birchip - Rainbow Road, Beulah
	Woomelang Transfer Station	Church Street & Duthies Road South, Woomelang
	Warracknabeal Transfer Station	Golf Links Road, Warracknabeal
	Minyip Transfer Station	Minyip - Rich Avon Road, Minyip
	Rupanyup Transfer Station	Dyer Street, Rupanyup
	Murtoa Transfer Station	Murtoa - Rupanyup Road, Murtoa

Table 15 shows facilities classified as organics processing facilities in the Grampians Region.

Table 15 Organic processing facilities in the Grampians Region

Facility Name	Operator	Local Government Area	Stage	Infrastructure Type	Primary capability
Active Research - Ballarat AD NEW	Active Research	Ballarat	Energy recovery	Bioenergy	Anaerobic digestion
Ballarat Green Waste Interchange	City of Ballarat	Ballarat	Transfer	Staging facility	
BE Bioenergy	BeBioenergy	West Wimmera	Energy recovery	Bioenergy	Biofuels production
Beaufort Hospital	Beaufort Skipton Health Service	Pyrenees	Energy recovery	Bioenergy	Biomass boiler/heat
Berrybank Farm Windermere	Berrybank Piggery (Charles Ife Pty Ltd)	Ballarat	Reprocessing	Reprocessing Facility	Composting in-vessel
Carisbrook	Central Goldfields Shire Council	Central Goldfields	Reprocessing	Reprocessing Facility	Composting in-vessel
Castlegate James (James and Son)	Castlegate James	Ballarat	Reprocessing	Reprocessing facility	Other
Creswick In-vessel composting	Hepburn Shire Council	Hepburn	Energy recovery	Bioenergy	Composting in-vessel
Davo's Worm Farms	Davo's Worm Farms	Hepburn	Reprocessing	Reprocessing Facility	Other
Delorean Energy - Calix Bioenergy NEW	Delorean Energy	Moorabool	Energy recovery	Bioenergy	Anaerobic digestion
Frews Abattoir	Frew Group	Northern Grampians	Energy recovery	Bioenergy	Biomass boiler/heat
Garden Recycling Centre	GRC	Ballarat	Reprocessing	Reprocessing Facility	
Good Dirt Lethbridge	The Good Dirt Company	Golden Plains	Reprocessing	Reprocessing Facility	Composting open windrow
Horsham Green Waste Processing	Horsham Rural City Council	Horsham	Reprocessing	Reprocessing Facility	Organics stockpiling
Horsham Rural City Council - AD NEW	Horsham Rural City Council	Horsham	Energy recovery	Bioenergy	Anaerobic digestion
Ken Davey - Pyrenees Shire Straw Digestion AD NEW	Pyrenees Shire	Pyrenees	Energy recovery	Bioenergy	Anaerobic digestion
Maddingly Brown Coal	Calleja Group (Maddingley Brown Coal)	Moorabool	Reprocessing	Reprocessing facility	Composting open windrow
MBC Commercial Landscape Supplies	Calleja Group	Moorabool	Reprocessing	Reprocessing Facility	
McCain Foods Ballarat Plant - new AD	McCain Foods Ltd	Ballarat	Energy recovery	Bioenergy	Anaerobic digestion
Meredith Dairy	Meredith Dairy	Golden Plains	Energy recovery	Bioenergy	Biomass boiler/heat
Organics Waste Processing Facility	Australian Bio Fert	Golden Plains	Reprocessing	Reprocessing facility	Thermal processing
Paarhammer Pty Ltd	Paarhammer Pty Ltd	Moorabool	Energy recovery	Bioenergy	Multiple
Pacific Heat & Power - Ararat Biomass Project NEW	Pacific Heat & Power	Ararat	Energy recovery	Bioenergy	Biomass boiler/heat

Facility Name	Operator	Local Government Area	Stage	Infrastructure Type	Primary capability
Parwan Valley Mushrooms	Parwan Valley Mushrooms	Moorabool			
Pinegro Products Mt Wallace	Pinegro Products Pty Ltd	Moorabool	Reprocessing	Reprocessing Facility	Composting open windrow
Pyrenees Sawmill	Pyrenees Timber Pty Ltd	Pyrenees	Energy recovery	Bioenergy	Biomass boiler/heat
Skipton Hospital Straw Boiler	Beaufort Skipton Health Service	Corangamite	Energy recovery	Bioenergy	Biomass boiler/heat
Trigg Dairy	Trigg Ron Farming	Moorabool	Energy recovery	Bioenergy	Anaerobic digestion
UniGrain	UniGrain Pty Ltd	Hepburn	Energy recovery	Bioenergy	Biomass boiler/heat
Waste to Energy Facility (JBD Industrial Park)	Calleja Group (Maddingley Brown Coal)	Moorabool	Energy recovery	Bioenergy	Thermal processing

7.2 Organics Markets

Different types of organic waste require different technologies and treatment systems. As described in Section 5, more than 1,209,700 t of organics were generated in the region in 2020-2021. This included around 29,000 t of FOGO, 2,200 t of biosolids and 1,178,500 t of commercial organics.

Previous sections, including Section 5, of this report already show the following:

- types of organic material feedstock that may be available
- quantities of this feedstock
- the locations of its sources and destinations and
- how the existing markets are measured and/or monitored.

SLR examined the market more broadly to cover the state and include an assessment of market maturity, potential for growth and/or diversification of products. The focus of this analysis is on diverse and sustainable markets in the region although this depends on the following:

- the types and quantities of feedstock available
- potential markets for product and
- the number and types of facilities that would be required to produce materials required by the markets.

The potential markets for the organic products could be compost, mulch, energy, soil conditioner, or other products. This section examines an analysis of the potential markets for organics products, waste-to-energy and refuse derived fuel in the Grampians region.

There are at least five facilities in the region accepting, aggregating and/or reprocessing organics.[32] Castlegate James, which manages around 40–50% of the organics total and is the only facility which accepts food waste, and Calleja Transport, which manages 40–45% of the organics total, are the major reprocessors of organic materials.

The Horsham Garden Recycling Centre, Davos Worm Farms and the Garden Recycling Centre (Ballarat) manage significantly smaller quantities. The Central Goldfields Shire Council currently operates an in-vessel composting facility, which manages the garden waste from its voluntary kerbside organics collection. The facilities produce a range of organic products, including composts, soil conditioners and biodiesel. Community expectations around the operation of facilities are likely to minimise the establishment of open windrow composting.

A number of landfills stockpile garden organic waste, which is not included in data on the quantity of organics managed in the region as it does not leave the site where it is deposited. This organic material is either mulched and used by councils for horticultural applications at parks and reserves, or occasionally offered to the community, used for daily cover or rehabilitation of landfills, and, as a last resort, disposed of using alternative methods.

In the region, organics are recovered and re-used in a number of other ways as follows:[33]

[32] Grampians Central West Waste and Resource Recovery Implementation Plan, 2017
[33] Grampians Central West Waste and Resource Recovery Implementation Plan, 2017

- Councils chip garden and woody waste to produce a raw mulch, which does not have an end market, but is used in their own horticultural practices and in some locations made available to residents as mulch.
- Mulch is used in combination with soil as a weekly or daily cover at some landfill sites
- Aquatic plant material harvested from Lake Wendouree is made available to residents and the community to take as they wish for domestic horticultural use such as mulch.
- A wide range of materials is composted into certified composts and soil additives.
- The wine industry uses some compost as mulch.
- The re-use of clean timber in medium-density fibreboard and particle board.

Councils indicated some issues with garden organics relate to contamination by way of what impurities are included when the material is received, the ability to chip garden organics down to a smaller size for composting, managing the stockpile, and the ability to functionally dispose of or sell the end material. It may be warranted for relevant stakeholders in the region to continue to examine potential agricultural sources for organics reprocessing such as wheat protein, stubble, and any other suitable by-products.

The GCWWRRG encourages residents in communities to compost more at home and use compost in their own gardens. The GCWWRRG Implementation Plan reinforces the need for addressing the issue of organic waste in the region.[34]

In the east of the Region, including Central Goldfields, Ballarat, Hepburn, and Pyrenees, a number of organic processing facilities have potential capacity to receive and process municipal organics in addition to those already processed from current kerbside organic collection services. Several potential processing options are identified in this Region, including the significant potential capacity of the PineGro composting facility at Mt Wallace located in Moorabool Shire Council, which has the capacity to process an additional 30,000-35,000 t per year.[35]

The west of the Region, including Horsham, Northern Grampians, West Wimmera and Yarriambiack, is lacking existing processing services and infrastructure, and requires a composting facility in this West of the Region. The Mt Wallace composting facility and other prospective facilities would enhance the region's prospects of having sufficient capacity to strengthen respective local and regional markets.

Recycled organic products, produced by processing garden and food waste collected across the Region, could include composts, soil conditioners and mulches. Markets for recycled organic products are currently varied in their maturity, stability, and degree of penetration. The main market is the urban amenity market, such as landscaping.[36]

Future market opportunities exist in agriculture markets, for example vegetables and broad acre cropping, where there is potential for large scale use of recycled organic products. Building market confidence in recycled organic products will increase demand for these products over time. To achieve this, it is essential that recycled organic products are highly visible in the market, well understood both in their potential uses and long term benefits and are fit for purpose and of high and consistent quality.

[34] Grampians Central West Waste and Resource Recovery Implementation Plan, 2017
[35] Grampians Region Organics Review, 2018
[36] Recycled organics market development, Sustainability Victoria, 2021

Sustainability Victoria provided a summary of the market by organic waste supply, organic product and use in 2011-2012[37], and this is shown in **Figure 6**.

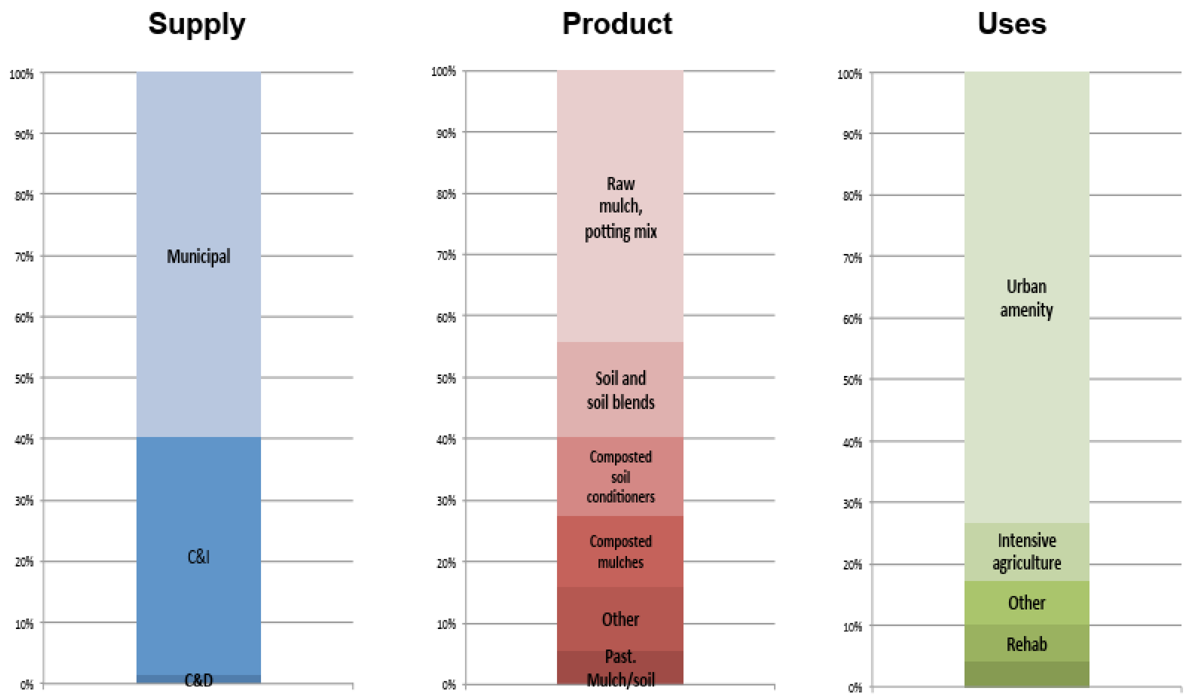


Figure 6 Recycled organics market supply, products and use by market share in 2011-12[38]

The key findings from this summary are:

- MSW was the largest source of organic markets, accounted for 60% of supply, and most of this was composted and some of this was shredded for use as mulch. This was almost entirely garden organics from green bins and drop-off to transfer stations. C&I accounted for 39% of supply and consists of forestry residuals, followed by construction and demolition waste, which was only 1% of supply and consists of timber.
- Uncomposted mulch was the major product for the urban amenity market, accounting for 44% by volume of market share. This was mostly high value output but contained some 'budget' products created from recycled timber sources. This category was described in the figure as raw mulch, potting mix.
- Composted and pasteurised soil conditioners and soil blends, which were processed from green waste, accounted for 29% of market share, were mostly used in the urban amenity market, but were also used in agriculture and environmental remediation.
- Composted and pasteurised mulches, which were also processed from green waste but with larger particle size, accounted for 18% by volume of market share and used in the urban amenity, agriculture, and remediation as a mulch product.

[37] Recycled Organics Market Analysis, 2013, Sustainability Victoria
[38] Recycled Organics Market Analysis, 2013, Sustainability Victoria

- Urban amenity accounted for almost three quarters of market sales, which was 73% by volume. Intensive agriculture accounted for 9% of market share, followed by rehabilitation (6% by volume) and environmental remediation (4% by volume).

Based on the estimated organics (as discussed in Section 5) for the region, it is predicted that the amount of composted materials is likely to increase over the next few years, thereby potentially creating an oversupply in the local market. Councils would need to closely monitor the demand for compost in the local region and adjust supply to meet the expected demand. Councils might also need to encourage agriculture and horticulture authorities to switch over into the new compost materials from traditional fertiliser / soil amendments.

7.3 Local Energy Market

7.3.1 Overview

Generating energy from waste provides the opportunity to extract value from waste materials that would otherwise be landfilled. This helps reduce reliance on landfills and prolongs landfill capacity. It also helps reducing greenhouse gas emissions and environmental impacts through the diversion of organic material going to landfill and reduces transport of waste where waste-to-energy facilities established near the production of the feedstock. The waste-to-energy technologies include thermal treatment, like incineration, gasification and pyrolysis, and biological processing, like anaerobic digestion.

The main types of waste-to-energy technologies, general applicability and typical scale are shown in **Table 16**. Some of these technologies are better suited to separated or homogeneous waste streams such as food waste or timber and others are better suited to mixed or heterogeneous waste streams such as mixed residual waste.[39]

Table 16 Waste to Energy Technologies and General Applicability

Waste Material	Food Waste	Garden Waste	Timber	Residual Waste
Anaerobic Digestion	X			X
Pyrolysis		X	X	
Gasification		X	X	
Large Scale Incineration				X
Small Scale Incineration, such as industrial boilers			X	
Landfill Gas Recovery				X

Bioenergy generates an estimated 2,500 GWh of electricity in Australia per year, contributing around 1% to Australia's electricity and around 12% of renewable energy generation. Around 10% of the world's primary energy consumption comes from bioenergy, the majority of which is used directly for heat, with around 4% being used for electricity generation.[40] Currently, bioenergy is one of the most used renewable energy sources in Victoria. Most of the bioenergy used is comprised of wood and wood-waste in the pulp and paper industry and in residential fireplaces. There is a significant potential to increase the use of bioenergy in Victoria.

Any facility with a capacity of under 1 MW electrical or 3 MW thermal requires local government approval.[41] Anything above those thresholds requires EPA approval through its Development Assessment Unit. There are a

[39] Waste Management and Resource Recovery Strategy, Hepburn Shire Council, 2014
[40] Bioenergy, Victoria State Government, https://www.energy.vic.gov.au/renewable-energy/bioenergy
[41] Bioenergy Fact Sheet, Victoria State Government

series of state environmental protection policies administered by the EPA that apply for bioenergy facilities. Energy Safe Victoria also has a role where gas handling or electrical conversion pathways are involved.

The Grampians Central West region has been innovative over the years in relation to EfW. A number of projects of varying scale demonstrate the investigations and resultant solutions that have proved beneficial to operators and communities. The City of Ballarat has done extensive investigative work in this area, including establishing a memorandum of understanding with an offtake partner to receive one of the end products – electricity – and identify a designated site immediately adjacent to the proposed transfer station to provide for synergy between these two uses. The City envisages private sector investment and continues to explore partnerships with potential parties, with the aim of developing a facility over the five-year timeframe. Should this facility be established, it may have implications on the broader infrastructure managed by Council, in particular the Ballarat Regional Landfill (Smythesdale) site.[42]

As the technologies suited to MSW require large quantities of waste, at least 100,000 t per year depending on the technology, to justify the large capital outlay involved, over $30 million for most systems, the City of Ballarat intends to work in collaboration with other councils and the GCWWRRG to investigate and assess innovative opportunities for energy from waste across the Grampians Region.[43]

A number of councils support EfW investigations, with improved sorting and feedstock production and GCWWRRG should continue to work with them. For example, Pyrenees Shire Council Waste Management Plan recommends that the Council promote the introduction of regional solutions with GCWWRRG, including the reintroduction of regional garden waste shredding, soil conditioner production and use, and an investigation into EfW systems. Many of the smaller councils are enthusiastic to learn what may be suitable for their local towns and industry.[44]

Hepburn Shire Council is progressing the planning and implementation of a local-level EfW facility. This project will convert organic garden municipal and commercial waste into a slurry. This slurry would then be used as feedstock for a number of processes including:[45]

- conversion into bioenergy through an anaerobic biodigester and then incinerated for electricity and heat
- conversion into compost
- other potential uses.

There are several waste-to-energy facilities operating in the Grampians Region. Some of the key waste to energy projects in the Region are discussed below.[46, 47]

[42] Grampians Central West Waste and Resource Recovery Implementation Plan, 2017
[43] Resource Recovery and Waste Management Strategy 2018-22, City of Ballarat
[44] Resource Recovery and Waste Management Strategy 2018-22, City of Ballarat
[45] Resource Recovery and Waste Management Strategy 2018-22, City of Ballarat
[46] Waste to Energy Projects in the Grampians, Grampians Central West Waste and Resource Recovery, https://recyclingrevolution.com.au/wp-content/uploads/2020/02/SDD200130-GCW-W2E-4pp-A4-Projects-brochure-v3-LR.pdf
[47] Waste to Energy, Grampians Central West Waste and Resource Recovery, SDD200130-GCW-W2E-2pp-A4-Overview-brochure-v6-LR.pdf (recyclingrevolution.com.au)

7.3.2 Berrybank Farm – Windermere

Berrybank Farm is a large piggery just west of Ballarat. It has a significant waste management system consisting of an anaerobic digester that turns piggery effluent (waste) into biogas to generate electricity energy, potting mix and an odourless organic fertiliser. The nutrient-rich water is also recycled for irrigation purposes. The biodigester has been in operation since 1989.

7.3.3 Pyrenees Straw to Energy – Beaufort

A consortium of nine landholders in partnership with Pyrenees Shire Council is researching the development of markets for straw from the region. There are potentially one million tonnes of straw per year available across the Grampians region which is the estimated amount being burnt. Business cases have been developed to trial energy from straw at the Skipton Hospital and a manufacturing site in the region. There is a well-established straw to energy industry in some European countries. The technology for harvesting, processing, transporting, and storing straw is not new. There are significant developments in machinery to produce straw pellets. These machines are operating in Europe.

7.3.4 Beaufort Hospital Bioenergy Project

A small rural hospital installed a biomass boiler to replace LPG for its heating and hot water. This has significantly reduced the energy costs of the hospital. The boiler is housed in a modified shipping container which is both a boiler house and a fuel store. The project was completed in 2014.

7.3.5 Meredith Dairy

Meredith Dairy is a well-known goat and sheep dairy located 100 km west of Melbourne. It installed a 240 kW wood biomass boiler to produce hot water for pasteurisation, washdown and domestic hot water within the factory. It has reduced their reliance on LPG and has significantly reduced their energy costs with a payback period of two years. The project was completed in 2017.

7.3.6 McCallum Linen – Ballarat

McCallum Linen has been funded by the Community Power Hub to prepare a business case for combined solar and wood waste power. It is proposed that a 2 megawatt fully automated woodchip boiler system will replace the current natural gas fired system and a 99 kW rooftop photovoltaic installation will generate a significant proportion of the enterprises year-round electricity demand and export excess electricity to the grid.

7.3.7 Skipton Hospital

Funding has been received for the establishment of a straw fired boiler at the Skipton Hospital. The project was officially launched in May 2019 and will provide hot water and heating for the hospital.

7.3.8 Hepburn Shire Council – Creswick

The project will construct an anaerobic digestor, process 1500 t of food and green waste with the aim of producing high quality syngas that could potentially be injected into the energy grid. A small pilot phase has been established at the Creswick Transfer Station.

7.3.9 Maddingley Brown Coal Waste to Energy Facility – Maddingley

The company plans to use solid recovered fuel to generate electricity at the JBD Industrial Park. It will involve construction of a sorting station and combustion unit at JBD industrial estate and the diversion of approximately 100,000 t of timber, cardboard, and soft plastics. Approximately 10 MW of electricity will be fed back to the grid, although significant upgrades to existing powerlines could be required.

The initiative is at the testing and approvals stage. The proposal has received a $500,000 state government grant through the Resource Recovery Infrastructure Fund towards the $30 million project.

7.3.10 Gekko Biodigester Trial – Bungaree:

Gekko Systems received funding from the Victorian Government to develop and trial a modular biodigester. The technology design and development of the biodigester is the result of collaboration between Gekko Systems and Melville Charles Piggery in Ballarat which has operated a biodigester for many years to optimise treatment efficiency. The first demonstration unit has been installed at Trigg's Dairy Farm, Bungaree. This is a 350-head shedded dairy with milking undertaken by four robots. The effluent from the dairy is collected and processed to produce biogas to generate power. The system will generate a significant proportion of the energy needs for the dairy.

7.3.11 Australian Bio Fert – Bacchus Marsh

Australian Bio Fert have undertaken a research and development project at Bacchus Marsh to use chicken waste and mortalities to produce a bio-organic fertiliser through torrification. Field trials are being undertaken to demonstrate the viability of the fertiliser and have plans to construct a $20 million processing facility at Lethbridge between Ballarat and Geelong.

7.4 Refuse Derived Fuel Market

The market for RDF for renewable energy production is developing in Australia. There are a number of barriers to establishing RDF facilities and using RDF in existing facilities. These difficulties include:

- Capital cost of establishing new technologies and facilities
- Quality of RDF
- Transport distances
- Securing suitable quantities to ensure the long-term sustainability of the facility
- Identifying ideal sites for RDF production
- Obtaining the required licenses and
- Finalising appropriate off-take agreements.

There are a number of operators in Australia producing or developing projects to produce RDF to replace fossil fuels in intensive operations such as cement kilns, paper mills and as an additive to coal fired power stations. Such operations target either biomass (timber and wood waste) or other dry residual waste with high calorific value that are unable to be readily recycled, as a means by which to drive resource recovery, diversion of waste from landfill disposal and reducing reliance on fossil fuels. RDF can also be used in current co-generation facilities at sugar mills.

Biochar could be produced through pyrolysis, which is the process of heating waste materials in the absence of oxygen. This biochar could be used later to produce heat and energy. Char may have other commercial value as a soil improvement, metallurgical reduction, and carbon sequestration product.

Apart from energy generation from waste, biochar production from waste could be a potential market for organic waste materials.

8 Organic Waste Processing Options Selection

8.1 Longlist of Options

This project focuses on the options that can process available FOGO from kerbside collection services as well as garden organics from transfer stations, resource recovery centres and other operations. Consideration has also been given to organic waste from commercial sources and biosolids from wastewater treatment plant.

SLR compiled a list of 14 options which included a range of organics processing technologies, and combinations of these, and transfer stations in different locations in the region. We also evaluated each option against environmental, technology, cost, and regulatory criteria using a traffic light system with red for negative, orange for neutral and green for positive. Those options with more greens and oranges were preferred over those with more reds and oranges. The longlist of 14 options was presented to the project group during a workshop. This options longlist is shown in Table 17. The main evaluation findings are also shown in the table.

Table 17 Longlist of Potential Organic Waste Management Options

Option	Feedstock type	Facility	Description	Environmental	Technology	Cost	Regulation
1	FOGO	Existing	Current operations that include landfilling, burning and composting using one IVC and one OWC	-	-	-	-
2	FOGO	New	• 1 large IVC 20,000-48,000 tpa near Ballarat • 3 small IVCs 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes. • 2 transfer stations for bulk haulage at smaller councils near West Wimmera and Warracknabeal	Emissions and impacts relatively low	Proven, mature technology	Costs relatively low	No significant regulatory barriers
3	FOGO	New	• 1 large IVC 20,000-48,000 tpa near Ballarat • 3 small IVCs 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes. • 2 small OWC in smaller Councils near West Wimmera and Yarriambiack	Odour and leachate issues associated with processing food	Proven, mature technology	Costs relatively low	EPA unlikely to approve open windrow composting for food
4	FOGO	New	• 1 large dry AD 20,000-48,000 tpa near Ballarat • 3 small IVCs 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes • 2 transfer stations for bulk haulage at smaller councils near West Wimmera and Warracknabeal	Emissions and impacts relatively low	Dry AD technology unproven for FOGO	Dry AD cost likely to be high, although offset because only one facility	No significant regulatory barriers

Option	Feedstock type	Facility	Description	Environmental	Technology	Cost	Regulation
5	FOGO and biosolids	New	• 1 large wet AD 22,000-51,000 tpa near Ballarat • 3 small IVCs 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes. • 2 transfer stations for bulk haulage at smaller councils near West Wimmera and Warracknabeal	Emissions and impacts relatively low	Wet AD suitable for food only feedstocks	AD costs likely to be high especially if separate food organics collections required	EPA's response to wet AD for food not known
6	FOGO	New	• 1 large dry AD 20,000-48,000 tpa near Ballarat • 1 medium dry AD 20,000 tpa in Horsham • 5 transfer stations for bulk haulage	Emissions and impacts relatively low	Dry AD technology unproven for FOGO	Dry AD costs likely to be high especially with two facilities	No significant regulatory barriers
7	FOGO	New	• 1 large pyrolysis facility - 20,000-48,000 tpa near Ballarat • 3 small IVCs - 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes.	Potential emissions from thermal treatment. May be of concern to community	Pyrolysis or gasification unproved for FOGO	Pyrolysis or gasification costs likely to be high	EPA's response to pyrolysis or gasification for FOGO not known
8	FOGO	New	• 1 large pyrolysis facility - 30,000-67,000 tpa near Ballarat • 7 transfer stations for bulk haulage from other councils near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell	Potential emissions from thermal treatment. May be of concern to community	Pyrolysis or gasification unproved for FOGO	Pyrolysis or gasification costs likely to be high	EPA's response to pyrolysis or gasification for FOGO not known
9	FOGO	New	• 1 large dry AD 30,000-67,000 tpa near Ballarat • 7 transfer stations for bulk haulage from other councils near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell	Emissions and impacts relatively low	Dry AD technology unproven for FOGO	AD costs likely to be high	No significant regulatory barriers

Option	Feedstock type	Facility	Description	Environmental	Technology	Cost	Regulation
10	FOGO	New	• 1 large vermiculture facility 20,000-48,000 tpa near Ballarat • 3 small vermiculture facilities 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes. • 2 transfer stations for bulk haulage at smaller councils near West Wimmera and Warracknabeal	No example vermiculture facilities processing FOGO so impacts not known	Vermiculture better for food only streams. Other large scale municipal facilities have failed	Cost unknown	No significant regulatory barriers
11	FOGO	New	• 1 large OWC 20,000-48,000 tpa near Ballarat • 3 small OWCs 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes. • 2 transfer stations for bulk haulage at smaller councils near West Wimmera and Warracknabeal	Odour and leachate issues associated with processing food	Open windrow composting not ideal for larger quantities of FOGO, slow for processing	Costs relatively low	EPA unlikely to approve open windrow composting for food
12	FOGO and commercial organics	New	• 1 large dry AD 90,000 tpa near Ballarat • 7 transfer stations for bulk haulage from other councils near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell	Emissions and impacts relatively low	Dry AD technology unproven for FOGO	Dry AD cost likely to be high, although offset by size of facility	No significant regulatory barriers
13	FOGO and commercial organics	New	• 1 large IVC 90,000 tpa near Ballarat • 7 transfer stations for bulk haulage from other councils near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell	Emissions and impacts relatively low	Proven, mature technology	Costs likely to be higher than other options	No significant regulatory barriers

Option	Feedstock type	Facility	Description	Environmental	Technology	Cost	Regulation
14	FOGO and commercial organics	New	• 1 large IVC 75,000 tpa near Ballarat • 3 small IVCs 3,000-7,000 tpa in larger councils near Horsham, Stawell, and Clunes. • 2 transfer stations for bulk haulage at smaller councils near West Wimmera and Warracknabeal	Emissions and impacts relatively low	Proven, mature technology	Costs likely to be higher than other options	No significant regulatory barriers

8.2 Shortlisted Options

Following the Workshop, Council confirmed selection of the five shortlisted to be taken forward for the Options Assessment, in addition to business as usual, the change nothing option. An overview of the shortlisted options is as follows:

- **Option 1**: Business as usual
- **Option 2**: FOGO composted via large IVC near Ballarat. Three smaller IVCs at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 4**: FOGO composted at new dry AD facility near Ballarat. Three smaller IVCs at other councils, such as, Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 5**: FOGO and biosolids composted at new wet AD facility near Ballarat. Three smaller IVCs at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 11**: FOGO composted at large open windrow composting facility near Ballarat. Three smaller open windrow composting facilities at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 13**: FOGO from all councils and a small proportion (approximately 2-5%) of the potentially available commercial organics, processing at a new IVC facility near Ballarat. Potential sources of commercial organics are McCains, Mars, and HPV plantation. All organics aggregated then bulk transported from other councils, near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell, to the facility at Ballarat.

In addition to the identification of the above organic waste options, Council also requested to include the additional option below:

- **Option 8**: One large pyrolysis facility near Ballarat and seven transfer stations for bulk haulage from other councils near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell.

Site locations are selected considering large population areas and low travel distance by road. Larger facilities are located close to the greatest sources of waste to increase road transport efficiencies.

9 Life Cycle Assessment

9.1 Introduction

This section outlines the approach adopted in undertaking a life cycle assessment (LCA) for the key options assessed. The goal of this LCA is to evaluate how each option performs with respect to impact category against the BAU waste management approach. This LCA study was undertaken in accordance with the ISO standards 14040/14044 and the guidance outlined in the ARENA LCA Guidelines.[48]

This LCA compares the environmental impacts, particularly the global warming potential (GWP) of the options assessed against the 'counterfactual', that is, the current baseline or BAU waste management approaches.

The modelling uses a life cycle assessment tool, WRATE, described below.

9.2 The WRATE Tool

The WRATE software is a life cycle assessment tool specifically designed to model the environmental impacts of waste and waste management processes. Its predominant use is for assessing the management of municipal and municipal type wastes, which would include commercial and industrial (C&I) waste types, so it is appropriate for the Grampians Organics Feasibility Study.

As a life cycle assessment tool, WRATE models the environmental impacts of all phases of a waste management facility's life cycle from construction, operation, maintenance, and decommissioning, where applicable. WRATE also models all elements of the waste management process from collection through to disposal.

WRATE was funded and developed by the UK Environment Agency (EA) and released to market in 2007. All users of the software pay a licence fee and must receive training in its use to ensure assessments are carried out to the required standard. SLR is a registered expert user of WRATE.

The use of the WRATE software is endorsed and encouraged by the EA and the UK Department for Environment, Food and Rural Affairs (Defra). Over many years the tool has been embedded within the waste management industry assisting with a range of projects for various organisation types:

- environmental impact calculation of options for local authority municipal waste management strategy development projects
- solution testing and business case development for local authority and private sector
- procurement support tool to assess the environmental impacts of bidder solutions within a local authority waste management tender process, many of these procurements received Defra funding
- planning application support or planning variations, including successful removal of restrictive planning conditions for energy recovery facility projects
- quantifying the 'green' credentials of waste projects being considered by the Green Investment Bank (now Green Investment Group) and annual reporting of carbon impact for investment projects.

[48] ARENA, 2016. ARENA Life Cycle Assessment of Bioenergy Products and Projects Method and Guidance. Retrieved from https://arena.gov.au/assets/2017/02/AU21285-ARENA-LCA-Guidelines-AW2.pdf

The software was developed to comply with the ISO standards for LCAs to ensure studies using the WRATE tool can be delivered to a high technical standard. The WRATE tool utilises a background database supplied by the Ecoinvent centre.
The LCA tool helps with the identification and quantification of the following environmental impacts:

- **direct burdens –** defined as emissions from the process itself, for example carbon dioxide as a result of a consequence of combustion or aerobic degradation
- **indirect burdens –** associated with the supply of energy and materials to the process, for example construction materials, electrical energy for motors and fans, and chemicals for pollution abatement equipment
- **avoided burdens –** associated with the recovery of energy and materials from the waste stream resulting in the avoidance of primary energy production and mineral extraction.

The environmental impact of a particular scenario is therefore calculated as the sum of direct burdens, indirect burdens and avoided burdens.

9.3 Life Cycle Inventory Analysis

This section provides the cradle-to-grave Life Cycle Inventory for the options assessed including the baseline and counterfactual. Primary data were obtained from project documentation provided to SLR, including details of waste sources and transport data. Additional data has been based on assumptions, literature, and publicly available information where applicable.

9.3.1 Principal Assumptions within a WRATE Model

When developing a project in WRATE, a number of key assumptions must be defined. These assumptions include the quantity and composition of the waste, the assessment year (assumed to be 2040 in this LCA Study), and the associated energy mix, which is the assumed energy mix that would be displaced by the energy generated from the relevant options. All of these assumptions would influence the output results.

Waste composition and quantities

The options proposed would process various mixtures of organic waste. The key organic waste categories considered in this LCA study are:

- Kerbside Residual Organics – modelled as food waste in WRATE
- Kerbside Green Organics – modelled as garden waste in WRATE
- Transfer Station Garden Organics drop off – modelled as garden waste in WRATE.

The composition of these key organic waste streams adopted in this LCA study have been assumed to remain relatively consistent over the project life.

Electricity Mix

The 'baseline' electricity mix was based on electricity generation data in Victoria, by fuel type for calendar year 2019 as obtained from the Australian Government Department of Industry Science Energy and Resources (2020).[49] Marginal fuel mix is calculated by considering the carbon intensive energy sources in the baseline fuel mix that are assumed to be offset by the electricity generated by the Nowra Biogas Plant. **Table 18** shows the baseline fuel mix and the marginal fuel mix adopted for this LCA. Adopting the fuel mix provided in **Table 18** is considered a reasonable assumption for the LCA given the high degree of uncertainty associated with any future forecast of energy mix in Victoria.

Table 18 Baseline Fuel Mix and Marginal Fuel Mix adopted in this LCA Study

Energy Source	Victorian Baseline Fuel Mix[50]	Marginal Fuel Mix[51]
Coal	76.0%	91.8%
Oil	0.3%	0.4%
Gas	0.0%	N/A
Gas combined-cycle gas turbine (CCGT)	6.4%	7.8%
Waste	1.4%	N/A
Solar Photovoltaic	3.9%	N/A
Wind	9.7%	N/A
Hydro	2.3%	N/A
Total	**100.0%**	**100%**

9.4 Baseline-Counterfactual Scenario

The Baseline-Counterfactual scenario was developed to assess the environmental impacts of the current BAU management of the waste streams. Details of waste quantities and transport distances were adopted from the assumptions used in the CBA. Some waste is diverted to burning and mulching from some councils under the BAU scenario, however in this LCA, these quantities have been assumed to be disposed of at the relevant landfills. This is due to the absence of waste management processes in WRATE that could model burning and mulching.

9.5 Other options and scenarios

For each organic waste processing option considered in this study, a separate scenario was developed in WRATE in order to evaluate the GWP over the project lifecycle. Similar to the baseline scenario, assumptions used in the CBA were adopted for the WRATE modelling. Waste collection in each council catchment has been excluded from the LCA boundary for all the options including BAU, hence no collection impacts are presented.

[49] Department of Industry, Science, Energy and Resources, Australian Energy Statistics, Table O, September 2020. Retrieved from https://www.energy.gov.au/publications/australian-energy-update-2020
[50] The 'baseline' fuel mix is a parameter used in WRATE, which defines the typical electricity grid and its fuel source contributions and should not be confused with the 'baseline' scenario
[51] The marginal fuel mix includes only the carbon intensive energy sources, which are assumed to be offset by the electricity generated from the Nowra Biogas Plant. In this LCA, the marginal fuel mix includes Coal, Oil and Gas CCGT

9.6 Modelling Results

The results presented in this section show a comparison of the baseline scenario (Option 1) versus the proposed option for GWP impact category. Avoided burdens are shown as negative values and burdens are shown as positive values in the figures providing results from the analysis. Since the waste quantities were not the same for all the options assessed, the results have been 'normalised' and presented per tonne of project waste to allow comparison of options against the baseline.

9.6.1 Option 2

Figure 7 shows results of the WRATE analysis for GWP for the Baseline versus Option 2, one large IVC at Ballarat, three small IVCs near Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera, for the assessment year 2040.

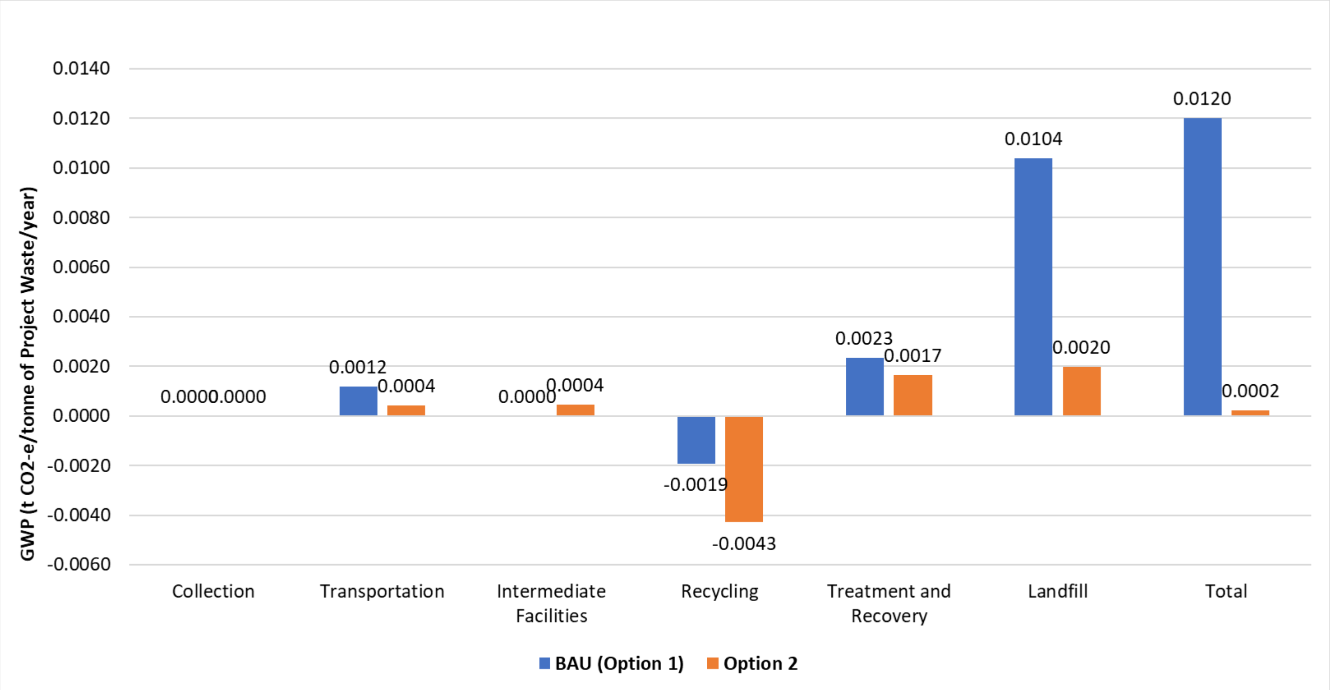


Figure 7 Comparison of GWP of Baseline v Option 2

Based on the results from WRATE analysis, recycling would result in the most significant reduction of carbon impacts with 0.004 t CO_2-e avoided per tonne of project waste per year. In this LCA study, recycling includes the use of compost produced from the composting facilities as a soil improver. There are existing composting facilities under the baseline scenario, hence there would be avoided carbon burdens associated with the use of compost under BAU waste management of 0.0019 t CO_2-e avoided per tonne of project waste per year. These avoided carbon burdens associated with the use of compost on land are derived from the avoided use of primary energy and resources related to the use of synthetic fertilisers.

Significant carbon burdens are as a result of landfill disposal of waste under the baseline scenario of 0.010 t CO_2-e per tonne of project waste per year. It is noted that some waste is diverted to burning and mulching from some Councils under the BAU scenario, however in this LCA, these quantities have been assumed to be disposed of at the relevant landfills. This is due to the absence of waste management processes in WRATE that could model burning and mulching. Under Option 2, waste would be diverted to the proposed composting facilities and only a smaller fraction of the incoming waste, the rejects, would be sent to landfill, hence the reduced carbon burdens associated with landfill disposal would be 0.002 t CO_2-e avoided per tonne of project waste per year.

There would be carbon burdens from the transportation of waste, products, and residue and from intermediate facilities, transfer stations and pre-treatment processes, however, these impacts are not considered significant.

Treatment and recovery, composting of FOGO, would result in carbon burdens in both the BAU scenario of 0.0023 t CO_2-e per tonne of project waste per year, and Option 2 of 0.0017 t CO_2-e per tonne of project waste per year. This is due to the carbon footprint associated with the composting processes.

Overall, the results from WRATE analysis indicate that Option 2 would result in a significant reduction in carbon impacts, an overall carbon burden of 0.0002 t CO_2-e per tonne of project waste per year, compared to the Baseline scenario, an overall carbon burden of 0.012 t CO_2-e per tonne of project waste per year.

9.6.2 Option 4

Figure 8 shows results of the WRATE analysis for GWP for the Baseline versus Option 4, one dry AD at Ballarat, three small IVCs near Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera, for the assessment year 2040.

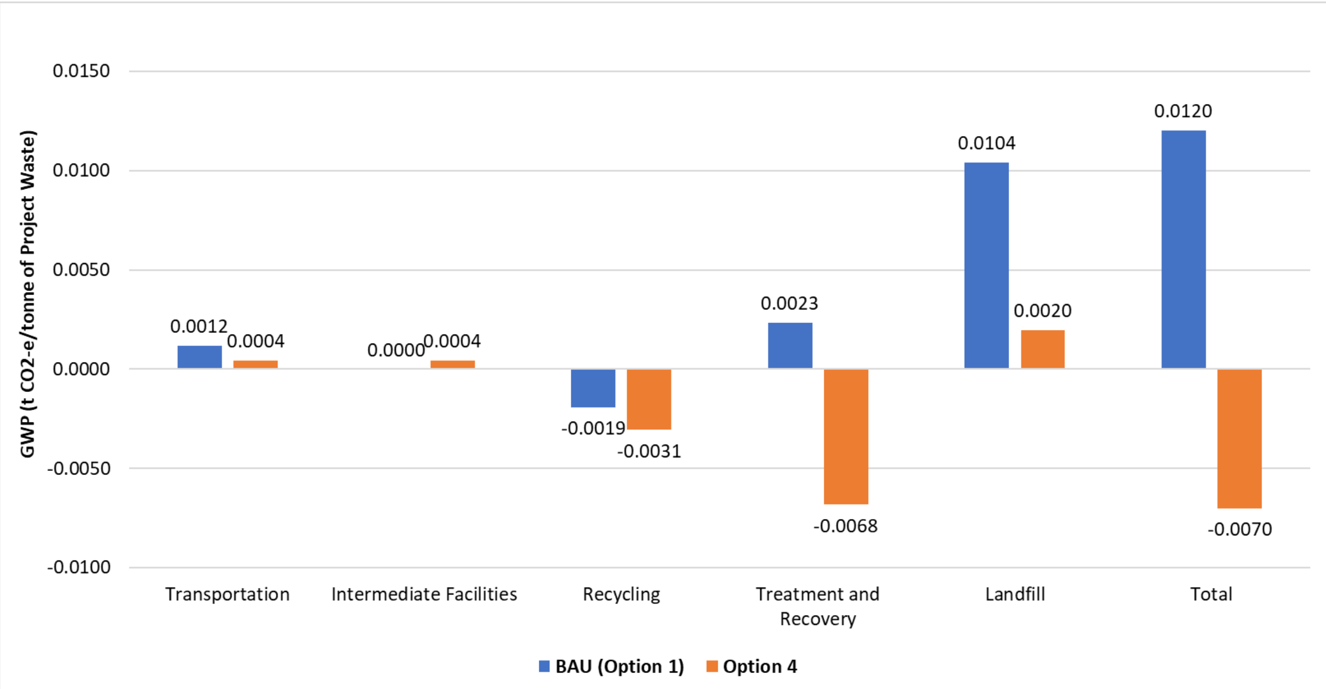


Figure 8 Comparison of GWP of Baseline v Option 4

Based on the results from WRATE analysis, treatment and recovery, dry AD of FOGO and energy recovery from biogas to generate electricity, would result in the most significant reduction of carbon impacts of 0.0068 t CO_2-

e avoided per tonne of project waste per year under Option 4 versus carbon burdens from existing composting facilities of 0.0023 t CO_2-e per tonne of project waste per year. This is largely due to avoided burdens from landfill disposal of organic waste, and avoided fossil energy use (grid electricity usage) from the electricity generated by the dry AD plant and fed into the grid.

Under the BAU scenario the use of compost produced from the existing composting facilities as a soil improver would result in avoided carbon burdens of 0.0019 t CO_2-e per tonne of project waste per year. Similarly, under Option 4, recycling, the use of compost produced from the proposed IVC facilities and digestate from the proposed dry AD plant as soil improvers would result in further avoided carbon burdens of 0.0031 t CO_2-e per tonne of project waste per year.

Significant carbon burdens are as a result of landfill disposal of waste under the Baseline scenario of 0.010 t CO_2-e per tonne of project waste per year. Under Option 4, waste would be diverted to the proposed IVC facilities and the dry AD plant, and only a smaller fraction of the incoming waste, the rejects from these proposed processing facilities, would be sent to landfill, hence the reduced carbon burdens associated with landfill disposal of 0.002 t CO_2-e per tonne of project waste per year.

Overall, the results from WRATE analysis indicate that Option 4 would result in significant avoided carbon impacts, overall avoided carbon burden of 0.0070 t CO_2-e per tonne of project waste per year, compared to the baseline scenario, overall carbon burden of 0.012 t CO_2-e per tonne of project waste per year.

9.6.3 Option 5

Figure 9 shows results of the WRATE analysis for GWP for the baseline versus Option 5, one wet AD at Ballarat, three small IVCs near Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera, for the assessment year 2040.

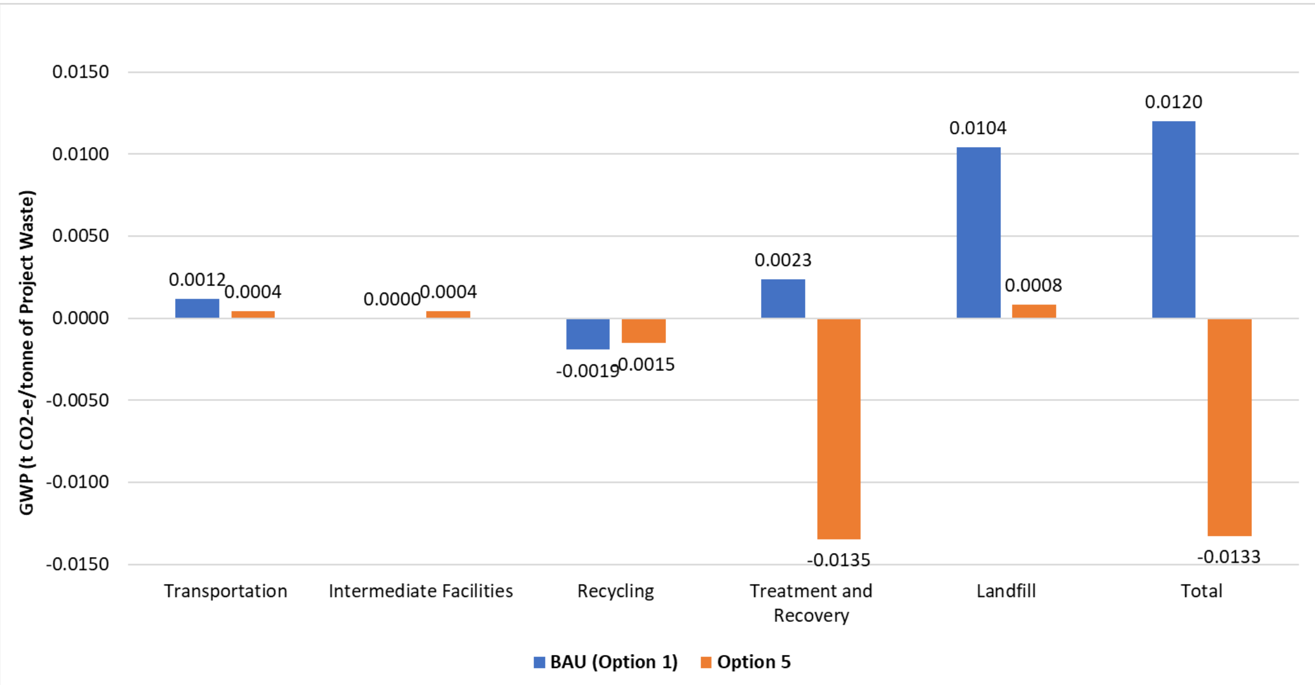


Figure 9 Comparison of GWP of Baseline vs Option 5

Based on the results from WRATE analysis, treatment and recovery, wet AD of FOGO and energy recovery from biogas to generate electricity would result in the most significant reduction of carbon impacts of 0.0135 t CO_2-e avoided per tonne of project waste per year under Option 5 versus carbon burdens from existing composting facilities of 0.0023 t CO_2-e per tonne of project waste per year. This is largely due to avoided burdens from landfill disposal of organic waste and avoided fossil energy use (grid electricity usage) from the electricity generated by the dry AD plant and fed into the grid.

Under the BAU scenario the use of compost produced from the existing composting facilities as a soil improver would result in avoided carbon burdens of 0.0019 t CO_2-e per tonne of project waste per year. Similarly, under Option 5, the use of compost produced from the proposed IVC facilities and digestate from the proposed wet AD plant as soil improvers would also result in avoided carbon burdens of 0.0015 t CO_2-e per tonne of project waste per year.

Significant carbon burdens are as a result of landfill disposal of waste under the baseline scenario of 0.01 t CO_2-e per tonne of project waste per year. Under Option 5, waste would be diverted to the proposed IVC facilities and the wet AD plant, and only a smaller fraction of the incoming waste, the rejects from these proposed processing facilities, would be sent to landfill, hence the reduced carbon burdens associated with landfill disposal of 0.0008 t CO_2-e per tonne of project waste per year.

Overall, the results from WRATE analysis indicate that Option 5 would result in significant avoided carbon impacts, overall avoided carbon burden of 0.013 t CO_2-e per tonne of project waste per year, compared to the baseline scenario, overall carbon burden of 0.012 t CO_2-e per tonne of project waste per year.

9.6.4 Option 8

Figure 10 shows results of the WRATE analysis for GWP for the Baseline versus Option 8, one pyrolysis plant at Ballarat and seven transfer stations for bulk haulage at Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell, for the assessment year 2040.

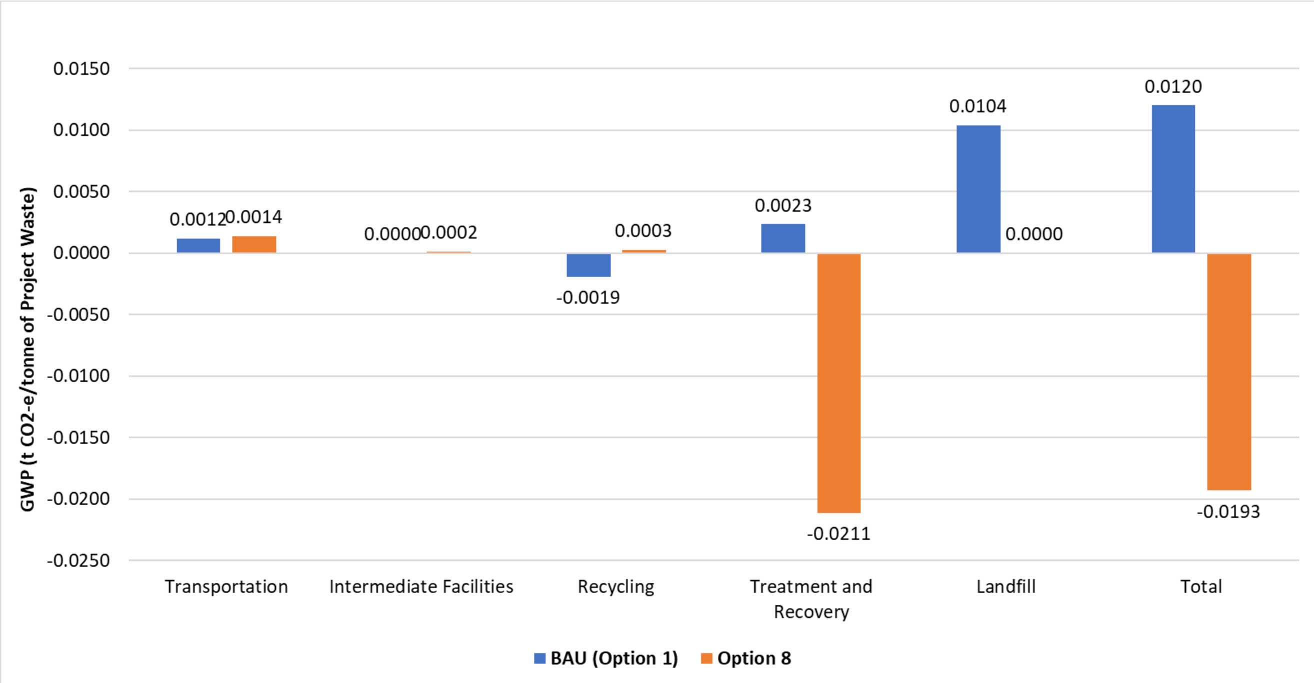


Figure 10 Comparison of GWP of Baseline v Option 8

Based on the results from WRATE analysis, treatment and recovery, pyrolysis, would result in the most significant reduction of carbon impacts of 0.02 t CO_2-e avoided per tonne of project waste per year under Option 8 versus carbon burdens from existing composting facilities of 0.0023 t CO_2-e per tonne of project waste per year. This is largely due to avoided burdens from landfill disposal of organic waste.

Under the BAU scenario the use of compost produced from the existing composting facilities as a soil improver would result in avoided carbon burdens of 0.0019 t CO_2-e per tonne of project waste per year. However, under Option 8, the use of char produced from the proposed pyrolysis facility would result in a very small carbon footprint of 0.0003 t CO_2-e per tonne of project waste per year.

Significant carbon burdens are as a result of landfill disposal of waste under the Baseline scenario of 0.010 t CO_2-e per tonne of project waste per year. Under Option 8, waste would be diverted to the proposed pyrolysis facility which reduces the volume of waste by a significant amount, over 85% by mass, resulting in very low quantities of rejects destined for landfill disposal hence the reduced carbon burdens associated with landfill disposal.

Overall, the results from WRATE analysis indicate that Option 8 would result in significant avoided carbon impacts, overall avoided carbon burden of 0.0193 t CO_2-e per tonne of project waste per year, compared to the baseline scenario, overall carbon burden of 0.012 t CO_2-e per tonne of project waste per year.

9.6.5 Option 11

Figure 11 shows results of the WRATE analysis for GWP for the baseline versus Option 11, one large OWC at Ballarat, three small OWCs at Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera, for the assessment year 2040.

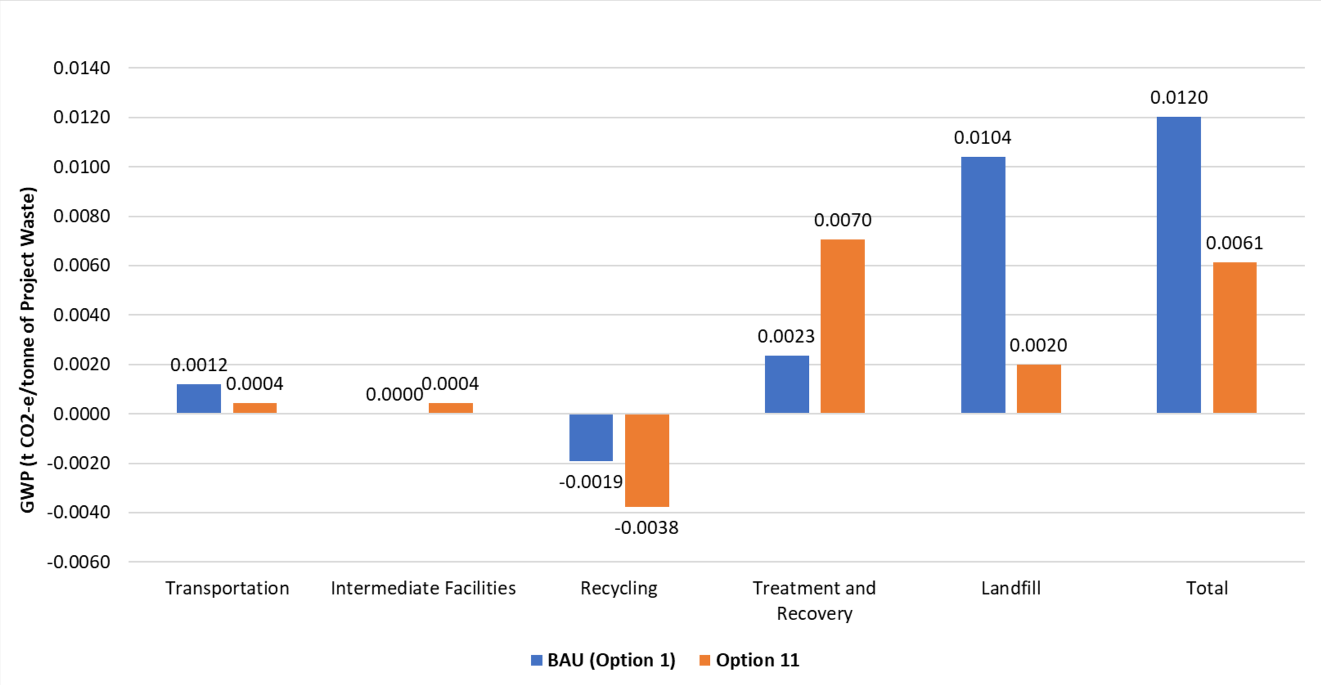


Figure 11 Comparison of GWP of Baseline vs Option 11

Based on the results from WRATE analysis, it is noted that recycling, the use of compost from the proposed facilities as a soil improver, would result in the most significant reduction of carbon impacts of 0.0038 t CO_2-e avoided per tonne of project waste per year under Option 11. Existing composting facilities under the baseline scenario would also result in avoided carbon burdens of 0.0019 t CO_2-e avoided per tonne of project waste per year.

All the other processes under the baseline scenario and Option 11, transportation, treatment and recovery, and landfill, would result in carbon burdens as illustrated in **Figure 11**. Significant carbon burdens would result from the proposed composting systems of 0.007 t CO_2-e per tonne of project waste per year, particularly open windrow composting, which involves direct emissions to the environment.

Overall, the results from WRATE analysis indicate that Option 11 would result in a reduction in carbon burdens, overall total carbon burden of 0.0061 t CO_2-e per tonne of project waste per year, compared to the baseline scenario, overall carbon burden of 0.012 t CO_2-e per tonne of project waste per year.

9.6.6 Option 13

Figure 12 shows results of the WRATE analysis for GWP for the Baseline versus Option 13, one large IVC at Ballarat and seven transfer stations for bulk haulage at Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell, for the assessment year 2040.

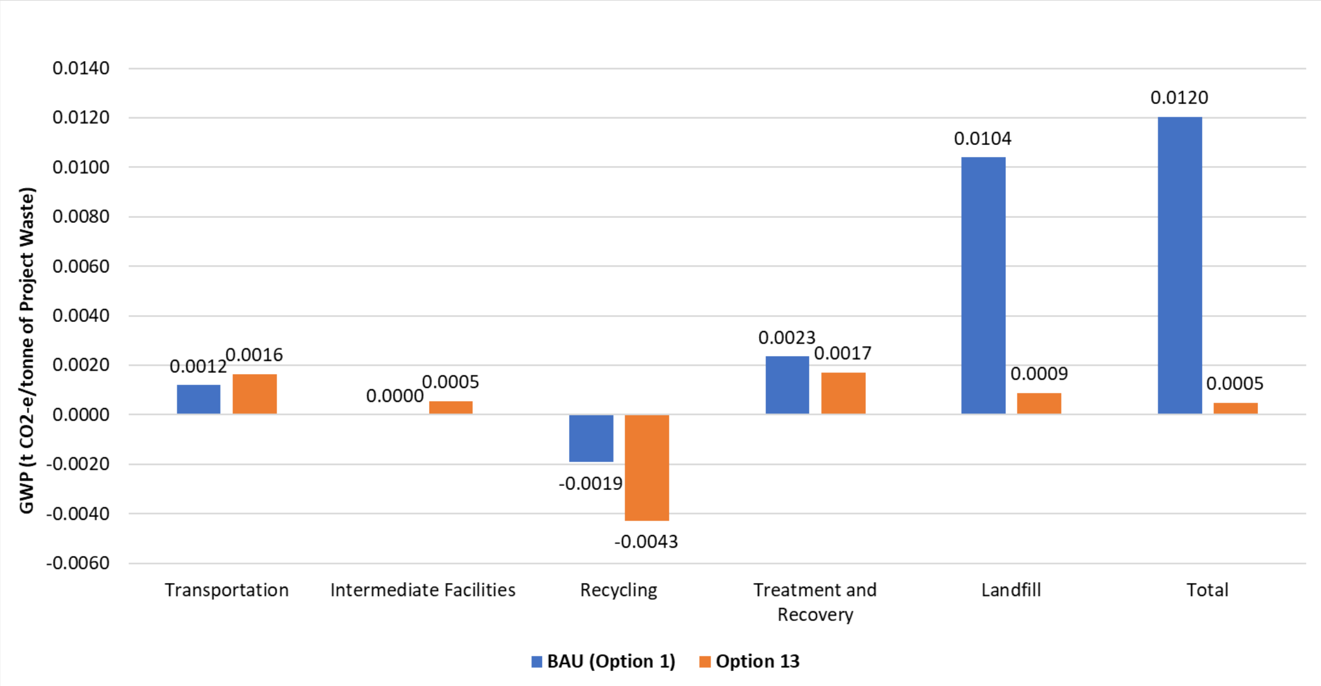


Figure 12 Comparison of GWP of Baseline v Option 13

Based on the results from WRATE analysis, it is noted that recycling, the use of compost from the proposed IVC as a soil improver, would result in the most significant reduction of carbon impacts of 0.0043 t CO_2-e avoided per tonne of project waste per year under Option 13. Existing composting facilities under the baseline scenario would also result in avoided carbon burdens of 0.0019 t CO_2-e avoided per tonne of project waste per year.

All the other processes, transportation, intermediate facilities, treatment and recovery, and landfill, would result in carbon burdens as illustrated in **Figure 12**. Transportation under Option 13 would result in higher carbon burdens of 0.0016 t CO_2-e per tonne of project waste per year than under the BAU scenario of 0.0012 t CO_2-e per tonne of project waste per year due to the larger transport distances to the centralised Ballarat large IVC facility.

Treatment and recovery, waste processing at the large IVC facility, would result in carbon burdens of 0.0017 t CO_2-e per tonne of project waste per year. This is slightly lower than the carbon burdens under the baseline scenario of 0.0023 t CO_2-e per tonne of project waste per year.

Option 13 would significantly reduce the volume of waste diverted to landfill hence the reduced carbon burdens associated with landfill disposal of 0.0009 t CO_2-e per tonne of project waste per year, whereas under the baseline scenario, a higher proportion of waste is still sent to landfill, resulting in a significant carbon burden of 0.010 t CO_2-e per tonne of project waste per year.

Overall, the results from WRATE analysis indicate that Option 13 would result in a reduction in carbon burdens, overall total carbon burden of 0.0005 t CO_2-e per tonne of project waste per year, compared to the baseline scenario, overall carbon burden of 0.012 t CO_2-e per tonne of project waste per year.

9.7 Summary Results

Figure 13 shows a summary of the total LCA GWP, expressed as tonnes CO2 equivalent, burdens and avoided burdens from the WRATE analysis of the options assessed.

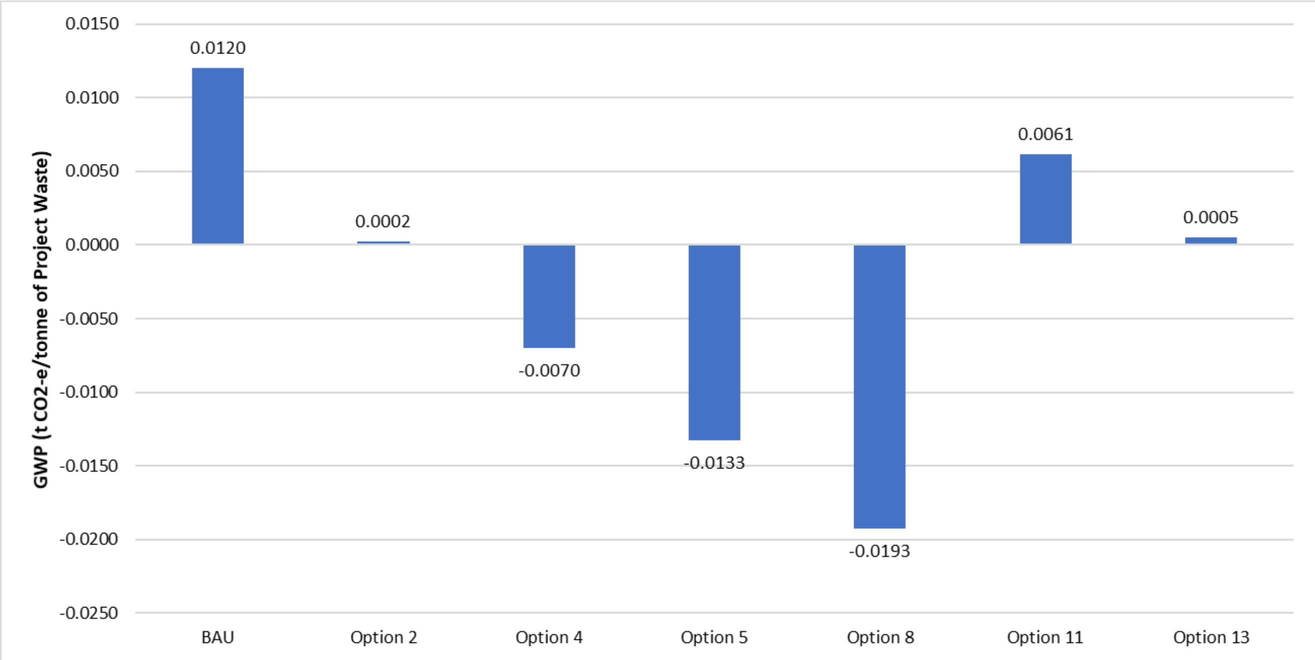


Figure 13 Comparison of total GWP for all Options

The results indicate the following:

- all the proposed options would result in a reduction in overall carbon impacts compared to the baseline scenario
- significant avoided total carbon burdens would be from Option 8 – Pyrolysis of organic waste of 0.0193 t CO_2-e avoided per tonne of project waste per year
- for the proposed options, excluding the baseline scenario, significant total carbon burdens would be from Option 11 – which includes OWC systems of 0.0061 t CO_2-e per tonne of project waste per year
- options with AD systems, Option 4 – dry AD and Option 5 – wet AD, would result in avoided total carbon burdens of 0.007 and 0.0133 t CO_2-e avoided per tonne of project waste per year respectively
- options with IVC systems, Option 2 and Option 13, would result in some carbon burdens of 0.0002 and 0.0005 t CO_2-e per tonne of project waste per year respectively, however, these total carbon impacts are significantly lower than total carbon burdens from the baseline scenario of 0.012 t CO_2-e per tonne of project waste per year.

10 Cost Benefit Analysis

10.1 Costs and Revenue Assumptions

A cost benefit analysis was undertaken for each of the shortlisted options over 20 years of the project. It is noted that no inflation rate has been applied to estimate the potential future cost and revenue and therefore real costs are adopted.

SLR has identified the potential cost and benefit streams associated with all options for the processing of available organics. The costs are associated with the capital costs and operating costs for all facilities. The operating costs include:

- FOGO collection
- processing
- feedstock transportation to the facility
- residual transportation to the landfill and
- residual disposal to landfill for each facility.

The revenue generation for all options includes:

- compost sale
- char sale for Option 8 only
- council gate fee
- commercial gate fee for Option 13 only
- carbon credits
- electricity generation for Option 4 and Option 5 only and
- large-scale generation certificates for Option 4 and Option 5 only.

The total value of landfill savings is also calculated over 20 years of the project.

The following assumptions have been adopted in estimating costs and revenues for the options considered in this study. **Table 19**, **Table 20**, **Table 21**, and **Table 22** provide a high-level summary of the key features of in-vessel and open windrow composting, dry anaerobic digestion, wet anaerobic digestion, and pyrolysis facilities respectively.

Table 19 Key Features of In-Vessel and Open Windrow Composting

Feature	Description
Typical feedstock	Mixed FOGO
Indicative compost or digestate production	Approximately 45% of input
Indicative reject production	Approximately 5% of input
Remaining balance	Attributable to process losses
Energy production	No
Technology maturity	Proven mature

Table 20 Key Features of Dry Anaerobic Digestion

Feature	Description
Typical feedstock	Mixed FOGO
Indicative solid digestate production	Approximately 95% of input
Indicative reject production	Approximately 5% of input
Energy production	Yes
Net electricity generation	0.108 MWh per tonne processed
Technology maturity	Emerging

Table 21 Key Features of Wet Anaerobic Digestion

Feature	Description
Typical feedstock	Mixed FOGO
Indicative liquid digestate production	Approximately 60% of input
Indicative solid digestate production	Approximately 35% of input
Indicative reject production	Approximately 5% of input
Energy production	Yes
Net electricity generation	0.25 MWh per tonne processed
Technology maturity	Unproven for FOGO

Table 22 Key Features of Pyrolysis

Feature	Description
Typical feedstock	Mixed FOGO
Indicative char production	Approximately 10% of input
Indicative reject production	Approximately 3% of input
Remaining balance	Attributable to process losses
Energy production	No (Note: energy generation is possible from pyrolysis however for this analysis we have assumed that the primary driver is generation of biochar)
Technology maturity	Unproven for FOGO

The capital and operating costs and revenue estimates were based on SLR experience from previous projects, unless otherwise specified. All cost benefit estimates are indicative, depending on different conditions, including permitting. The landfill space savings are calculated by multiplying the total quantity of derived material with the residual disposal rate at landfill. **Table 23** provides the list of assumptions for the cost and revenue estimation. The assumptions for GHG emissions calculation are provided in **Appendix E**.

Table 23 List of assumptions for cost and revenue estimation

Parameter	Unit	Value
Capital costs		
Capital cost for transfer station	Per tonne	$25

Parameter	Unit	Value
Capital cost for small open windrow composting[52]	Per tonne	$107
Capital cost for large open windrow composting	Per tonne	$161
Capital cost for small IVC[53]	Per tonne	$200
Capital cost for large IVC	Per tonne	$400
Capital cost for dry AD with IVC for digestate	Per tonne	$883
Capital cost for wet AD with IVC for digestate	Per tonne	$500
Capital cost for pyrolysis	Per tonne	$500
Operating costs		
Operating cost for transfer station	Per tonne	$15
Operating cost for small open windrow composting[54]	Per tonne	$47
Operating cost for large open windrow composting[55]	Per tonne	$58
Operating cost for small IVC	Per tonne	$60
Operating cost for large IVC	Per tonne	$80
Operating cost for dry AD with IVC for solid digestate	Per tonne	$132
Operating cost for wet AD with IVC for solid digestate	Per tonne	$50
Operating cost for pyrolysis	Per tonne	$50
Operating cost for FOGO collection	Per tonne	$44
Other costs		
Contracts Manager salary for FOGO collection[56]	Per annum	$105,000
Proportion of contract for Contract Manager's role		30%
Transportation cost[57]	Per tonne per km	$0.45
Residual disposal rate at Dooen Landfill (Horsham)[58]	Per tonne	$171.00
Residual disposal rate at Smythesdale Landfill (Ballarat)[59]	Per tonne	$218.50
Residual disposal rate at Stawell (Cleanaway) Landfill[60]	Per tonne	$185.52
Treated fly ash disposal rate at SUEZ Taylors Road Landfill (Dandenong South)	Per tonne	$877.00
Revenue		
Compost sale price[61]	Per cubic metre	$27.5

52 Shared Organics facility feasibility study, Glenelg Shire Council and Southern Grampians Shire Council, 2017
53 Grampians Region Organics Review-2018
54 Shared Organics facility feasibility study, Glenelg Shire Council and Southern Grampians Shire Council, 2017
55 Shared Organics facility feasibility study, Glenelg Shire Council and Southern Grampians Shire Council, 2017
56 Average Contracts Manager Salary in Melbourne; https://www.payscale.com/research/AU/Job=Contracts_Manager/Salary/f9a522ef/Melbourne
57 Regional Resource Recovery Processing Facilities, Grampians Central West Waste and Resource Recovery Group, Arcadis 2020
58 The disposal rate includes increased EPA levy (i.e., $20) from 1 July 2022 for all Victorian landfills along with the current disposal fee (i.e., $151) at Dooen Landfill.
59 The disposal rate includes increased EPA levy (i.e., $20) from 1 July 2022 for all Victorian landfills along with the current disposal fee (i.e., $198.50) at Smythesdale Landfill.
60 The disposal rate includes increased EPA levy (i.e., $20) from 1 July 2022 for all Victorian landfills along with the current disposal fee (i.e., $165.52) Stawell (Cleanaway) Landfill.
61 Recycled Organics Market Analysis, 2013, Sustainability Victoria

Parameter	Unit	Value
Mulch sale price	Per cubic metre	$5
Char sale price	Per tonne	$10
Council gate fee for revenue generation[62]	Per tonne	$30
Commercial gate fee for revenue generation[63]	Per tonne	$235
Australian carbon credit units (ACCUs)[64]	Per tCO_2	$37
Electricity sale price[65]	Per MWh	$27
Large Scale Generation Certificates (LGCs)[66]	Per MWh	$30

It has been assumed that the air pollution control residue (APCR) generated from pyrolysis process will be classified as 'Category B' prescribed industrial (hazardous) waste, and that it would be disposed at SUEZ Taylors Road Landfill, the only landfill in Victoria licensed to receive 'Category B' prescribed industrial (hazardous) waste.[67] Chemical analysis would be required during operation to determine the hazard level of the residue.

If testing found the APCR to be 'Categroy A' waste, the EPA would typically require treatment, such as stabilisation, before disposal. Consideration of this scenario is beyond the scope of this project. It may possible to seek a waste designation from the EPA to enable disposal of the APCR to a different landfill, such as Stawell Landfill.

Regarding the new small composting facility at Clunes (Option 2, Option 4, Option 5, and Option 11), it was assumed that the collection would take place in Clunes and the processing would take place at Creswick. With only a small distance between these two sites, transportation was not included in the calculation.

It was assumed that the products, such as compost, would be sold at the facility, so no transportation cost was included to sell the products to market. SLR also assumed that no cost was involved for mulching, shredding and liquid digestate discharge, and no transportation would be needed to transport biosolids from wastewater treatment plant in Ballarat to the wet AD facility in Ballarat. Since all proposed transfer stations are situated in the same councils, no transportation was assumed to be involved to the transfer stations.

In order to estimate the transportation cost, distance for feedstock from sources to facilities and distance for residues from facilities to disposal locations were also considered. These distances were calculated using Google Maps. **Table 24** lists the assumed transportation distances.

62 Review of Council Municipal Waste Services and Waste Management Plan 2015, Pyrenees Shire Council
63 The fee includes increased EPA levy (i.e., $20) from 1 July 2022 for all Victorian landfills along with the current disposal fee (i.e., $215) for commercial waste at Smythesdale landfill (Ballarat).
64 Australian carbon credit units - Clean Energy Regulator; http://www.cleanenergyregulator.gov.au/Infohub/Markets/Pages/qcmr/september-quarter-2021/Australian-carbon-credit-units-(ACCUs).aspx
65 Wholesale statistics, Australian Energy Regulator
66 Clean Energy Regulator (2021). Quarterly Carbon Market report – June Quarter 2021
67 Assessment of the potential for methane gas movement from Victorian landfills (Appendix 5), VIC EPA

Table 24 Assumed Transportation Distances

Parameter	Distance (km)
Distance from Hepburn to Creswick	30
Distance from Ballarat to Pinegro	50
Distance from Central Goldfields to Carisbrook	15
Distance from Horsham to Dooen landfill	20
Distance from Yarriambiack to Dooen landfill	50
Distance from West Wimmera to Dooen landfill	112
Distance from Ballarat to Smythesdale Landfill	17
Distance from Carisbrook to Stawell (Cleanaway) landfill	115
Distance from Pyrenees to Stawell (Cleanaway) landfill	78
Distance from Northern Grampians to Stawell (Cleanaway) landfill	73
Distance from Warracknabeal to Stawell	105
Distance from Hepburn to Ballarat	45
Distance from West Wimmera to Horsham	93
Distance from Central Goldfields to Clunes	32
Distance from Pyrenees to Clunes	52
Distance from Northern Grampians to Stawell	35
Distance from Clunes to Smythesdale Landfill	42
Distance from Stawell to Stawell Landfill	10
Distance from Horsham to Ballarat	190
Distance from Warracknabeal to Ballarat	228
Distance from West Wimmera to Ballarat	281
Distance from Central Goldfields to Ballarat	72
Distance from Beaufort to Ballarat	50
Distance from Stawell to Ballarat	124
Distance from Ballarat to SUEZ Taylors Road Landfill	157
Distance for commercial organics to Ballarat [68]	20

In order to calculate the cost per household rate, total number of households data for eight councils were collected for 2011 and 2016 from Australian Bureau of Statistics.[69] Annual household growth rate was calculated using Compound Annual Growth Rate (CAGR) method and this growth rate was applied to estimate the total number of households in the subsequent years. It is noted that the cost per household was calculated with only total operating cost divided by total number of households for the respective year; so, it does not take into account the upfront capital cost.

[68] It was assumed that the commercial organics would come from Mars, McCains and HPV plantation in Ballarat.
[69] Search Census data, https://www.abs.gov.au/census/find-census-data/search-by-area

10.2 Option 1

10.2.1 Description of Organics Management

The business as usual (BAU) organics system to process FOGO from kerbside residual organics, kerbside green organics, and transfer station organic drop-off from all eight councils is shown in **Appendix F**. Based on the available data, around 57% organics are composted, 14% are mulched, 4% are burnt, and 25% of organics are disposed at landfills.

10.2.2 Cost Benefit Estimates

SLR has estimated the potential cost and benefit streams associated with Option 1 for the processing of available organics. **Table 25** and **Table 26** show a summary of indicative operating costs, and potential revenue estimates along with landfill saving for Option 1 (BAU), based on the projected quantities, for Year 1 (2021), Year 2 (2022), Year 10 (2030) and Year 20 (2040).

Table 25 Summary of the indicative operating cost for Option 1

Parameter	Year 1	Year 2	Year 10	Year 20
City of Ballarat				
FOGO quantities (tpa)	-	15,302	24,359	35,680
Capital cost	-	-	-	-
Operating cost	-	$2,115,864	$3,368,201	$4,933,623
Central Goldfields Shire Council				
FOGO quantities (tpa)	-	1,059	1,500	2,145
Capital cost	-	-	-	-
Operating cost	-	$205,127	$277,437	$383,186
Hepburn Shire Council				
FOGO quantities (tpa)	-	318	426	562
Capital cost	-	-	-	-
Operating cost	-	$68,845	$81,577	$97,492
Horsham Rural City Council				
FOGO quantities (tpa)	-	1,776	2,340	3,044
Capital cost	-	-	-	-
Operating cost	-	$319,685	$421,132	$547,941
West Wimmera Shire Council				
FOGO quantities (tpa)	-	127	174	232
Capital cost	-	-	-	-
Operating cost	-	$28,121	$38,435	$51,328
Yarriambiack Shire Council				
FOGO quantities (tpa)	-	283	376	492
Capital cost	-	-	-	-

Parameter	Year 1	Year 2	Year 10	Year 20
Operating cost	-	$54,845	$72,776	$95,191
Pyrenees Shire Council				
FOGO quantities (tpa)	-	483	688	952
Capital cost	-	-	-	-
Operating cost	-	$106,643	$151,891	$210,067
Northern Grampians Shire Council				
FOGO quantities (tpa)	-	1,015	1,587	2,301
Capital cost	-	-	-	-
Operating cost	-	$221,677	$346,461	$502,441
Total Capital Cost	**-**	**-**	**-**	**-**
Total Operating Cost	**-**	**$3,120,807**	**$4,757,911**	**$6,821,269**
Cost per Tonne	**-**	**$102**	**$102**	**$102**
Cost per Household	**-**	**$39**	**$54**	**$67**

Table 26 Summary of the potential revenue and landfill savings for Option 1

Parameter	Year 1	Year 2	Year 10	Year 20
Compost				
Compost quantities (tpa)	-	7,357	11,617	16,973
Potential revenue from compost sales	-	$470,482	$742,978	$1,085,453
Mulch				
Mulch quantities (tpa)	-	4,335	6,608	9,480
Potential revenue from mulch sales	-	$28,903	$44,051	$63,200
ACCUs				
Net abatement (tCO_2-e)	-	10,332	16,909	25,178
Potential revenue from ACCUs	-	$382,270	$625,641	$931,604
Total Revenue or Income	**-**	**$881,655**	**$1,412,671**	**$2,080,257**
Landfill savings				
Savings from landfill space	-	$4,289,396	$6,736,807	$9,813,523
Total Value of Landfill Savings	**-**	**$4,289,396**	**$6,736,807**	**$9,813,523**

The total operating expense (opex) for the existing waste management facilities over 20 years is estimated to be approximately $94.2 million. It was estimated that total compost production, mulch production, and diverted material from landfill over 20 years would be around 230,706 tonnes, 130,717 tonnes and 643,397 tonnes respectively. Based on the estimates, total income over 20 years would be $28.1 million. Total value of landfill savings over 20 years was expected to be around $133.7 million.

10.3 Option 2

10.3.1 Description of Organics Management

This option includes processing of all FOGO from kerbside residual organics, kerbside green organics, and transfer station organic drop-off from all eight councils using one large IVC at Ballarat, three small IVCs near Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera. **Table 27** outlines the new processing facilities summary for Option 2.

Table 27 Summary of new processing facilities for Option 2

New Facility	Location	Waste Type	Source of Feedstock	Capacity (tpa)
Transfer Station 1	Warracknabeal	FOGO	Yarriambiack Shire Council	666 - 1,156
Transfer Station 2	West Wimmera	FOGO	West Wimmera Shire Council	457 - 834
Small IVC 1	Horsham	FOGO	Horsham Rural City Council and West Wimmera Shire Council	3,129 - 5,414
Small IVC 2	Stawell	FOGO	Yarriambiack Shire Council and Northern Grampians Shire Council	3,214 - 6,930
Small IVC 3	Clunes	FOGO	Pyrenees Shire Council and Central Goldfields Shire Council	3,402 - 6,833
Large IVC	Ballarat	FOGO	City of Ballarat and Hepburn Shire Council	20,782 - 47,570

The residuals from the large IVC would be disposed at Smythesdale landfill, while the residuals from small IVC 1, small IVC 2 and small IVC 3 would be disposed at Dooen landfill, Stawell (Cleanaway) landfill and Smythesdale landfills respectively.

Appendix F shows the simplified material flow diagram for Option 2. This diagram includes combination of organic processing technologies with maximum capacity to be used. This maximum capacity is based on the estimated waste generation projection in 2040.

10.3.2 Cost Benefit Estimates

Table 28 and **Table 29** show a summary of indicative capital and operating costs, and potential revenue estimates along with landfill saving for Option 2, based on the projected quantities, for Year 1 (2021), Year 2 (2022), Year 10 (2030) and Year 20 (2040).

Table 28 Summary of the indicative costs for Option 2

Parameter	Year 1	Year 2	Year 10	Year 20
FOGO collection				
FOGO quantities (tpa)	-	30,526	46,524	66,747
FOGO collection cost	-	$1,374,630	$2,078,543	$2,968,388
Transfer Station 1 (Warracknabeal)				
Processing quantities (tpa)	-	666	884	1,156
Capital cost	$28,899	-	-	-

Parameter	Year 1	Year 2	Year 10	Year 20
Processing cost	-	$9,990	$13,257	$17,339
Transfer Station 2 (West Wimmera)				
Processing quantities (tpa)	-	457	625	834
Capital cost	$20,861	-	-	-
Processing cost	-	$6,857	$9,373	$12,517
Small IVC 1 (Horsham)				
Processing quantities (tpa)	-	3,129	4,144	5,414
Capital cost	$1,082,729	-	-	-
Processing cost	-	$187,729	$248,658	$324,819
Feedstock transportation cost from West Wimmera to facility	-	$19,132	$26,150	$34,921
Residual transportation cost to the landfill	-	$1,408	$1,865	$2,436
Residual disposal cost at Dooen landfill	-	$26,751	$35,434	$46,287
Small IVC 2 (Stawell)				
Processing quantities (tpa)	-	3,214	4,865	6,930
Capital cost	$1,386,044	-	-	-
Processing cost	-	$192,817	$291,927	$415,813
Feedstock transportation cost from Northern Grampians to facility	-	$40,125	$62,711	$90,945
Feedstock transportation cost from Warracknabeal to facility	-	$31,469	$41,758	$54,619
Residual transportation cost to the landfill	-	$723	$1,095	$1,559
Residual disposal cost at Stawell (Cleanaway) landfill	-	$29,810	$45,132	$64,285
Small IVC 3 (Clunes)				
Processing quantities (tpa)	-	3,402	4,826	6,833
Capital cost	$1,366,635	-	-	-
Processing cost	-	$204,093	$289,570	$409,990
Feedstock transportation cost from Pyrenees to facility	-	$23,842	$33,958	$46,964
Feedstock transportation cost from Central Goldfields to facility	-	$34,310	$48,600	$69,497
Residual transportation cost to the landfill	-	$3,214	$4,561	$6,457
Residual disposal cost at Smythesdale landfill	-	$37,162	$52,726	$74,652
Large IVC (Ballarat)				
Processing quantities (tpa)	-	20,782	32,688	47,570
Capital cost	$19,028,166	-	-	-

Parameter	Year 1	Year 2	Year 10	Year 20
Processing cost	-	$1,662,537	$2,615,024	$3,805,633
Feedstock transportation cost from Hepburn to facility	-	$31,807	$42,651	$56,206
Residual transportation cost to the landfill	-	$7,949	$12,503	$18,196
Residual disposal cost at Smythesdale landfill	-	$227,040	$357,114	$519,707
Total Capital Cost	**$22,913,334**	**-**	**-**	**-**
Total Operating Cost	**-**	**$4,153,397**	**$6,312,606**	**$9,041,230**
Cost per Tonne	**-**	**$136**	**$136**	**$135**
Cost per Household	**-**	**$52**	**$71**	**$89**

Table 29 Summary of the potential revenue and landfill savings for Option 2

Parameter	Year 1	Year 2	Year 10	Year 20
Compost				
Compost quantities (tpa)	-	13,737	20,936	30,036
Potential revenue from compost sales	-	$878,501	$1,338,909	$1,920,930
Gate fees				
Potential revenue from council gate fee	-	$915,771	$1,395,711	$2,002,424
ACCUs				
Net abatement (tCO_2-e)	-	25,529	38,908	55,822
Potential revenue from ACCUs	-	$944,575	$1,439,611	$2,065,408
Total Revenue or Income	**-**	**$2,738,847**	**$4,174,231**	**$5,988,761**
Landfill savings				
Savings from landfill space	-	$5,978,735	$9,154,307	$13,163,646
Total Value of Landfill Savings	**-**	**$5,978,735**	**$9,154,307**	**$13,163,646**

As shown in the tables, total capital expenditure (capex) for one large IVC, three small IVCs, and two transfer stations was approximately $22.9 million, and total opex for over 20 years was $124.9 million. It was estimated that total compost production and diverted material from landfill over 20 years would be around 414,164 tonnes and 874,347 tonnes respectively. Based on the estimates, total income over 20 years would be $82.6 million. Total value of landfill savings over 20 years was expected to be around $181.2 million.

10.4 Option 4

10.4.1 Description of Organics Management

This option includes processing of all FOGO from kerbside residual organics, kerbside green organics, and transfer station organic drop-off from all eight councils using one dry AD at Ballarat, three small IVCs near Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera.

Biogas generated from the dry AD would be used in a combined heat and power (CHP) plant to generate electricity. Heat from the CHP unit would be used for digester heating requirements. The produced digestate would be further processed in a small IVC producing compost. **Table 30** outlines the new processing facilities summary for Option 4.

Table 30 Summary of new processing facilities for Option 4

New Facility	Location	Waste Type	Source of Feedstock	Maximum Capacity (tpa)
Transfer Station 1	Warracknabeal	FOGO	Yarriambiack Shire Council	666 - 1,156
Transfer Station 2	West Wimmera	FOGO	West Wimmera Shire Council	457 - 834
Small IVC 1	Horsham	FOGO	Horsham Rural City Council and West Wimmera Shire Council	3,129 - 5,414
Small IVC 2	Stawell	FOGO	Yarriambiack Shire Council and Northern Grampians Shire Council	3,214 - 6,930
Small IVC 3	Clunes	FOGO	Pyrenees Shire Council and Central Goldfields Shire Council	3,402 - 6,833
Dry AD	Ballarat	FOGO	City of Ballarat and Hepburn Shire Council	20,782 - 47,570

The residual from dry AD facility would be disposed at Smythesdale landfill, while the residual from small IVC 1, small IVC 2 and small IVC 3 would be disposed at Dooen landfill, Stawell (Cleanaway) landfill and Smythesdale landfill respectively. **Appendix F** illustrates the simplified material flow diagram for Option 4.

10.4.2 Cost Benefit Estimates

Table 31 and **Table 32** show a summary of indicative capital and operating costs, and potential revenue estimates along with landfill saving for Option 4, based on the projected quantities, for Year 1 (2021), Year 2 (2022), Year 10 (2030) and Year 20 (2040).

Table 31 Summary of the indicative costs for Option 4

Parameter	Year 1	Year 2	Year 10	Year 20
FOGO collection				
FOGO quantities (tpa)	-	30,526	46,524	66,747
FOGO collection cost	-	$1,374,630	$2,078,543	$2,968,388
Transfer Station 1 (Warracknabeal)				
Processing quantities (tpa)	-	666	884	1,156
Capital cost	$28,899	-	-	-
Processing cost	-	$9,990	$13,257	$17,339
Transfer Station 2 (West Wimmera)				
Processing quantities (tpa)	-	457	625	834
Capital cost	$20,861	-	-	-
Processing cost	-	$6,857	$9,373	$12,517

Parameter	Year 1	Year 2	Year 10	Year 20
Small IVC 1 (Horsham)				
Processing quantities (tpa)	-	3,129	4,144	5,414
Capital cost	$1,082,729	-	-	-
Processing cost	-	$187,729	$248,658	$324,819
Feedstock transportation cost from West Wimmera to facility	-	$19,132	$26,150	$34,921
Residual transportation cost to the landfill	-	$1,408	$1,865	$2,436
Residual disposal cost at Dooen landfill	-	$26,751	$35,434	$46,287
Small IVC 2 (Stawell)				
Processing quantities (tpa)	-	3,214	4,865	6,930
Capital cost	$1,386,044	-	-	-
Processing cost	-	$192,817	$291,927	$415,813
Feedstock transportation cost from Northern Grampians to facility	-	$40,125	$62,711	$90,945
Feedstock transportation cost from Warracknabeal to facility	-	$31,469	$41,758	$54,619
Residual transportation cost to the landfill	-	$723	$1,095	$1,559
Residual disposal cost at Stawell (Cleanaway) landfill	-	$29,810	$45,132	$64,285
Small IVC 3 (Clunes)				
Processing quantities (tpa)	-	3,402	4,826	6,833
Capital cost	$1,366,635	-	-	-
Processing cost	-	$204,093	$289,570	$409,990
Feedstock transportation cost from Pyrenees to facility	-	$23,842	$33,958	$46,964
Feedstock transportation cost from Central Goldfields to facility	-	$34,310	$48,600	$69,497
Residual transportation cost to the landfill	-	$3,214	$4,561	$6,457
Residual disposal cost at Smythesdale landfill	-	$37,162	$52,726	$74,652
Dry AD (Ballarat)				
Processing quantities (tpa)	-	20,782	32,688	47,570
Capital cost	$42,004,677	-	-	-
Processing cost	-	$2,752,538	$4,329,499	$6,300,701
Feedstock transportation cost from Hepburn to facility	-	$31,807	$42,651	$56,206
Residual transportation cost to the landfill	-	$15,501	$24,381	$35,482
Residual disposal cost at Smythesdale landfill	-	$442,728	$696,373	$1,013,428
Total Capital Cost	**$45,889,844**	**-**	**-**	**-**
Total Operating Cost	**-**	**$5,466,637**	**$8,378,218**	**$12,047,306**
Cost per Tonne	**-**	**$179**	**$180**	**$180**
Cost per Household	**-**	**$69**	**$94**	**$118**

Table 32 Summary of the potential revenue and landfill savings for Option 4

Parameter	Year 1	Year 2	Year 10	Year 20
Compost				
Compost quantities (tpa)	-	13,269	20,200	28,966
Potential revenue from compost sales	-	$848,597	$1,291,873	$1,852,478
Electricity				
Electricity Exported (MWh)	-	2,240	3,523	5,127
Potential revenue from electricity sales	-	$60,477	$95,125	$138,434
LGCs				
Eligible electricity for LGCs (MWh)	-	2,237	3,518	5,120
Potential revenue from LGCs	-	$67,107	$105,553	$153,611
Gate fees				
Potential revenue from council gate fee	-	$915,771	$1,395,711	$2,002,424
ACCUs				
Net abatement (tCO_2-e)	-	25,864	39,436	56,589
Potential revenue from ACCUs	-	$956,977	$1,459,119	$2,093,796
Total Revenue or Income	**-**	**$2,848,928**	**$4,347,380**	**$6,240,744**
Landfill savings				
Savings from landfill space	-	$5,763,047	$8,815,049	$12,669,924
Total Value of Landfill Savings	**-**	**$5,763,047**	**$8,815,049**	**$12,669,924**

As shown in the tables, total capex for one dry AD, three small IVCs and two transfer stations was approximately $45.9 million, and total opex for over 20 years was $165.9 million. It was estimated that total compost production and diverted material from landfill over 20 years would be around 399,554 tonnes and 843,503 tonnes respectively, while the expected electricity generation would be around 70 GWh. Based on the estimates, total income over 20 years would be $86 million. Total value of landfill savings over 20 years was expected to be around $174.5 million.

10.5 Option 5

10.5.1 Description of Organics Management

This option includes processing of all FOGO from kerbside residual organics, kerbside green organics, and transfer station organic drop-off from all eight councils as well as biosolids from WWTP in Ballarat. The new facilities include one wet AD at Ballarat, three small IVCs near Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera. Biogas generated from the wet AD would be used in a CHP plant to generate electricity. Heat from the CHP unit would be used for digester heating requirements. The produced digestate would be further processed in a small IVC producing compost. **Table 33** outlines the new processing facilities summary for Option 5.

Table 33 Summary of new processing facilities for Option 5

New Facility	Location	Waste Type	Source of Feedstock	Maximum Capacity (tpa)
Transfer Station 1	Warracknabeal	FOGO	Yarriambiack Shire Council	666 - 1,156
Transfer Station 2	West Wimmera	FOGO	West Wimmera Shire Council	457 - 834
Small IVC 1	Horsham	FOGO	Horsham Rural City Council and West Wimmera Shire Council	3,129 - 5,414
Small IVC 2	Stawell	FOGO	Yarriambiack Shire Council and Northern Grampians Shire Council	3,214 - 6,930
Small IVC 3	Clunes	FOGO	Pyrenees Shire Council and Central Goldfields Shire Council	3,402 - 6,833
Wet AD	Ballarat	FOGO and biosolids	City of Ballarat and Hepburn Shire Council	22,221 - 50,904

The residuals from wet AD facility would be disposed at Smythesdale landfill, while the residuals from small IVC 1, small IVC 2 and small IVC 3 would be disposed at Dooen landfill, Stawell (Cleanaway) landfill and Smythesdale landfill respectively. **Appendix F** illustrates the simplified material flow diagram for Option 5.

10.5.2 Cost Benefit Estimates

Table 34 and **Table 35** show a summary of indicative capital and operating costs, and potential revenue estimates along with landfill saving for Option 5, based on the projected quantities, for Year 1 (2021), Year 2 (2022), Year 10 (2030) and Year 20 (2040).

Table 34 Summary of the indicative costs for Option 5

Parameter	Year 1	Year 2	Year 10	Year 20
FOGO collection				
FOGO quantities (tpa)	-	30,526	46,524	66,747
FOGO collection cost	-	$1,374,630	$2,078,543	$2,968,388
Transfer Station 1 (Warracknabeal)				
Processing quantities (tpa)	-	666	884	1,156
Capital cost	$28,899	-	-	-
Processing cost	-	$9,990	$13,257	$17,339
Transfer Station 2 (West Wimmera)				
Processing quantities (tpa)	-	457	625	834
Capital cost	$20,861	-	-	-
Processing cost	-	$6,857	$9,373	$12,517
Small IVC 1 (Horsham)				
Processing quantities (tpa)	-	3,129	4,144	5,414
Capital cost	$1,082,729	-	-	-
Processing cost	-	$187,729	$248,658	$324,819

Parameter	Year 1	Year 2	Year 10	Year 20
Feedstock transportation cost from West Wimmera to facility	-	$19,132	$26,150	$34,921
Residual transportation cost to the landfill	-	$1,408	$1,865	$2,436
Residual disposal cost at Dooen landfill	-	$26,751	$35,434	$46,287
Small IVC 2 (Stawell)				
Processing quantities (tpa)	-	3,214	4,865	6,930
Capital cost	$1,386,044	-	-	-
Processing cost	-	$192,817	$291,927	$415,813
Feedstock transportation cost from Northern Grampians to facility	-	$40,125	$62,711	$90,945
Feedstock transportation cost from Warracknabeal to facility	-	$31,469	$41,758	$54,619
Residual transportation cost to the landfill	-	$723	$1,095	$1,559
Residual disposal cost at Stawell (Cleanaway) landfill	-	$29,810	$45,132	$64,285
Small IVC 3 (Clunes)				
Processing quantities (tpa)	-	3,402	4,826	6,833
Capital cost	$1,366,635	-	-	-
Processing cost	-	$204,093	$289,570	$409,990
Feedstock transportation cost from Pyrenees to facility	-	$23,842	$33,958	$46,964
Feedstock transportation cost from Central Goldfields to facility	-	$34,310	$48,600	$69,497
Residual transportation cost to the landfill	-	$3,214	$4,561	$6,457
Residual disposal cost at Smythesdale landfill	-	$37,162	$52,726	$74,652
Wet AD (Ballarat)				
Processing quantities (tpa)	-	22,221	34,969	50,904
Capital cost	$25,452,245	-	-	-
Processing cost	-	$1,111,065	$1,748,469	$2,545,224
Feedstock transportation cost from Hepburn to facility	-	$31,807	$42,651	$56,206
Residual transportation cost to the landfill	-	$11,475	$18,057	$26,286
Residual disposal cost at Smythesdale landfill	-	$327,736	$515,755	$750,778
Total Capital Cost	**$29,337,412**	**-**	**-**	**-**
Total Operating Cost	**-**	**$3,706,147**	**$5,610,246**	**$8,019,982**
Cost per Tonne	**-**	**$116**	**$115**	**$114**
Cost per Household	**-**	**$47**	**$63**	**$79**

Table 35 Summary of the potential revenue and landfill savings for Option 5

Parameter	Year 1	Year 2	Year 10	Year 20
Compost				
Compost quantities (tpa)	-	7,885	11,734	16,647
Potential revenue from compost sales	-	$504,251	$750,420	$1,064,642
Electricity				
Electricity Exported (MWh)	-	5,555	8,742	12,726
Potential revenue from electricity sales	-	$149,994	$236,043	$343,605
LGCs				
Eligible electricity for LGCs (MWh)	-	2,418	3,805	5,539
Potential revenue from LGCs	-	$72,543	$114,159	$166,180
Gate fees				
Potential revenue from council gate fee	-	$915,771	$1,395,711	$2,002,424
Potential revenue from commercial gate fee	-	$338,305	$536,173	$783,507
ACCUs				
Net abatement (tCO_2-e)	-	27,091	41,381	59,431
Potential revenue from ACCUs	-	$1,002,382	$1,531,081	$2,198,954
Total Revenue or Income	**-**	**$2,983,245**	**$4,563,586**	**$6,559,312**
Landfill savings				
Savings from landfill space	-	$6,192,590	$9,494,193	$13,661,070
Total Value of Landfill Savings	**-**	**$6,192,590**	**$9,494,193**	**$13,661,070**

As shown in the tables, total capex for one wet AD, three small IVCs, and two transfer stations was approximately $29.3 million, and total opex for over 20 years was $110.9 million. It was estimated that total compost production and diverted material from landfill over 20 years would be around 231,373 tonnes and 905,272 tonnes respectively, while the expected electricity generation would be around 173.67 GWh. Based on the estimates, total income over 20 years would be $90.3 million. Total value of landfill savings over 20 years was expected to be around $188 million.

10.6 Option 8

10.6.1 Description of Organics Management

This option includes processing of all FOGO from kerbside residual organics, kerbside green organics, and transfer station organic drop-off from all eight councils using one pyrolysis plant at Ballarat and seven transfer stations for bulk haulage at Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell. **Table 36** outlines the new processing facilities summary for Option 8.

Table 36 Summary of new processing facilities for Option 8

New Facility	Location	Waste Type	Source of Feedstock	Maximum Capacity (tpa)
Transfer Station 1	Horsham	FOGO	Horsham Rural City Council	2,672 - 4,579
Transfer Station 2	Warracknabeal	FOGO	Yarriambiack Shire Council	666 - 1,156
Transfer Station 3	Hepburn	FOGO	Hepburn Shire Council	1,571 - 2,776
Transfer Station 4	West Wimmera	FOGO	West Wimmera Shire Council	457 - 834
Transfer Station 5	Central Goldfields	FOGO	Central Goldfields Shire Council	2,383 - 4,826
Transfer Station 6	Beaufort	FOGO	Pyrenees Shire Council	1,019 - 2,007
Transfer Station 7	Stawell	FOGO	Northern Grampians Shire Council	2,548 - 5,774
Thermal Treatment (Pyrolysis)	Ballarat	FOGO	City of Ballarat, Hepburn Shire Council, Horsham Rural City Council, West Wimmera Shire Council, Yarriambiack Shire Council, Northern Grampians Shire Council, Pyrenees Shire Council, and Central Goldfields Shire Council	30,526 - 66,747

The treated fly ash, assumed to be Category B waste, from the pyrolysis plant near Ballarat would be disposed at SUEZ Taylors Road Landfill, which is the only landfill in Victoria licensed to receive Category B prescribed industrial (hazardous) waste. **Appendix F** illustrates the simplified material flow diagram for Option 8.

10.6.2 Cost Benefit Estimates

Table 37 and **Table 38** show a summary of indicative capital and operating costs, and potential revenue estimates along with landfill saving for Option 8, based on the projected quantities, for Year 1 (2021), Year 2 (2022), Year 10 (2030) and Year 20 (2040).

Table 37 Summary of the indicative costs for Option 8

Parameter	Year 1	Year 2	Year 10	Year 20
FOGO collection				
FOGO quantities (tpa)	-	30,526	46,524	66,747
FOGO collection cost	-	$1,374,630	$2,078,543	$2,968,388
Transfer Station 1 (Horsham)				
Processing quantities (tpa)	-	2,672	3,519	4,579
Capital cost	$114,480	-	-	-
Processing cost	-	$40,075	$52,792	$68,688
Transfer Station 2 (Warracknabeal)				
Processing quantities (tpa)	-	666	884	1,156
Capital cost	$28,899	-	-	-
Processing cost	-	$9,990	$13,257	$17,339
Transfer Station 3 (Hepburn)				
Processing quantities (tpa)	-	1,571	2,106	2,776

Parameter	Year 1	Year 2	Year 10	Year 20
Capital cost	$69,390	-	-	-
Processing cost	-	$23,561	$31,593	$41,634
Transfer Station 4 (West Wimmera)				
Processing quantities (tpa)	-	457	625	834
Capital cost	$20,861	-	-	-
Processing cost	-	$6,857	$9,373	$12,517
Transfer Station 5 (Central Goldfields)				
Processing quantities (tpa)	-	2,383	3,375	4,826
Capital cost	$120,654	-	-	-
Processing cost	-	$35,740	$50,625	$72,392
Transfer Station 6 (Beaufort)				
Processing quantities (tpa)	-	1,019	1,451	2,007
Capital cost	$50,175	-	-	-
Processing cost	-	$15,283	$21,768	$30,105
Transfer Station 7 (Stawell)				
Processing quantities (tpa)	-	2,548	3,982	5,774
Capital cost	$144,356	-	-	-
Processing cost	-	$38,214	$59,725	$86,614
Pyrolysis (Ballarat)				
Processing quantities (tpa)	-	30,526	46,524	66,747
Capital cost	$33,373,727	-	-	-
Processing cost	-	$1,526,284	$2,326,185	$3,337,373
Feedstock transportation costs:				
from Horsham to facility	-	$228,426	$300,913	$391,522
from Warracknabeal to facility	-	$68,333	$90,675	$118,602
from Hepburn to facility	-	$31,807	$42,651	$56,206
from West Wimmera to facility	-	$57,808	$79,011	$105,515
from Central Goldfields to facility	-	$77,198	$109,349	$156,368
from Beaufort to facility	-	$22,925	$32,652	$45,158
from Stawell to facility	-	$142,156	$222,177	$322,203
Residual transportation cost to the landfill	-	$64,699	$98,607	$141,471
Residual disposal cost at SUEZ Taylors Road Landfill	-	$803,131	$1,224,039	$1,756,126
Total Capital Cost	**$33,922,543**	**-**	**-**	**-**
Total Operating Cost	**-**	**$4,567,119**	**$6,843,933**	**$9,728,220**
Cost per Tonne	**-**	**$150**	**$147**	**$146**
Cost per Household	**-**	**$57**	**$77**	**$95**

The thermal treatment processes, like pyrolysis, generate air pollution control residues (APCR) which may potentially contain some contaminants, and hence these would likely to be disposed of at a licenced facility that accepts such material. APCR is pre-classified by the EPA as 'Reportable Priority Waste' in th Environment Protection Regulations, 2021. Chemical analysis would need to be done to determine the hazard level of this material. After treatment this material can be disposed at a licenced landfill facility.

The generated bottom ash (or char) is also pre-classified by the EPA as 'Reportable Priority Waste' and as a result cannot be directly supplied to end users for beneficial reuse. Councils would need to seek approval from the EPA to enable land application of char pursuant to the new waste duties.

Table 38 Summary of the potential revenue and landfill savings for Option 8

Parameter	Year 1	Year 2	Year 10	Year 20
Char				
Char quantities (tpa)	-	3,053	4,652	6,675
Potential revenue from char sales	-	$30,526	$46,524	$66,747
Gate fees				
Potential revenue from council gate fee	-	$915,771	$1,395,711	$2,002,424
Total Revenue or Income	**-**	**$946,296**	**$1,442,235**	**$2,069,171**
Landfill savings				
Savings from landfill space	-	$6,104,603	$9,347,029	$13,440,775
Total Value of Landfill Savings	**-**	**$6,104,603**	**$9,347,029**	**$13,440,775**

As shown in the tables, capex for one pyrolysis and seven transfer stations was approximately $33.9 million, and total opex for over 20 years was $135.2 million. Estimates of total char production and diverted material from landfill over 20 years is around 92,036 tonnes and 892,754 tonnes respectively. Based on the estimates, total income over 20 years would be approximately $28.5 million. Total value of landfill savings over 20 years was expected to be around $185 million.

Pyrolysis is not yet included as an eligible project for ACCUs and will not earn carbon credits through the Emissions Reduction Fund.

10.7 Option 11

10.7.1 Description of Organics Management

This option includes processing of all FOGO from kerbside residual organics, kerbside green organics, and transfer station organic drop-off from all eight councils using one large OWC at Ballarat, three small OWCs at Horsham, Stawell, and Clunes, and two transfer stations for bulk haulage at Warracknabeal and West Wimmera. **Table 39** outlines the new processing facilities summary for Option 11.

Table 39 Summary of new processing facilities for Option 11

New Facility	Location	Waste Type	Source of Feedstock	Maximum Capacity (tpa)
Transfer Station 1	Warracknabeal	FOGO	Yarriambiack Shire Council	666 - 1,156
Transfer Station 2	West Wimmera	FOGO	West Wimmera Shire Council	457 - 834
Small OWC 1	Horsham	FOGO	Horsham Rural City Council and West Wimmera Shire Council	3,129 - 5,414
Small OWC 2	Stawell	FOGO	Yarriambiack Shire Council and Northern Grampians Shire Council	3,214 - 6,930
Small OWC 3	Clunes	FOGO	Pyrenees Shire Council and Central Goldfields Shire Council	3,402 - 6,833
Large OWC	Ballarat	FOGO	City of Ballarat and Hepburn Shire Council	20,782 - 47,570

The residuals from large OWC would be disposed at Smythesdale landfill, while the residuals from small OWC 1, small OWC 2 and small OWC 3 would be disposed at Dooen landfill, Stawell (Cleanaway) landfill and Smythesdale landfill respectively. **Appendix F** illustrates the simplified material flow diagram for Option 11.

10.7.2 Cost Benefit Estimates

Table 40 and **Table 41** show a summary of indicative capital and operating costs, and potential revenue estimates along with landfill saving for Option 11, based on the projected quantities, for Year 1 (2021), Year 2 (2022), Year 10 (2030) and Year 20 (2040).

Table 40 Summary of the indicative costs for Option 11

Parameter	Year 1	Year 2	Year 10	Year 20
FOGO collection				
FOGO quantities (tpa)	-	30,526	46,524	66,747
FOGO collection cost	-	$1,374,630	$2,078,543	$2,968,388
Transfer Station 1 (Warracknabeal)				
Processing quantities (tpa)	-	666	884	1,156
Capital cost	$28,899	-	-	-
Processing cost	-	$9,990	$13,257	$17,339
Transfer Station 2 (West Wimmera)				
Processing quantities (tpa)	-	457	625	834
Capital cost	$20,861	-	-	-
Processing cost	-	$6,857	$9,373	$12,517
Small OWC 1 (Horsham)				
Processing quantities (tpa)	-	3,129	4,144	5,414
Capital cost	$579,260	-	-	-
Processing cost	-	$147,054	$194,782	$254,441

Parameter	Year 1	Year 2	Year 10	Year 20
Feedstock transportation cost from West Wimmera to facility	-	$19,132	$26,150	$34,921
Residual transportation cost to the landfill	-	$1,408	$1,865	$2,436
Residual disposal cost at Dooen landfill	-	$26,751	$35,434	$46,287
Small OWC 2 (Stawell)				
Processing quantities (tpa)	-	3,214	4,865	6,930
Capital cost	$741,533	-	-	-
Processing cost	-	$151,040	$228,676	$325,720
Feedstock transportation cost from Northern Grampians to facility	-	$40,125	$62,711	$90,945
Feedstock transportation cost from Warracknabeal to facility	-	$31,469	$41,758	$54,619
Residual transportation cost to the landfill	-	$723	$1,095	$1,559
Residual disposal cost at Stawell (Cleanaway) landfill	-	$29,810	$45,132	$64,285
Small OWC 3 (Clunes)				
Processing quantities (tpa)	-	3,402	4,826	6,833
Capital cost	$731,150	-	-	-
Processing cost	-	$159,873	$226,830	$321,159
Feedstock transportation cost from Pyrenees to facility	-	$23,842	$33,958	$46,964
Feedstock transportation cost from Central Goldfields to facility	-	$34,310	$48,600	$69,497
Residual transportation cost to the landfill	-	$3,214	$4,561	$6,457
Residual disposal cost at Smythesdale landfill	-	$37,162	$52,726	$74,652
Large OWC (Ballarat)				
Processing quantities (tpa)	-	20,782	32,688	47,570
Capital cost	$7,635,052	-	-	-
Processing cost	-	$1,205,339	$1,895,892	$2,759,084
Feedstock transportation cost from Hepburn to facility	-	$31,807	$42,651	$56,206
Residual transportation cost to the landfill	-	$7,949	$12,503	$18,196
Residual disposal cost at Smythesdale landfill	-	$227,040	$357,114	$519,707
Total Capital Cost	**$9,736,755**	**-**	**-**	**-**

Parameter	Year 1	Year 2	Year 10	Year 20
Total Operating Cost	-	**$3,569,527**	**$5,413,608**	**$7,745,380**
Cost per Tonne	-	**$117**	**$116**	**$116**
Cost per Household	-	**$45**	**$61**	**$76**

Table 41 Summary of the potential revenue and landfill savings for Option 11

Parameter	Year 1	Year 2	Year 10	Year 20
Compost				
Compost quantities (tpa)	-	13,737	20,936	30,036
Potential revenue from compost sales	-	$878,501	$1,338,909	$1,920,930
Gate fees				
Potential revenue from council gate fee	-	$915,771	$1,395,711	$2,002,424
ACCUs				
Net abatement (tCO_2-e)	-	25,529	38,908	55,822
Potential revenue from ACCUs	-	$944,575	$1,439,611	$2,065,408
Total Revenue or Income	-	**$2,738,847**	**$4,174,231**	**$5,988,761**
Landfill savings				
Savings from landfill space	-	$5,978,735	$9,154,307	$13,163,646
Total Value of Landfill Savings	-	**$5,978,735**	**$9,154,307**	**$13,163,646**

As shown in the tables, total capex for one large OWC, three small OWCs, and two transfer stations was approximately $9.7 million, and total opex for over 20 years was $107 million. It was estimated that total compost production and diverted material from landfill over 20 years would be around 414,164 tonnes and 874,347 tonnes respectively. Based on the estimates, total income over 20 years would be $82.6 million. Total value of landfill savings over 20 years was expected to be around $181.2 million.

10.8 Option 13

10.8.1 Description of Organics Management

This option includes processing of all FOGO from kerbside residual organics, kerbside green organics, and transfer station organic drop-off as well as a small proportion (approximately 2-5%) of the potentially available commercial organics from all eight councils, using one large IVC at Ballarat and seven transfer stations for bulk haulage at Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell. **Table 42** outlines the new processing facilities summary for Option 13.

Table 42 Summary of new processing facilities for Option 13

New Facility	Location	Waste Type	Source of Feedstock	Maximum Capacity (tpa)
Transfer Station 1	Horsham	FOGO	Horsham Rural City Council	2,672 - 4,579
Transfer Station 2	Warracknabeal	FOGO	Yarriambiack Shire Council	666 - 1,156
Transfer Station 3	Hepburn	FOGO	Hepburn Shire Council	1,571 - 2,776

New Facility	Location	Waste Type	Source of Feedstock	Maximum Capacity (tpa)
Transfer Station 4	West Wimmera	FOGO	West Wimmera Shire Council	457 - 834
Transfer Station 5	Central Goldfields	FOGO	Central Goldfields Shire Council	2,383 - 4,826
Transfer Station 6	Beaufort	FOGO	Pyrenees Shire Council	1,019 - 2,007
Transfer Station 7	Stawell	FOGO	Northern Grampians Shire Council	2,548 - 5,774
Large IVC	Ballarat	FOGO and commercial organics	City of Ballarat, Hepburn Shire Council, Horsham Rural City Council, West Wimmera Shire Council, Yarriambiack Shire Council, Northern Grampians Shire Council, Pyrenees Shire Council, and Central Goldfields Shire Council	90,000

The residuals from large IVC near Ballarat would be disposed at Smythesdale landfill. **Appendix F** illustrates the simplified material flow diagram for Option 13. Again, it is noted that only a small proportion (around 2-5%) of the total potentially available organic commercial waste was used in this option.

10.8.2 Cost Benefit Estimates

Table 43 and **Table 44** show a summary of indicative capital and operating costs, and potential revenue estimates along with landfill saving for Option 13, based on the projected quantities, for Year 1 (2021), Year 2 (2022), Year 10 (2030) and Year 20 (2040).

Table 43 Summary of the indicative costs for Option 13

Parameter	Year 1	Year 2	Year 10	Year 20
FOGO collection				
FOGO quantities (tpa)	-	30,526	46,524	66,747
FOGO collection cost	-	$1,374,630	$2,078,543	$2,968,388
Transfer Station 1 (Horsham)				
Processing quantities (tpa)	-	2,672	3,519	4,579
Capital cost	$114,480	-	-	-
Processing cost	-	$40,075	$52,792	$68,688
Transfer Station 2 (Warracknabeal)				
Processing quantities (tpa)	-	666	884	1,156
Capital cost	$28,899	-	-	-
Processing cost	-	$9,990	$13,257	$17,339
Transfer Station 3 (Hepburn)				
Processing quantities (tpa)	-	1,571	2,106	2,776
Capital cost	$69,390	-	-	-
Processing cost	-	$23,561	$31,593	$41,634
Transfer Station 4 (West Wimmera)				
Processing quantities (tpa)	-	457	625	834

Parameter	Year 1	Year 2	Year 10	Year 20
Capital cost	$20,861	-	-	-
Processing cost	-	$6,857	$9,373	$12,517
Transfer Station 5 (Central Goldfields)				
Processing quantities (tpa)	-	2,383	3,375	4,826
Capital cost	$120,654	-	-	-
Processing cost	-	$35,740	$50,625	$72,392
Transfer Station 6 (Beaufort)				
Processing quantities (tpa)	-	1,019	1,451	2,007
Capital cost	$50,175	-	-	-
Processing cost	-	$15,283	$21,768	$30,105
Transfer Station 7 (Stawell)				
Processing quantities (tpa)	-	2,548	3,982	5,774
Capital cost	$144,356	-	-	-
Processing cost	-	$38,214	$59,725	$86,614
Commercial organics				
Organics quantities (tpa)	-	59,474	43,476	23,253
Organics transportation cost to facility	-	$535,269	$391,287	$209,273
Large IVC (Ballarat)				
Processing quantities (tpa)	-	90,000	90,000	90,000
Capital cost	$36,000,000	-	-	-
Processing cost	-	$7,200,000	$7,200,000	$7,200,000
Feedstock transportation costs to facility:				
from Horsham	-	$228,426	$300,913	$391,522
from Warracknabeal	-	$68,333	$90,675	$118,602
from Hepburn	-	$31,807	$42,651	$56,206
from West Wimmera	-	$57,808	$79,011	$105,515
from Central Goldfields	-	$77,198	$109,349	$156,368
from Beaufort	-	$22,925	$32,652	$45,158
from Stawell	-	$142,156	$222,177	$322,203
Residual transportation cost to the landfill	-	$34,425	$34,425	$34,425
Residual disposal cost at Smythesdale landfill	-	$983,250	$983,250	$983,250
Total Capital Cost	**$36,548,816**	**-**	**-**	**-**
Total Operating Cost	**-**	**$10,925,949**	**$11,804,065**	**$12,920,199**
Cost per Tonne	**-**	**$121**	**$131**	**$144**
Cost per Household	**-**	**$137**	**$133**	**$127**

Table 44 Summary of the potential revenue and landfill savings for Option 13

Parameter	Year 1	Year 2	Year 10	Year 20
Compost				
Compost quantities (tpa)	-	40,500	40,500	40,500
Potential revenue from compost sales	-	$2,590,116	$2,590,116	$2,590,116
Gate fees				
Potential revenue from council gate fee	-	$915,771	$1,395,711	$2,002,424
Potential revenue from commercial gate fee	-	$13,976,464	$10,216,931	$5,464,348
ACCUs				
Net abatement (tCO_2-e)	-	75,268	75,268	75,268
Potential revenue from ACCUs	-	$2,784,925	$2,784,925	$2,784,925
Total Revenue or Income	**-**	**$20,267,276**	**$16,987,683**	**$12,841,814**
Landfill savings				
Savings from landfill space	-	$18,324,116	$18,178,900	$17,990,293
Total Value of Landfill Savings	**-**	**$18,324,116**	**$18,178,900**	**$17,990,293**

As shown in the tables, total capex for one large IVC and seven transfer stations would be approximately $36.5 million, and total opex for over 20 years would be $226.2 million. Total compost production and diverted material from landfill over 20 years is estimated to be around 769,500 tonnes and 1,624,500 tonnes respectively. Based on the estimates, total income over 20 years would be $315.3 million. Total value of landfill savings over 20 years was expected to be around $345.1 million.

10.9 Summary of project costs and revenue

Table 45 shows a summary of the total estimated costs and benefits over 20 years of the project, and the net present value (NPV) based on 7% of real discount rate,[70] based on the assessment undertaken for the selected options.

Table 45 Summary of costs and revenue estimates for all options assessed over 20 years

Item Description	Option 1 (BAU)	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13
Total cost	$94.2 m	$147.8 m	$211.8 m	$140.2 m	$169.1 m	$116.8 m	$262.8 m
Total capital costs	$0.0 m	$22.9 m	$45.9 m	$29.3 m	$33.9 m	$9.7 m	$36.5 m
Total operational costs	$94.2 m	$124.9 m	$165.9 m	$110.9 m	$135.2 m	$107.0 m	$226.2 m
Total income	$28.1 m	$82.6 m	$86.0 m	$90.3 m	$28.5 m	$82.6 m	$315.3 m
Total value of landfill savings	$133.7 m	$181.2 m	$174.5 m	$188.0 m	$185.0 m	$181.2 m	$345.1 m
NPV	$31.2 m	$43.4 m	$1.3 m	$50.6 m	$4.6 m	$64.0 m	$196.8 m

70 SLR assumption

Option 13 shows the highest NPV among all the options. This is primarily due to the inclusion of commercial organics, with kerbside FOGO, as feedstock for this option. Commercial organics were assumed to come from Northern Grampians Shire Council, as majority of the commercial organics are generated in Northern Grampians Shire Council (see Section 5). However, it is noted that only a small proportion (around 2-5%) of the total potentially available organic commercial waste was used in this option. No agreements for the supply of commercial organics have been established. To make this option viable, access to the estimated quantities of commercial organic will need to be confirmed.

Excluding Option 13, which includes commercial organcis, the next highest NPV is Option 11 which is followed closely by Option 5.

The comparative total results by year shown in **Appendix G**.

11 Multi-Criteria Analysis

11.1 Scoring Criteria

The aim of the options appraisal is to assess and rank each of the shortlisted options using a range of assessment criteria. This subsection outlines the options appraisal methodology and criteria.

The shortlisted options were awarded scores of between 1 and 5 against each assessment criteria using the multi-criteria assessment shown in **Appendix H**. A score of 1 meant the option scored poorly against the criteria compared to a score of 5 meaning the option scored highly against the criteria. The scoring criteria have adopted a quantitative approach where applicable, with qualitative measures used where a numerical approach was not appropriate.

11.2 Criteria Weighting

The assessment criteria were assigned weightings by priority. These weighting are given using our best judgement considering the overall importance of the criteria for the best possible organic processing option. **Table 46** shows the weightings of the assessment criteria.

Table 46 Assessment Criteria Weightings

Category	Assessment Criteria	Sub-Criteria	Criterion Number	Weighting	
Facility and Technology Criteria	Speed of process (including planning, approval, and construction)		1	8%	20%
	Technical complexity		2	8%	
	Management and resource complexity		3	8%	
	Total footprint - Space required to process current and future quantities, as well as storage for compost maturation		4	10%	
	Proportion of output, for example, compost, digestate or mulch, each option produces	Compost	5	10%	
		Mulch	6	6%	
		Char	7	4%	
		Electricity	8	10%	
	Effectiveness of technology		9	10%	
	Ability to process feedstock		10	10%	
	Technological maturity		11	8%	
	Scalability		12	8%	
	Subtotal			**100%**	
Technical and General	Feasibility and practicality of solution		13	25%	20%
	Match with proposed collection methods		14	15%	
	Compliance with State Government waste management goals and policy objectives		15	25%	
	Availability of markets for products and use of products		16	15%	
	Potential impacts on resources of participating councils		17	10%	
	Benefits from regional partnering		18	10%	
	Subtotal			**100%**	

Category	Assessment Criteria	Sub-Criteria	Criterion Number	Weighting	
Financial	Risks and benefits of increases in landfill levy	Landfill savings value	19	30%	25%
	Net present value		20	70%	
	Subtotal			**100%**	
Social	Consistency with strategic directions of participating councils and GCWWRRG		21	15%	10%
	Employment opportunities		22	35%	
	Community acceptance and benefits		23	40%	
	Quality of community's living environment		24	10%	
	Subtotal			**100%**	
Environmental	Environmental impact – dust, noise, odour, and pollution		25	10%	25%
	Quantity and quality of material diverted from landfill - resource reuse and recovery.		26	40%	
	Carbon impact from LCA		27	50%	
	Subtotal			**100%**	
TOTAL					**100%**

11.3 Options Appraisal

Scores were awarded based on relevant data provided to SLR throughout the project, augmented by publicly available information, SLR's internal databases and performed calculations described in previous sections. The awarded scores, prior to application of the weightings, are shown in **Appendix I**, which also includes rationale for the scores.

Some of the key features of the assessment are:

- In-vessel composting is a proven mature technology. Compared to the other technologies, costs and emissions are relatively low in IVC. Moreover, there is no significant regulatory barriers for this technology.
- Although the open windrow composting is a proven mature technology, and cost is relatively low, this technology has some public health and environmental risks due to odour and leachate issues using food waste in the process. It is unlikely for EPA to approve open windrow composting for food waste.
- Emissions are relatively low in anaerobic digestion, but it would take more planning and construction time than that for pyrolysis and composting facilities. Dry anaerobic digestion is unproven for FOGO, while wet anaerobic digestion is not suitable for green organics processing.
- Advanced thermal treatment, like pyrolysis, is an unproven technology for food organics processing. There are also increased public health and environmental concerns associated with potential emissions from pyrolysis.

The overall results of the MCA analysis resulted in the following weighted results.

Table 47 Multi-Criteria Analysis Summary

Criteria		Facility and Technology Criteria	Technical and General	Financial	Social	Environmental	Total	Rank
	Weighting	**20%**	**20%**	**25%**	**10%**	**25%**	**100%**	
Option 1	Business as usual	0.52	0.59	0.75	0.18	0.38	2.41	6
Option 2	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	0.70	0.96	0.83	0.47	0.53	3.48	2
Option 4	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	0.63	0.84	0.65	0.46	0.53	3.10	5
Option 5	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	0.53	0.68	1.00	0.46	0.53	3.20	3
Option 8	7 Transfer stations, 1 Pyrolysis plant (FOGO)	0.43	0.59	0.65	0.24	0.48	2.38	7
Option 11	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	0.68	0.80	1.00	0.24	0.43	3.14	4
Option 13*	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	0.74	0.98	1.25	0.43	0.63	4.02	1

* Option 13 includes commercial organics, along with kerbside FOGO, as feedstock for this option.

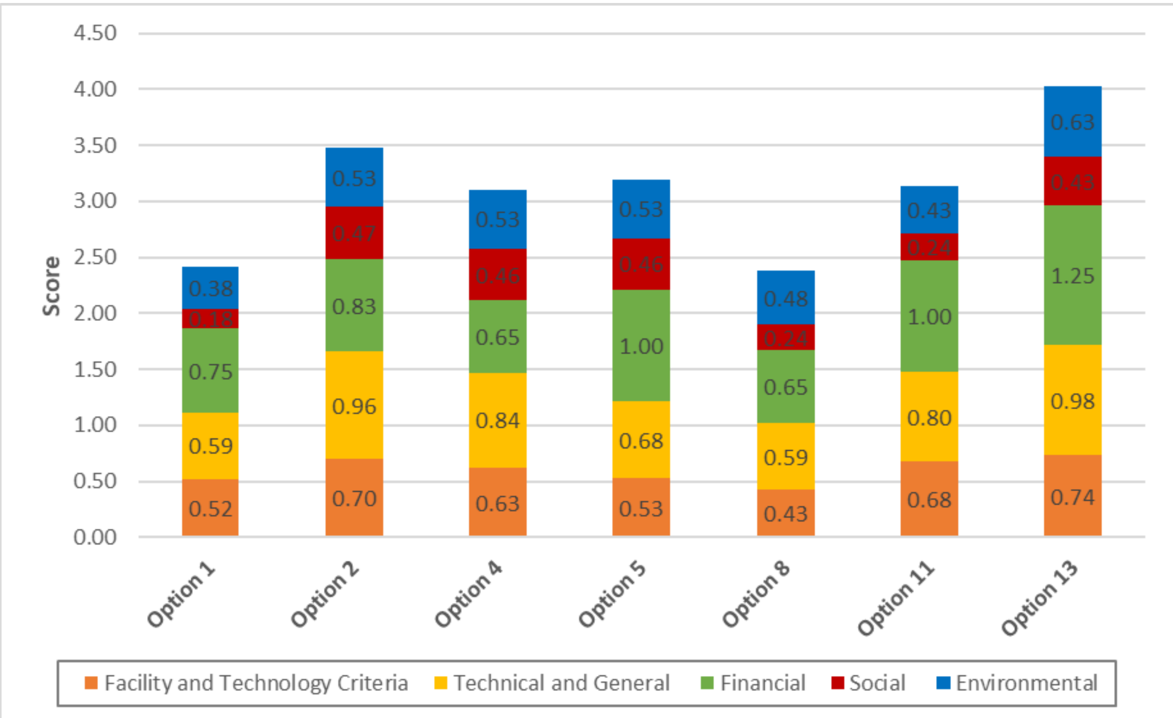


Figure 14 Multi-Criteria Analysis Summary Scores

As shown in **Table 47** and **Figure 14**, Option 13, with one large IVC and seven transfer stations, has the highest score of all the short-listed options, followed by Option 2, with one large IVC, three small IVCs, and two transfer stations.

Although Option 13 scored highest on all but one criteria, it was only slightly higher than Option 2 in each case with the exception of Financial. For this criterium Option 13 scored significanty higher than Option 2 primarily due to the inclusion of commercial organics, along with kerbside FOGO, as feedstock for Option 13 even though no agreements for the supply of commercial organics have been established. To make Option 13 viable, access to the estimated quantities of commercial organic will need to be confirmed.

12 Site Identification

SLR used global information systems to identify possible sites for new wastre infrastructure. The sites were selected based on the determined selection criteria in specific areas.

A 15 km zone around each of the selected towns was created and sites identified in these. Searching for sites outsidew this zone impacted on feasibility based on driving time to the site and the use on amenities.

The spatial data, which were available on datashare from the Victoria State Government's Department of Environment, Land, Water and Planning, was used for the lot identification. Lots were then cross referenced with plan zoning areas and eliminated if the zone did not allow a waste facility.

Lots were then filtered by hectare size and eliminated if part of an easement, in proximity to a water body, in proximity to transport access and within an environmentally protected area. Ther size of the lots fort each facility type in each town is shown in **Table 48**.

Table 48 Facility locations and areas allows

Facility Size	Location	Area (ha)	Option
One large 46,000 t IVC facility	Ballarat	2	2
One large AD facility	Ballarat	2	4, 5
One pyrolysis facility	Ballarat	2	8
One large OWC facility	Ballarat	10	11
One large 90,000 t IVC facility	Ballarat	2	13
One small IVC facility	Clunes	2	2, 4, 5
One small IVC facility	Horsham	2	2, 4, 5
One small IVC facility	Stawell	2	2, 4, 5
One small OWC facility	Clunes	5	11
One small OWC facility	Horsham	5	11
One small OWC facility	Stawell	5	11
One transfer station	Beaufort	1	8, 13
One transfer station	Central Goldfields	1	8, 13
One transfer station	Hepburn	1	8, 13
One transfer station	Horsham	1	8, 13
One transfer station	Stawell	1	8, 13
One transfer station	Warracknabeal	1	2, 4
One transfer station	Warracknabeal	1	2, 4, 5, 8, 11, 13
One transfer station	West Wimmera	1	2, 4, 5, 8, 11, 13

Bushfire prone areas (BPA) were considered but then disregarded as the entire study area was designated BPA.

Data sets used for the site identification included:

- Vicmap Planning, both zoning and overlays

- Designated Bushfire Prone Area
- Vicmap Property Simplified 1
- Vicmap Address
- Vicmap Flood Database
- Easement – Vicmap Property
- Parks and Conservation Reserves (PARKRES)
- Ramsar Wetland Areas in Victoria at 1:25000
- Vicmap Hydro 1:25000 - waterbodies, watercourses
- Vicmap Transport Scale: Various - roads
- Vicmap Admin - locality and LGA polygon boundaries.

The analysis identifed numerous potential sites in the Grampians region and these are shown on the maps in **Appendix J**.

13 Potential Ownership and Operation Models

13.1 Introduction

The bulk of waste facility development costs are usually borne by the parties involved, typically local government and/or its partners. Typically, waste management is a role undertaken by municipal authorities, but it may be challenging for municipal authorities to provide the capital costs to develop waste infrastructure. A range of ownership, funding and operational models exists therefore, to overcome this barrier.

SLR undertook an assessment of the potential ownership and operating models for establishing one or more regional organic processing facilities. The traditional procurement models and public private partnership models are discussed below:

13.2 Traditional Procurement

Most waste infrastructure in Australia is developed using traditional procurement models that require the government authority to retain ownership. There are variations to this model, a number of which are described below.

13.2.1 Construct Only

Under this model an authority prepares a design, either in-house or through an independent consultant, then calls for tenders from construction firms to build the facility to the design for a fixed price. The authority is responsible for operating and maintaining the facility, either using its own staff and management or one or more third-party contractors.

13.2.2 Design and Construct

Under a design and construct (D&C) model, an authority develops a performance specification that describes the outcomes that a proposed facility must achieve and the requirements it must meet. The authority then issues a tender to which private design and construct contractors respond. The preferred contractor will design and construct a facility that meets the performance specification for a fixed price. The authority is responsible for operating and maintaining the facility, either using its own staff and management or one or more third-party contractors.

13.2.3 Design, Construct and Maintain

Sometimes referred to as a ‘design, build and maintain’, or a DCM model, this is the same as a design and construct arrangement but with the additional specification that the contractor must also maintain the facility for a certain period, usually between 10 and 30 years. The authority is responsible for operating and maintaining the facility, either using its own staff and management or one or more third-party contractors. The contractor does not own the facility but is paid a fixed monthly fee for planned activities as well as additional fees for any unplanned activities. Payments may be linked to performance and/or withdrawn or reduced if the facility is not available or fails to perform at specified levels.

Under this model, contractors can design and build the facility in a way that minimises the design, construction, and maintenance costs, which reduces whole-of-life costs for the authority. Tenderers for large DCM projects often involve several specialist contractors working together, each undertaking different roles in the joint venture.

13.2.4 Design, Construct, Maintain and Operate

Design, construct (or build), maintain and operate (DCMO or DBMO) models are similar to the DCM model but as well as maintaining the facility, the contractor also operates it for a specified period. The contractor does not own the facility. This is a common delivery model for waste management facilities under which activities are contracted to an entity for a specific period, perhaps 15 to 20 years. Large projects often involve several specialist contractors who take different roles in the joint venture and are more or less involved over the life of the facility.

13.2.5 Managing Contractor

An authority appoints a managing contractor who then engages subcontractors through a competitive tender process to prepare a design for the facility and construct it. The managing contractor is typically engaged early in the process to assist the authority define the scope, develop the design and prepare work packages. The managing contractor is paid a fixed fee and is reimbursed for the amounts paid to subcontractors. The managing contractor may also receive incentive payments for achieving cost, time and quality targets. Once construction is complete the authority is responsible for the maintenance of the facility.

13.2.6 Alliance

Under this model, all the major parties, the authority, the contractor and the designer, agree to collectively share all risks associated with the design and construction of the facility. Maintenance of the facility is not normally covered by an alliance contract. Contracting under this arrangement is complex. The contract includes a sophisticated ‘cost plus’ system where the authority pays the contractor’s and designer’s direct costs as well as a fee on account of profit margin and contribution to overheads that is adjusted upwards or downwards depending upon the collective performance of the alliance members against agreed key performance indicators.

The main benefit of this arrangement is that participants agree to a ‘no blame’ regime, under which they give up any entitlement to make claims against each other for poor performance or negligence. This encourages alliance participants to accept stretch targets, and abandon adversarial behaviour designed to protect legal positions.

This model is particularly suited to risky projects, or projects with uncertain or changing scope, for which it is difficult to calculate a fixed price.

13.2.7 Operator Franchise

Under this model, the authority engages a contractor to operate and maintain infrastructure owned by the authority. The infrastructure is often uneconomic to duplicate, so ownership stays with the authority to avoid a contractor establishing a monopoly of indefinite duration. The result is effectively a franchise, which is open to tender from time to time to encourage competition, innovation, and value for money. These kinds of franchises are common in the transport sector.

13.3 Public Private Partnership Models

Increasingly, new waste infrastructure is being delivered under public private partnership (PPP or ‘P3’) models. In a PPP, unlike traditional procurement, it is usually the private sector that finances and builds the infrastructure and is ultimately responsible for its condition and performance over the life of the project.

Governments generally retain the responsibility of providing core services. This is often the case where they have responsibilities to the general public using the service, as would be the case with local councils and waste collections. Non-core services are included in the private sector scope and typically include maintenance, cleaning and security. In some cases, governments have expanded the scope of private sector provision to include core services although this depends on the complexity and nature of the project and the project's ability to be decoupled from government operations. It also depends on the economic and political climate and government appetite for risk transfer at a particular point in time.

A range of PPP models is discussed below.

13.3.1 Lease, Develop and Operate

Under a lease, develop and operate (LDO) model, a private company is granted a long-term lease to operate and expand an existing facility. The company is responsible for maintenance and operation and agrees to invest in facility improvements and can recover the investment plus a reasonable return over the term of the lease. This model provides a platform for the private sector to perform well but does not require any capital investment from the private sector.

13.3.2 Build, Own, Operate and Transfer

The purpose of a build, own, operate and transfer (BOOT) structure is to limit the cost liabilities to the public sector. Typically BOOT projects involve the design, construction, maintenance, and operations for a period, perhaps 20 to 50 years. BOOT projects are usually fully financed by the private sector which also takes on revenue risk. At the end of the contract period, the facility is returned to government ownership. This kind of model is usually used for infrastructure such as toll roads, long distance rail, utilities such as electricity and water, and telecommunications.

BOOT is a good solution for most projects, especially if the government has a large infrastructure financing gap. It minimises the public cost by taking advantage of private sector efficiencies for minimal investment. Often there are incentives to the private organisation developing the infrastructure, such as tax breaks. BOOTs also reduce public debt because the private sector absorb the debt of the initial phases. Governments can balance their budget but their influence in the infrastructure's development is reduced. Governments can put the saved money towards other programs, thus allowing them to govern and meet infrastructure requirements at the same time.

Private sector contractors can apply their expertise and develop innovative solutions, usually not possible when the private sector is not involved. As a result, both parties play to their strengths. Public sector provides structure and cost containment while the private sector provides efficiencies and resource access, allowing projects to be completed faster. A project's development by two parties also fosters more trust in the feasibility of the task as two parties are monitoring it.

Although often used for linear transport projects, BOOT structures are not best for all infrastructure projects. They are not likely to be beneficial for urban road and rail projects. For utility services, it is possible that privatisation of networks might provide even greater gains. In addition, they may be suitable for large-scale infrastructure projects such as large buildings but not for a small number of street front shops such as a strip mall.

The private sector will not be attracted until funds are in place to begin project planning. As a result, the public sector often looks for private entities which already have a funding mechanism in place to complete the proposed project. In addition, large revenues must be generated during the operational phase to attract the private sector. BOOT contracts have long transfer waiting times because by stretching out the relationship private organizations increase the chances of making returns on their investments, plus profits, before losing control of the project.

BOOT projects require strong corporate governance and can often fail due to lack of communication between the private and public sectors. When the project is managed poorly on the private side, the public side must be able to step in. If the public sector has limited expertise in infrastructure, then the private sector can take advantage of this. Both sides must have knowledge of the complexity, competitiveness, and risks involved to ensure a balanced relationship.

BOOT projects can also have higher transaction costs than other contract opportunities and can be time-consuming.

13.3.3 Build, Own and Operate

Build, own and operate (BOO) projects operate in a similar way to BOOT projects, except that there is no transfer of ownership, the private sector owns the facility in perpetuity. The long term right to operate the facility provides the developer with significant financial incentive for capital investment although they may be subject to regulatory constraints on operations and, in some cases, pricing.

BOO is best suited to projects that involve significant investment and operating content. It is often the step before privatization and can be a good solution for toll roads. However, it has similar drawbacks as BOOT projects and there is unlikely to be help from the public sector in financial crises.

13.3.4 Build, Operate, Lease and Transfer

Under the build, operate, lease and transfer (BOLT) model, the government gives concession to a private entity to build a facility and, at the end of the project, transfers ownership to the government. It is an effective way to deliver public services and has the benefit of full authority to government. On the downside, the private sector has limited motivation to engage in this model due to the transfer of ownership.

13.3.5 Build, Own and Maintain

A build, own and maintain (BOM) arrangement involves the private sector developer building, owning, and maintaining a facility. The government leases the facility and operates it using public sector staff. This differs from BOOT because full authority remains with the public sector.

13.3.6 Rehabilitate, Own, Operate and Transfer

Rehabilitate, own, operate and transfer (ROOT) is largely the same as a BOOT but applies to the rehabilitation of an existing facility rather than the construction of a new one. It is suitable for capacity expansion and road upgrading and for projects that involve a significant investment or operating content. Its disadvantages are similar to BOOT.

The preferred ownership and operating model for waste processing infrastructure in the Grampian region will depend on several factors including the risk profile of the Council, in-house technical expertise, type of technology being considered, skills and experience of contractors available in the local market and financial implications.

14 Delivery Models

The following section provides an overview of the main potential delivery options available to Council to take a waste infrastructure project through to fruition.

The key areas considered are the approach to procuring the required services, including discussion of respective types of risk that need to be assessed and contextualised, and means of funding the project, both at the project initiation and procurement stage and for subsequent development of a new facility or facilities.

14.1 Contract Procurement Strategy

A significant factor in determining the complexity and duration of the implementation program for the project(s) will be the agreement of a procurement strategy. The key points for consideration in the development of the contract procurement strategy for Council are:

- procurement routes
- contract types
- delivery timescales and
- procurement risks.

These issues are described briefly in the following sections.

14.1.1 Procurement Routes

The procurement routes available may be dictated by national or regional procurement legislation and/or the requirements of external funding bodies.

Under European Union procurement legislation for example, there are a number of routes open to councils for contract procurement, each of which is structured to reflect different levels of project complexity and permitted engagement with bidders during the procurement process.

For a project where the nature of the technical solution cannot be fully defined at the outset and where aspects of the solution, cost, contract and risk profile will need to be agreed through dialogue with bidders, then the Competitive Dialogue route is commonly used. Under this procedure, bidders who satisfy the requirements of a pre-qualification questionnaire will typically be invited to submit outline solutions which are then discussed in dialogue between the procuring authority and the respective bidder and then evaluated. The highest scoring bidders are then invited to submit detailed solutions for further dialogue and evaluation, with typically the two highest scoring bidders being invited to submit final tenders on which the procuring authority bases its appointment of a preferred bidder. This route therefore allows the procuring authority to refine and negotiate solutions throughout the process, an approach which would be recommended for a project of this complexity.

Given the continuous evolution of procurement routes, it would seem appropriate to remain open-minded about the optimum structure until the point that this decision becomes time-critical to the delivery of the project. In the meantime, Council should analyse its available skills and resources and consider how best these could be complemented by the private sector.

14.1.2 Contract Types

There are several different contract types that Council could consider supporting the development of its waste management services and infrastructure. These are summarised in **Table 49** below.

Table 49 Contract Types

Contract Type	Overview
Service Contract	Council pays a gate fee and enters into a short term, medium term or long term or 'pay as you go' arrangement with the facility operator who would either (a) use an existing facility to provide the service, or (b) develop a new bespoke facility. Services procured in this way typically make use of existing waste management infrastructure, such as an established third-party merchant plant, to provide a service for which the procuring authority will pay a monthly sum or a gate fee per tonne. The procuring authority needs to set out in detail the specification for the service to be delivered by the contractor. In terms of new waste treatment infrastructure (IVC, OWC, AD and/or ATT), Council would not require any capital finance under this contract type and the gate fee would be financed entirely from Council's revenue budget. Unless obvious local or regional options already exist in terms of third-party AD and/or ATT facilities, a service contract is likely to be more appropriate in the context of delivery of Council's new, expanded kerbside collections services including FOGO.
Design and Build	Council procures the new infrastructure and service through a design and build approach where contractors tender for the design and construction works, and the completed facility is subsequently operated by Council. Under this arrangement, the facility would be financed and operated by Council, although typically a long-term maintenance agreement would be entered into with the contractor. Council should be mindful that the operation of modern waste treatment facilities requires specialist skills and training to ensure effective, compliant treatment of the waste and avoid malfunction or damage to costly, specialist equipment. Council may prefer that these risks, and associated liabilities, sit with a specialist operator rather than its own workforce. Capital finance for the facility would be through grant funding or borrowing with the operational finance from Council's annual revenue budget. Under this procurement option, Council would be required to provide a detailed technical specification for the facility and would contract directly with an engineering procurement and construction (EPC) contractor for the delivery of the works, with the waste processing technologies most likely provided by specialist technology providers under sub-contracts with the EPC Contractor. The main contract would include a set of key performance indicators, supported by penalties for underperformance which would be reflected in the sub-contracts. Council would then operate the facility itself or procure a separate term contract for the operation and maintenance of the facility.
Design, Build and Operate	Council procures the new infrastructure through a design and build approach where suitable contractors tender for the design, construction, and subsequent operation of the facility. The facility would be financed fully by Council and operated by the contractor for an agreed period. Capital finance for the facility would be secured through grant funding or borrowing with the gate fee financed from Council budget. Given the relatively lesser scale of capital investment required, this option would be better suited to an IVC or OWC facility than an AD or ATT, if Council was to decide to provide an element of capital funding for its projects.

Contract Type	Overview
Design, Build, Finance and Operate	Alternatively, the Contractor can provide all or part of the required funding under a Design, Build, Finance and Operate contract (DBFO), with the repayment terms negotiated. This type of Contract is commonly used for the procurement of long-term residual waste contracts in the UK, under the Competitive Dialogue procurement procedure. Such an arrangement could be suitable for the development of any of the three waste treatment facilities which Council requires.
Partnerships	This may involve either a special purpose vehicle (SPV) or a joint venture (JV) type model. An SPV is created as an entirely separate entity with the sole purpose of delivering a project. For example, to design, build, finance and operate a residual waste management plant. Under an SPV, the required project capital finance may be a mix of equity provision from the main Contractor plus project finance, that is, debt, provided by external lenders or funders, as required. A JV is an entity created through equity provision from two or more firms to undertake works in a particular area. Under a partnership approach, Council would procure the new infrastructure and service where contractors tender for the design, construction and operation of the facility and also have an equity provision option as part of a project SPV or JV. The facility would be financed partially by the SPV or JV members, including the Contractor, and partially by Council, and operated by the Contractor for an agreed period. Council's contribution to the capital finance for the facility would be through grant funding or borrowing with the gate fee financed from Council's revenue budget. This option involves the selection of a contractor that will be required to deliver service requirements that are likely to change and evolve with time. The Partnership, in selecting such an approach, primarily seeks to identify the contractor that it considers it can work with most effectively to deliver such changes without resort to further procurement. Such contracts are often based on DBFO and maintain typical contract documentation, augmented by appropriate controls over contract variations to ensure value for money is maintained, for example, open book accounting, agreed profit levels, service benchmarking and others. Due to the scale of investment required, a partnership arrangement could be an appropriate solution for the development of either an AD or ATT facility.

14.1.3 Delivery Timescales

The delivery timescale for the procurement phase of a contract under the above options is likely to be of the order of 18 to 24 months, from publication of the Contract Notice to Contract Award for a complex project such as an AD facility, and about 12 months for a less complex project such as an IVC facility.

However, this is highly dependent on project specific issues such as site selection, site conditions and approvals. Typically, the options involving stages of dialogue with bidders and/or the need to secure project finance may take longer, to take account of the steps required in the dialogue process and also the requirement for any funder due diligence process, prior to financial closure.

14.1.4 Procurement Risks

The risk associated with the contract procurement process may be significant and the risk profile varies across the range of procurement options. The key areas of procurement risk which need to be considered, with a brief description of each, are summarised in **Table 50** below:

Table 50 Procurement Risk Overview

Risk Category	Overview
Program Risk	Assess the deliverability of each of the procurement routes in terms of timescale. Under this risk area, the procurement route which represents the least risk to Council in terms of deliverability is the service contract where a facility is in existence.
Funding Risk	Assess the capital funding requirement for the project.
Technology Risk	Assess the risk of procuring a poor or underperforming technology and the operational risks associated with running the facility.
Target Compliance	Assess the risk associated with not meeting statutory targets, for example, recycling rate or landfill diversion.
Risk Transfer	Assess the risk associated with Council's ability to transfer the risk to third parties. The Service Contract options would be the most difficult contracts for Council to transfer risk to third parties, due to the normally short-term nature of these contracts and the reluctance of the third party to accept the risk. The procurement routes where the contractor operates the facilities on behalf of Council would represent an easier route for risk transfer, although this will normally be reflected in the cost of the project.
Procurement Route	Assess the risk associated with Council's ability to deliver the preferred procurement method, based on its previous experience.
Cost	Assess the risk associated with the cost of the service excluding the capital investment covered under Funding Risk.
Flexibility	Assess the risk associated with the flexibility of the service offered in terms of modification to the service[71].
Ownership	Assess the risk associated with ownership of the facility at the end of the contract period.
Specification	Assess the risk associated with specifying the needs of the contract.
Statutory Consent	Assess the risk associated with obtaining and complying with statutory consents issued for the facility.
Partnership Engagement	Assess the risk associated with engaging with the contracting party and procuring a deliverable project.
Continuity	Assess the risks associated with procuring a service which will provide continuity of deliverability and cost.
Legal	Assess the legal risks associated with procurement of the contract.
Standards/Policy	Assess future changes to standards and policy which may impact on the level of service and the ability of the service to be delivered.

Council should consider the development of a bespoke risk profile which reflects local conditions as a key element of the early stages of project implementation.

This could be achieved through one or more procurement workshops designed to:

- review the procurement routes and contract types in detail, taking account of the technical options being considered
- evaluate the opportunities for joint working with neighbouring authorities and confirm the conditions required for this and
- carry out a qualitative risk assessment of the various individual risks against each of the contract options to develop a procurement risk profile that will assist Council in deciding its preferred route for contract procurement.

[71] In addition to Change Protocols, Council should include any variations known to occur from the outset and include Provisional Options for known variations that may occur. These types of considerations should be addressed at the procurement strategy stage.

14.2 Project Funding Options

For a long-term project such as the development of a new waste treatment facility, the two key elements of funding that need to be agreed are:

- funding of the project initiation and procurement phase and
- funding of the development of the facility.

It is generally the case that local authorities will be required to finance the inception of the project and subsequent procurement exercise internally, although there may be financial support available from state government or grant funding bodies for such activities. Statewide Waste and Resource Recovery Infrastructure Plan (SWRRIP) has a specific funding stream for the development of business cases.

Project funding options are not provided with any weighting or recommendation but to build the knowledge base for further discussion.

The specific funding mechanism for development of the facility, in terms of funding sources and particularly the parties responsible for provision of funding, will be dictated by the contract type and procurement route selected. However, the key sources of funding for this type of development are likely to be:

- debt funding
- equity funding
- grant funding provided from national or regional government and
- council borrowing, for example through the Local Government's Treasury Corporation of Victoria loans or Finance and Accounting Support Team (FAST) program.

In many cases, a combination of these sources is drawn upon to establish an overall package which is acceptable and sufficiently attractive to all parties.

Securing private financing can be the most critical component of any infrastructure project and can be one of the main challenges for energy from waste projects, EfW or ATT, particularly in cases where the procuring authority has elected to use a technology other than conventional mass burn incineration.

The sources available to finance the construction, operation and maintenance of facilities vary depending on factors including the adopted technology, contract structure and revenue-generating potential of the project.

Lenders typically expect that a private partner will have a long-term waste contract with the procuring authority, which provides the primary source of income for a private partner. For technologies which have electricity as an output, lenders will also expect to see a project supported by a power purchase agreement (PPA), with these revenue streams combining to support the case that the project is bankable for lenders.

In Victoria, the Treasury Corporation of Victoria has actively provided tailored loans and financing, advisory and investment services for local government seeking to establish resource recovery projects.

14.2.1 Debt Funding

Debt financing is defined as borrowing money without giving up ownership of assets. Debt financing commonly has strict conditions or covenants attached, in addition to the requirement to pay interest and principal, the amount borrowed, at specified dates.

For typical energy from waste project finance deals, much of the funding requirement is met by long term debt finance. This can typically vary between 60% and 80% of the overall capital requirement on such schemes, with the balance of funding being provided from equity or mezzanine finance. The amount of debt that lenders are prepared to advance will vary according to the perceived project risk profile and the borrower's ability to repay the loan. In general, the project risk profile from a lender's perspective will include:

- revenue assumptions based on guaranteed waste flows and supply agreements and hence annual gate fees
- the amount of electricity that can be generated and security of related PPAs
- minimum guaranteed availability of the process to ensure forecast gate fees and electricity sales are realised and
- sufficient residual value in the project should it fail to meet expected targets.

More competitive borrowing rates will be available for proven technologies such as MBT or conventional EfW facilities. However, it may not be possible to raise bank finance for what are considered to be more 'innovative' technologies, for example, some types of advanced thermal treatment. Development of these technologies is more likely to be funded by venture capital. The consequence is that the cost of funding is likely to be higher than for established technologies.

14.2.2 Equity Funding

Equity financing often means issuing additional shares and transferring a proportion of ownership to an investor and ensures that the project developers financing is fully committed and cannot be withdrawn or cancelled half-way through the construction, operation, or concession phases.

Equity funding is commonly used in combination with debt funding to secure the required overall level of financial support. Since the credit crunch of 2007-2008, the gearing, or loan to value, ratio that banks have been prepared to provide for this type of project in the UK has fallen. Before the credit crunch, gearing ratios of 15% risk capital, equity, and subordinated debt, to 85% senior debt were typical, and in certain cases ratios of 10% risk capital to 90% senior debt were achieved for waste management projects.

However, since the credit crunch, banks have required investors to put up more risk capital. Based on recently concluded waste treatment projects in the UK, a ratio of 25% risk capital to 75% senior debt is more likely.

14.2.3 Government Funding

In recognition of the importance of delivering waste treatment infrastructure to move away from landfill and provide more sustainable waste management solutions, many governments, including the UK and Canada, have provided significant sources of funding to support local authorities in facility development.

In the UK, several local authorities have developed waste treatment infrastructure using government funding provided through the Private Finance Initiative (PFI), a method of funding very large projects in a way that should transfer risk to the private sector in return for a guaranteed long-term contract.

The theory of PFI financing is that the extra costs of setting up the contract and paying what may be a higher price, is more than compensated by the contractor delivering higher performance standards as they are carrying the performance risks.

PFI was promoted by the UK Government as a way of funding waste projects primarily because many waste technologies are expensive to build. The Government provides some of the funding to make PFIs viable, in the form of PFI Credits, which acts as an incentive to use the PFI method of funding. The Treasury allocated the Department for Environment Food and Rural Affairs about A$4 billion for distribution to subsidise PFI waste projects.

In 2010, funding for several PFI projects was withdrawn due to spending cuts at national level, although a number of the local authorities previously allocated PFI credits have continued to develop waste treatment infrastructure using alternative means of funding.

One such example is Milton Keynes Council, whose subsequent PPP project, which reached financial close in June 2013, was one of the first to be completed using short-term debt facilities covering the construction period, with the Council repaying the contractor's capital expenditure following successful commissioning of the facility. This model balances risk transfer during the construction phase with long-term value for money for the public sector.

In Canada, a number of EfW projects are receiving funding from the Canadian Government.

14.2.4 Prudential Borrowing

Prudential Borrowing is the term used in the UK to describe borrowing directly by local authorities to fund capital expenditure. This approach may appear attractive on the basis that local authorities are able to obtain more competitive rates than private sector organisations.

In the local context, preferential borrowing is available to Council through the Local Government's Treasury Corporation of Victoria low cost loan facilities.The *Local Council Lending Framework* was announced in September 2021, and is understood to be aimed at providing capital for Councils for operations and for project-specific infrastructure.

14.2.5 Alternative Approaches

As an example of an alternative approach to the delivery of a waste treatment solution using energy from waste, SLR has been closely involved in a joint procurement by five UK local authorities, which uses a combination of corporate funding to deliver a front-end fuel preparation plant and then uses existing merchant energy from waste plant capacity to deliver the back-end solution.

Clearly this approach depends on the availability of suitable third-party facilities with capacity to accept new sources of feedstock.

14.2.6 Funding Types Summary

Waste treatment projects are commonly funded using a combination of the funding solutions described above to best reflect local need and circumstances. The availability of funding sources for the project will vary depending on a number of factors including, among others, choice of technology, project ownership, economics, and experience.

When making the decision of which funding option is the best to pursue, Council must take full account of the relative costs of the debt only, debt or equity hybrid, and equity only options, and obviously the availability of suitable funding sources.

Successful investment models aim to strike an adequate balance between interdependent factors such as feedstock strategy, plant design, technology choice, EPC arrangements and wider revenue streams in a way that effectively balances risks and rewards for all project partners.

Lenders will tend to provide more favourable financing terms for projects that feature mature and proven, that is, bankable technologies, such as mass burn incineration in the context of residual waste treatment.

The availability of energy and materials markets can also significantly impact the economics of a project. Council should conduct a thorough analysis of these markets to understand the potential benefits that may be available.

A more detailed financial analysis and consideration of appropriate funding sources and mechanisms should be undertaken as part of the development of a full business case for each element of this project.

15 Conclusions

15.1 Project Review

Organic waste is typically one of the priority target waste streams for any jurisdiction seeking to increase diversion of waste from landfill. Diverting organic waste from landfill offers several environmental, economic, and social benefits including:

- Reducing greenhouse gas emissions from landfill
- Production of renewable energy, for example, from anaerobic digestion process
- Production of compost which, subject to meeting any applicable quality standards, can replace use of primary materials such as peat and
- Creation of employment opportunities through development and operation of new facilities and distribution of products.

Northern Grampians Shire Council, on behalf of eight Grampians councils (i.e., Horsham Rural City Council, Yarriambiack Shire Council, Hepburn Shire Council, West Wimmera Shire Council, City of Ballarat, Central Goldfields Shire Council, Pyrenees Shire Council, and Northern Grampians Shire Council) commissioned SLR Consulting Australia Pty Ltd to investigate high level options for processing kerbside food organics and garden organics (FOGO) that the participating councils will be collecting. It describes the current landscape of organic material waste generation in the region, processing, current and potential future disposal pathways.

15.2 Research, Consultation, and Data Analysis

After performing research and consulting with stakeholders, data analysis was conducted. Data provided by Council was analysed to establish quantities and sources of organics to estimate future waste generation trends and these were modelled over 20 years to 2040.

The data showed that 1,215,867 t of organics are present in the region in 2020-2021. Currently around 59% of FOGO is generated in the City of Ballarat. The analysis also forecasted the total amount of waste generation in 2039-2040, which is estimated to be 1,506,812 t, and around 67% of potential FOGO is expected to come from the City of Ballarat. **Table 51** provides a summary of potential quantities of all organic waste streams, including FOGO, WWTP biosolids, and commercial organics, for 2020 and 2040 from the considered eight councils.

Table 51 Organic Waste Streams Summary for 2020 and 2040

Waste streams	Council name	2020 (t)	2040 (t)
FOGO	Horsham Rural City Council	2,491	4,579
	Yarriambiack Shire Council	830	1,156
	Hepburn Shire Council	2,227	2,776
	West Wimmera Shire Council	619	834
	City of Ballarat	17,320	44,795
	Central Goldfields Shire Council	2,451	4,826
	Pyrenees Shire Council	741	2,007

Waste streams	Council name	2020 (t)	2040 (t)
	Northern Grampians Shire Council	2,422	5,774
	Subtotal	**29,101**	**66,747**
WWTP biosolids		2,187	3,334
CHW forestry plantation		6,107	6,107
Commercial organics		1,178,472	1,426,331
TOTAL		**1,215,867**	**1,506,812**

The organics processing technologies for processing FOGO in the region are discussed in this report. These technologies include open windrow composting (OWC), in-vessel composting (IVC), vermicomposting, anaerobic digestion (AD), and thermal treatment. A high-level SWOT analysis is also conducted for the FOGO treatment technologies.

The potential markets for organics products, waste-to-energy and refuse derived fuel in the Grampians region were also investigated. The organic products could be compost, mulch, soil conditioner, or other products. Based on the estimated organics for the region, it is predicted that the amount of composted materials is likely to increase over the next few years, thereby potentially creating an oversupply in the local market. Councils would need to closely monitor the demand for compost in the local region and adjust supply to meet the expected demand. Councils might also need to encourage agriculture and horticulture authorities to switch over into the new compost materials from traditional fertiliser / soil amendments.

15.3 Options Assessment

A longlist of 14 options were presented to Council during a workshop at the conclusion of the feasibility and market research. Among these options, the short-listed options (including business as usual and additional options) selected by the Client are:

- **Option 1**: Business as usual
- **Option 2**: FOGO composted via large IVC near Ballarat. Three smaller IVCs at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 4**: FOGO composted at new dry AD facility near Ballarat. Three smaller IVCs at other councils, such as, Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 5**: FOGO and biosolids composted at new wet AD facility near Ballarat. Three smaller IVCs at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal
- **Option 8**: One large pyrolysis facility near Ballarat and seven transfer stations for bulk haulage from other councils near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell.
- **Option 11**: FOGO composted at large open windrow composting facility near Ballarat. Three smaller open windrow composting facilities at other councils, such as Horsham, Stawell, and Clunes. Two transfer stations for bulk haulage at smaller councils, such as West Wimmera and Warracknabeal.

- **Option 13**: FOGO from all councils and a small proportion (approximately 2-5%) of the potentially available commercial organics, processing at a new IVC facility near Ballarat. Potential sources of commercial organics are McCains, Mars, and HPV plantation. All organics aggregated then bulk transported from other councils, near Horsham, Warracknabeal, Hepburn, West Wimmera, Central Goldfields, Beaufort, and Stawell, to the facility at Ballarat.

Table 52 provides the summary of potential production/generation output and landfill diversion summary for each short-listed option over 20 years.

Table 52 Project life output and landfill diversion summary

Item Description	Option 1 (BAU)	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13
Total compost production over 20 years (tonnes)	230,706	414,164	399,554	231,373	-	414,164	769,500
Total mulch production over 20 years (tonnes)	130,717	-	-	-	-	-	-
Total char production over 20 years (tonnes)	-	-	-	-	92,036	-	-
Total electricity generation over 20 years (GWh)	-	-	69.99	173.67	-	-	-
Total material derived from landfill over 20 years (tonnes)	643,397	874,347	843,503	905,272	892,754	874,347	1,624,500

The results of the cost benefit analysis undertaken as part of this project are shown in Table 53 below. This shows the estimated total costs and benefits for each option over 20 years, from 2021-2022 to 2040-2041. These figures take into account the construction and operating costs, and potential income.

Table 53 Project life costs, benefit, and net present value

Item Description	**Option 1**	**Option 2**	**Option 4**	**Option 5**	**Option 8**	**Option 11**	**Option 13**
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)
Total cost over 20 years	$94.2 m	$147.8 m	$211.8 m	$140.2 m	$169.1 m	$116.8 m	$262.8 m
Total capital costs over 20 years	$0.0 m	$22.9 m	$45.9 m	$29.3 m	$33.9 m	$9.7 m	$36.5 m
Total operational costs over 20 years	$94.2 m	$124.9 m	$165.9 m	$110.9 m	$135.2 m	$107.0 m	$226.2 m
Total income over 20 years	$28.1 m	$82.6 m	$86.0 m	$90.3 m	$28.5 m	$82.6 m	$315.3 m
Total value of landfill savings over 20 years	$133.7 m	$181.2 m	$174.5 m	$188.0 m	$185.0 m	$181.2 m	$345.1 m
Total benefit NPV	$31.2 m	$43.4 m	$1.3 m	$50.6 m	$4.6 m	$64.0 m	$196.8 m

The table shows that Option 13 has the highest NPV among all the options. This is due to the inclusion of commercial organics, with FOGO, as feedstock for this option. However, it is noted that only a small proportion (around 2-5%) of the total potentially available organic commercial waste was used in this option. No agreements for the supply of commercial organics have been established. To make this option viable, access to the estimated quantities of commercial organic will need to be confirmed. Excluding Option 13, the next highest NPV is Option 11 which is followed closely by Option 5.

Figure 15 shows a summary of the total LCA GWP, expressed as tonnes CO_2 equivalent, burdens and avoided burdens from the WRATE analysis of the options assessed.

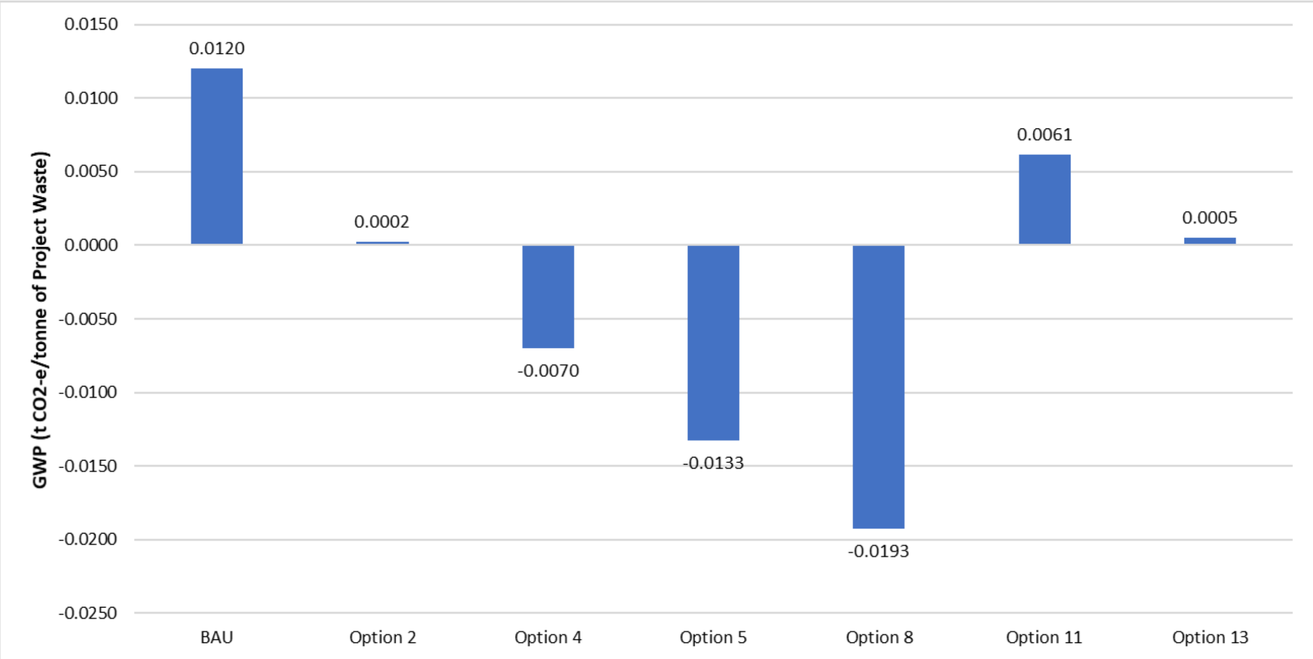


Figure 15 Comparison of total GWP for all Options

The LCA results indicate the following:

- all the proposed options would result in a reduction in overall carbon impacts compared to the baseline scenario
- significant avoided total carbon burdens would be from Option 8 – Pyrolysis of organic waste of 0.0193 t CO_2-e avoided per tonne of project waste per year
- for the proposed options, excluding the baseline scenario, significant total carbon burdens would be from Option 11 – which includes OWC systems of 0.0061 t CO_2-e per tonne of project waste per year
- options with AD systems, Option 4 – dry AD and Option 5 – wet AD, would result in avoided total carbon burdens of 0.007 and 0.0133 t CO_2-e avoided per tonne of project waste per year respectively
- options with IVC systems, Option 2 and Option 13, would result in some carbon burdens of 0.0002 and 0.0005 t CO_2-e per tonne of project waste per year respectively, however, these total carbon impacts are significantly lower than total carbon burdens from the baseline scenario of 0.012 t CO_2-e per tonne of project waste per year.

A multi-criteria assessment was performed for each of the short-listed options using a range of assessment criteria. Scores were awarded based on relevant data provided to SLR throughout the project, augmented by publicly available information, SLR's internal databases and performed calculations described in previous sections.

Options were scored according to the following criteria:

- Facility and Technology Criteria
  - Speed of development process (including planning, approval, and construction)
  - Technical complexity
  - Management and resource complexity
  - Total footprint - Space required to process current and future quantities, as well as storage for compost maturation
  - Proportion of output, for example, compost, mulch, char, and electricity, each option produces
  - Effectiveness of technology
  - Ability to process feedstock
  - Technological maturity
  - Scalability
- Technical and General
  - Feasibility and practicality of solution
  - Match with proposed collection methods
  - Compliance with State Government waste management goals and policy objectives
  - Availability of markets for products and use of products
  - Potential impacts on resources of participating councils
  - Benefits from regional partnering
- Financial
  - Risks and benefits of increases in landfill levy
  - Net present value
- Social
  - Consistency with strategic directions of participating councils and GCWWRRG
  - Employment opportunities
  - Community acceptance and benefits
  - Quality of community's living environment
- Environmental
  - Environmental impact – dust, noise, odour, and pollution
  - Quantity and quality of material diverted from landfill - resource reuse and recovery
  - Carbon impacts.

Some of the key features of the assessment are:

- In-vessel composting is a proven mature technology. Compared to the other technologies, costs and emissions are relatively low in IVC. Moreover, there is no significant regulatory barriers for this technology.
- Although the open windrow composting is a proven mature technology, and cost is relatively low, this technology has some public health and environmental risks due to odour and leachate issues using food waste in the process. It is unlikely for EPA to approve open windrow composting for food waste.
- Emission is relatively low in anaerobic digestion, but it would take more planning and construction time than that for pyrolysis and composting facilities. Dry anaerobic digestion is unproven for FOGO, while wet anaerobic digestion is not suitable for green organics processing.
- Thermal treatment, like pyrolysis, is an unproven technology for food organics processing. There are also some public health and environmental risks associated with emission from pyrolysis.

Table 54 and **Figure 16** below shows the summary of multi-criteria analysis results.

Table 54 Multi-Criteria Analysis Summary

Criteria		Facility and Technology Criteria	Technical and General	Financial	Social	Environmental	Total	Rank
	Weighting	**20%**	**20%**	**25%**	**10%**	**25%**	**100%**	
Option 1	Business as usual	0.52	0.59	0.75	0.18	0.38	2.41	6
Option 2	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	0.70	0.96	0.83	0.47	0.53	3.48	2
Option 4	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	0.63	0.84	0.65	0.46	0.53	3.10	5
Option 5	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	0.53	0.68	1.00	0.46	0.53	3.20	3
Option 8	7 Transfer stations, 1 Pyrolysis plant (FOGO)	0.43	0.59	0.65	0.24	0.48	2.38	7
Option 11	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	0.68	0.80	1.00	0.24	0.43	3.14	4
Option 13	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	0.74	0.98	1.25	0.43	0.63	4.02	1

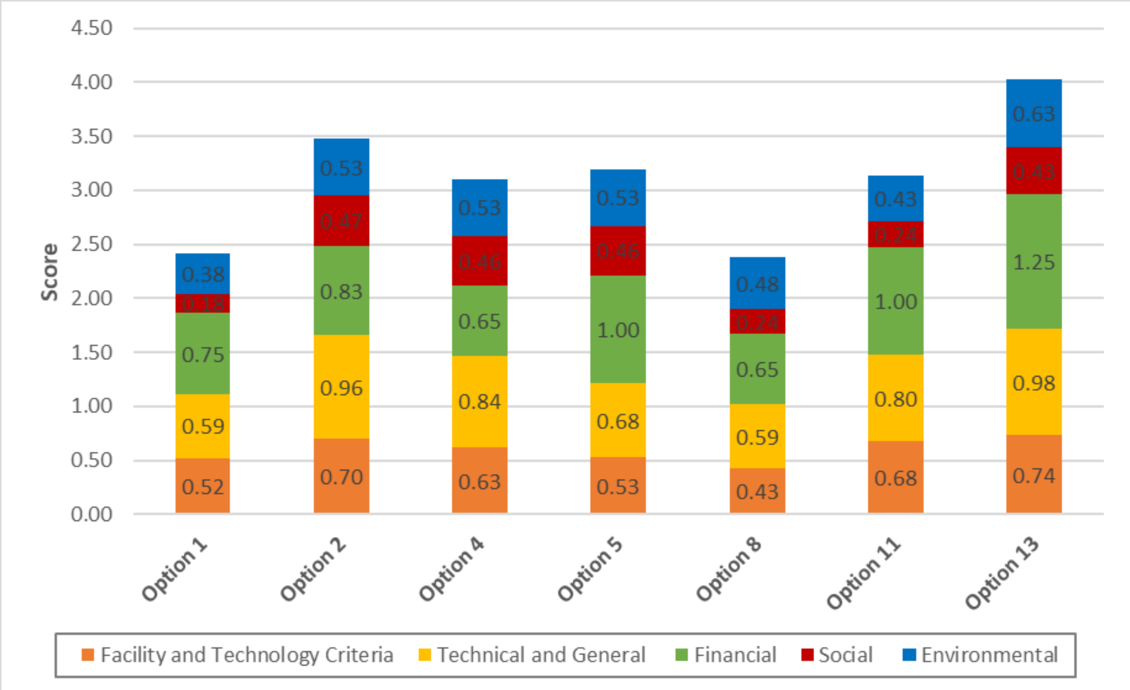


Figure 16 Multi-Criteria Analysis Summary Scores

Based on the assessment, Option 13, with one large IVC and seven transfer stations, has the highest score of all the short-listed options, followed by Option 2, with one large IVC, three small IVCs, and two transfer stations.

Although Option 13 scored highest on all but one criteria, it was only slightly higher than Option 2 in each case with the exception of Financial. For this criterium Option 13 scored signifcanty higher than Option 2 primarily due to the inclusion of a small proportion of the potentially available commercial organics, along with kerbside FOGO, as feedstock for Option 13 even though no agreements for the supply of commercial organics have been established. To make Option 13 viable, access to the estimated quantities of commercial organic will need to be confirmed.

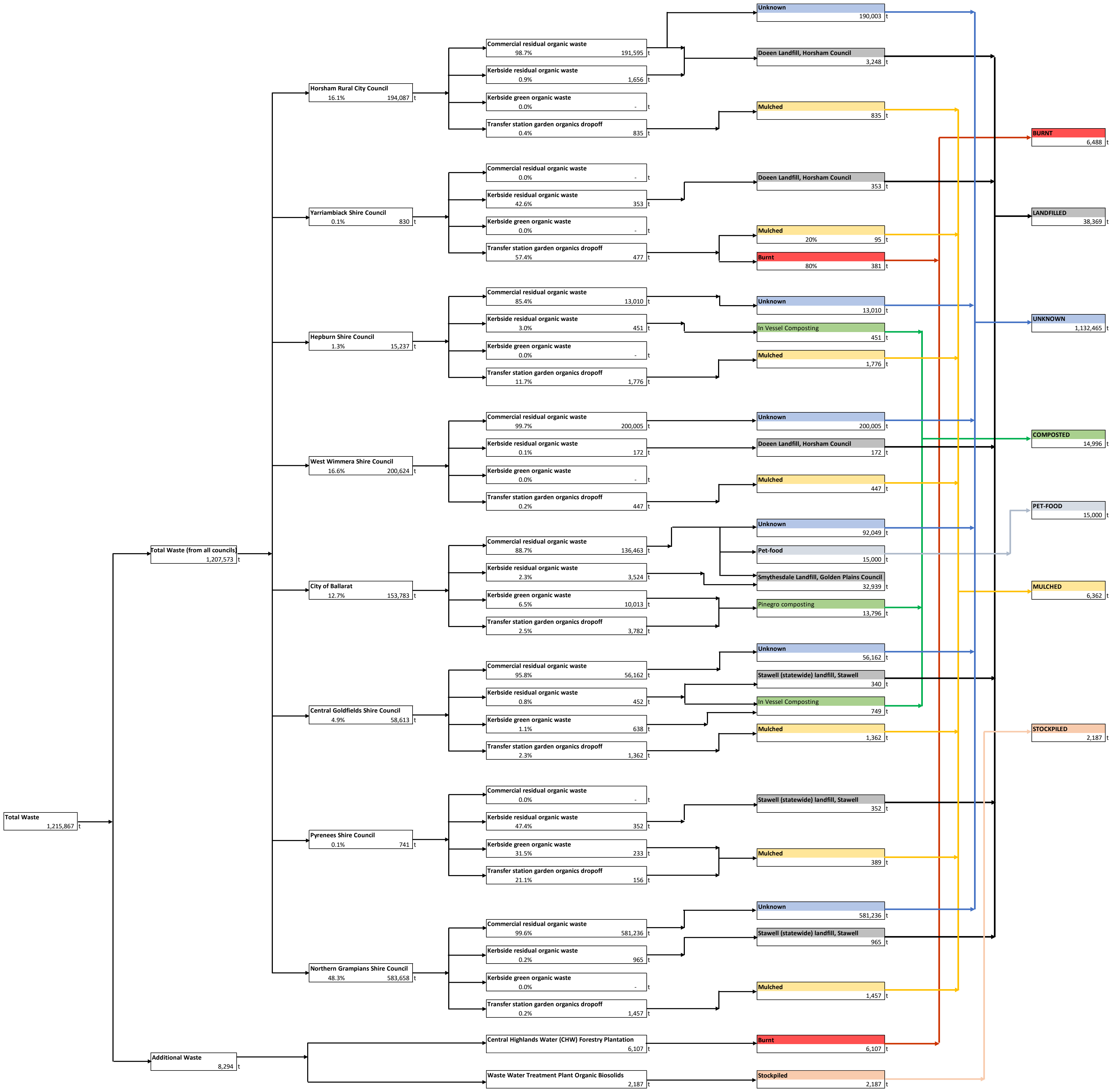
15.4 Next Steps

- Prepare a detailed timeline over which the following tasks should be undertaken
- Prepare a detailed business case for the preferred 2 to 3 options with more accurate construction, operational and product and offtake costs and income
- Develop a community engagement strategy and plan, and begin to express the need for, and benefits of, new waste facilities to the community
- Investigate potential assistance for waste infrastructure development from State Government including funding
- Begin to inform elected officials of the technical aspects of the proposed processing technologies and their benefits fr the preferred options
- Choose preferred sites for development and acquire if necessary
- Develop an approvals pathway for the preferred options

- Prepare and issue request for information or expression of interest for technology suppliers and operators of the proposed selected technologies.
- Council to take actions in market development for new compost materials.

APPENDIX A

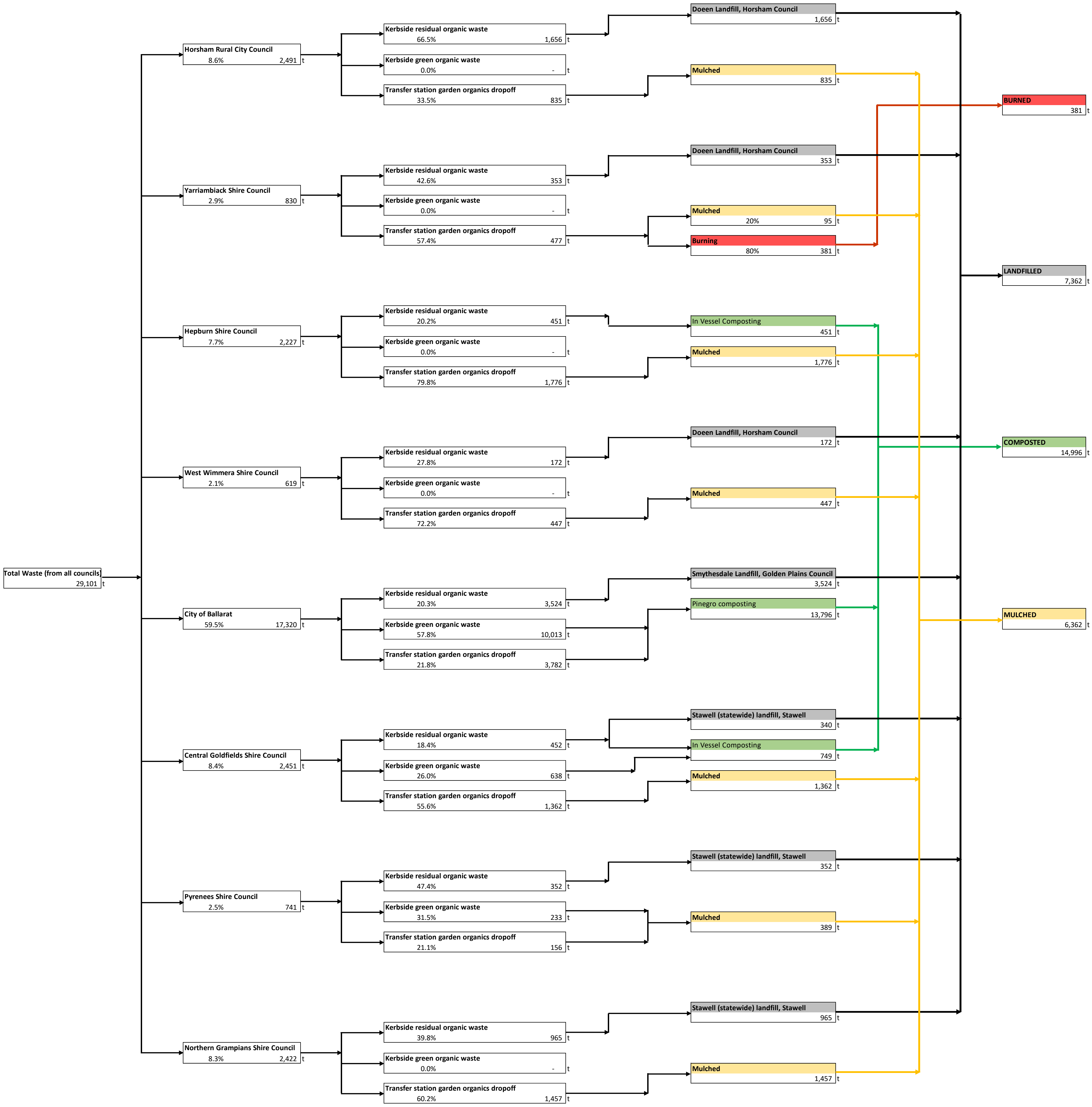
Mass Balance Total Waste Flow Chart



Total Waste 1,215,867 t
Total Waste (from all councils) 1,207,573 t
Additional Waste 8,294 t
Horsham Rural City Council 16.1% 194,087 t
Commercial residual organic waste 98.7% 191,595 t
Kerbside residual organic waste 0.9% 1,656 t
Kerbside green organic waste 0.0% - t
Transfer station garden organics dropoff 0.4% 835 t
Unknown 190,003 t
Doeen Landfill, Horsham Council 3,248 t
Mulched 835 t
Yarriambiack Shire Council 0.1% 830 t
Commercial residual organic waste 0.0% - t
Kerbside residual organic waste 42.6% 353 t
Kerbside green organic waste 0.0% - t
Transfer station garden organics dropoff 57.4% 477 t
Doeen Landfill, Horsham Council 353 t
Mulched 20% 95 t
Burnt 80% 381 t
Hepburn Shire Council 1.3% 15,237 t
Commercial residual organic waste 85.4% 13,010 t
Kerbside residual organic waste 3.0% 451 t
Kerbside green organic waste 0.0% - t
Transfer station garden organics dropoff 11.7% 1,776 t
Unknown 13,010 t
In Vessel Composting 451 t
Mulched 1,776 t
West Wimmera Shire Council 16.6% 200,624 t
Commercial residual organic waste 99.7% 200,005 t
Kerbside residual organic waste 0.1% 172 t
Kerbside green organic waste 0.0% - t
Transfer station garden organics dropoff 0.2% 447 t
Unknown 200,005 t
Doeen Landfill, Horsham Council 172 t
Mulched 447 t
City of Ballarat 12.7% 153,783 t
Commercial residual organic waste 88.7% 136,463 t
Kerbside residual organic waste 2.3% 3,524 t
Kerbside green organic waste 6.5% 10,013 t
Transfer station garden organics dropoff 2.5% 3,782 t
Unknown 92,049 t
Pet-food 15,000 t
Smythesdale Landfill, Golden Plains Council 32,939 t
Pinegro composting 13,796 t
Central Goldfields Shire Council 4.9% 58,613 t
Commercial residual organic waste 95.8% 56,162 t
Kerbside residual organic waste 0.8% 452 t
Kerbside green organic waste 1.1% 638 t
Transfer station garden organics dropoff 2.3% 1,362 t
Unknown 56,162 t
Stawell (statewide) landfill, Stawell 340 t
In Vessel Composting 749 t
Mulched 1,362 t
Pyrenees Shire Council 0.1% 741 t
Commercial residual organic waste 0.0% - t
Kerbside residual organic waste 47.4% 352 t
Kerbside green organic waste 31.5% 233 t
Transfer station garden organics dropoff 21.1% 156 t
Stawell (statewide) landfill, Stawell 352 t
Mulched 389 t
Northern Grampians Shire Council 48.3% 583,658 t
Commercial residual organic waste 99.6% 581,236 t
Kerbside residual organic waste 0.2% 965 t
Kerbside green organic waste 0.0% - t
Transfer station garden organics dropoff 0.2% 1,457 t
Unknown 581,236 t
Stawell (statewide) landfill, Stawell 965 t
Mulched 1,457 t
Central Highlands Water (CHW) Forestry Plantation 6,107 t
Waste Water Treatment Plant Organic Biosolids 2,187 t
Burnt 6,107 t
Stockpiled 2,187 t
BURNT 6,488 t
LANDFILLED 38,369 t
UNKNOWN 1,132,465 t
COMPOSTED 14,996 t
PET-FOOD 15,000 t
MULCHED 6,362 t
STOCKPILED 2,187 t

APPENDIX B

Mass Balance FOGO Flow Chart



Total Waste (from all councils)
29,101 t
Horsham Rural City Council
8.6% 2,491 t
Kerbside residual organic waste
66.5% 1,656 t
Kerbside green organic waste
0.0% - t
Transfer station garden organics dropoff
33.5% 835 t
Doeen Landfill, Horsham Council
1,656 t
Mulched
835 t
Yarriambiack Shire Council
2.9% 830 t
Kerbside residual organic waste
42.6% 353 t
Kerbside green organic waste
0.0% - t
Transfer station garden organics dropoff
57.4% 477 t
Doeen Landfill, Horsham Council
353 t
Mulched
20% 95 t
Burning
80% 381 t
Hepburn Shire Council
7.7% 2,227 t
Kerbside residual organic waste
20.2% 451 t
Kerbside green organic waste
0.0% - t
Transfer station garden organics dropoff
79.8% 1,776 t
In Vessel Composting
451 t
Mulched
1,776 t
West Wimmera Shire Council
2.1% 619 t
Kerbside residual organic waste
27.8% 172 t
Kerbside green organic waste
0.0% - t
Transfer station garden organics dropoff
72.2% 447 t
Doeen Landfill, Horsham Council
172 t
Mulched
447 t
City of Ballarat
59.5% 17,320 t
Kerbside residual organic waste
20.3% 3,524 t
Kerbside green organic waste
57.8% 10,013 t
Transfer station garden organics dropoff
21.8% 3,782 t
Smythesdale Landfill, Golden Plains Council
3,524 t
Pinegro composting
13,796 t
Central Goldfields Shire Council
8.4% 2,451 t
Kerbside residual organic waste
18.4% 452 t
Kerbside green organic waste
26.0% 638 t
Transfer station garden organics dropoff
55.6% 1,362 t
Stawell (statewide) landfill, Stawell
340 t
In Vessel Composting
749 t
Mulched
1,362 t
Pyrenees Shire Council
2.5% 741 t
Kerbside residual organic waste
47.4% 352 t
Kerbside green organic waste
31.5% 233 t
Transfer station garden organics dropoff
21.1% 156 t
Stawell (statewide) landfill, Stawell
352 t
Mulched
389 t
Northern Grampians Shire Council
8.3% 2,422 t
Kerbside residual organic waste
39.8% 965 t
Kerbside green organic waste
0.0% - t
Transfer station garden organics dropoff
60.2% 1,457 t
Stawell (statewide) landfill, Stawell
965 t
Mulched
1,457 t
BURNED
381 t
LANDFILLED
7,362 t
COMPOSTED
14,996 t
MULCHED
6,362 t

APPENDIX C

Australian Processing Technology Examples

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
DiCOM System[72]	Shenton Park, WA	Western Metropolitan Regional Council (WMRC)	AnaeCo	Facility is no longer operating	Five councils, 45,000 population.	Organics from the municipal waste stream	Multiple outputs: - A high quality compost - Biofuel - Biogas - Recyclables	Stage 1 - waste sorting and preparation facility - single DiCOM bioreactor with associated ancillary equipment Stage 2: - Two DiCom bioreactors - Enhancement of the sorting facility	- Stage 1 - 18,500 tpa - Stage 2 - 55,000 tpa	Mixed waste bin. Organics separated at the facility. Households do not have to separate organic waste	AnaeCo the plant's developer was placed into administration December 2018 after a contractual dispute.
SAWT	Kemps Creek, NSW	SUEZ	SUEZ		Mixed waste from Liverpool FOGO from Penrith.[73]	Source-separated food and garden organics and residual waste from kerbside collected bins[74]	Compost and mixed waste organic output (MWOO)[75]	MBT and tunnel composting Two processing lines one for municipal solid waste and small amounts of commercial and industrial, and the other for source-separated food and organics.[76]	- 50,000 tpa of MSW - 35,000 tpa of C&I - 40,000 tpa of separated organics[77]	Separate food and garden organics and residual bins- Two or three bin system - Household mixed waste bins collected - Commercial organics and mixed waste bins[78]	- Changing nature of waste stream compositions during the lifetime of contractual agreements. -Regulatory ban on applying MWOO to land - Compost quality is tightly controlled by regulations and applications can be limited. Potential concerns with high risk of cross contamination of compost with MWOO. - Low or negative revenue from compost and MWOO - Economies of scale favouring larger facilities - Odour control[79]

[72] WMRC and AnaeCO, date unknown, DiCOM SYSTEM - The case for converting a modern waste transfer station to a fully integrated multifunction resource recovery and bioconversion facility.
[73] https://www.suez.com.au/en-au/who-we-are/suez-in-australia-and-new-zealand/our-locations/waste-management-kemps-creek
[74] WSROC, 2015, Western Sydney Regional - Waste and Recycling Infrastructure Needs Assessment
[75] SITA Australia, date published unknown, Resource Recovery and ARRT Credentials
[76] Confidential source
[77] Confidential source
[78] SITA Australia, date published unknown, Resource Recovery and ARRT Credentials
[79] Sustainability Victoria, 2018, Resource Recovery Technology Guide

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Veolia MBT[80]	Woodlawn, NSW	Veolia				- Mixed putrescible waste, primarily from municipal sector with some from commercial section - Other organics	- MWOO - Residuals (can by up to 50 %) - RDF - Recovered rigid plastics, steel and aluminium	Mechanical Biological Treatment	Typical of MBTs: 50,000 to 250,000 tpa		-Regulatory ban on applying MWOO to land - Changing nature of waste stream compositions during the lifetime of contractual agreements. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Undeveloped and limited market for RDF - Low or negative revenue from compost or RDF - Economies of scale favouring larger facilities - Odour control - Risks related to operating AD for organics
Richgro AD facility[81]	Perth, WA					- Source separated putrescible organics, particularly food and garden organics - Manure - Food processing waste - Biosolids	- Biogas - Electricity, heat - Stabilised digestate or compost - Liquid digestate or fertiliser in controlled circumstances	Anaerobic Digestion	Typical: 10,000 - 80,000 tpa		- Quality of the digestate - Secure markets for digestate in close proximity when digestate is of adequate quality - Contamination management and impact on process equipment - Biogas quality and compliance with standards - Monitoring, controlling and optimising for biogas production - Odour control - Community engagement approach

[80] Sustainability Victoria, 2018, Resource Recovery Technology Guide
[81] Sustainability Victoria, 2018, Resource Recovery Technology Guide

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Earthpower Biomass Facility[82]	Camellia, NSW Australia	Veolia and Cleanaway through Earthpower	Babcock & Brown Environmental Investments			Range of organic feedstock including: - liquid organic waste - source separated commercial food and organics. Only small amounts of kerbside food organics	- 3MW Biogas to be used for electricity, of high quality - Fertiliser, of high quality - Emission reduction credits	- Anaerobic digestion - Energy recovery - Biological treatment of organic waste	80,000-100,000 tpa	N/a	- Quality of the digestate - Secure markets for digestate in close proximity when digestate is of adequate quality - Contamination management and impact on process equipment - Biogas quality and compliance with standards - Monitoring, controlling and optimising for biogas production - Odour control - Community engagement approach[83]
Pinegro products MAF composting facility[84]	Morwell, VIC					- Source separated organics, particularly garden organics - Commercial organics - Agricultural and forestry residue - Potential to include food organics if covered	- Compost / soil conditioner - Mulch - Blended soil products	Aerated Static Pile Composting	Typical of aerated static pile composting: 2,000-50,000 tpa	N/a	Sites are required to have buffers while being close to waste sources and end markets - Secure markets for compost in close proximity - Contamination management and impact on product quality and value - Odour control challenges, particularly during turning and loading activities --Bioaerosol impacts. Micro-organisms can become airborne in fine particles and mist during turning and loading - Experience and existing networks for marketing of products - Product quality control procedures and compliance with AS4454 - Community engagement approach

82 WSN Environmental Solutions, 2008, What Happens at the Macarthur Resource Recovery Park
83 Sustainability Victoria, 2018, Resource Recovery Technology Guide
84 Sustainability Victoria, 2018, Resource Recovery Technology Guide

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Lismore MAF composting facility[85]	Lismore, NSW					- Source separated organics, particularly garden organics - Commercial organics - Agricultural and forestry residue - Biosolids - Potential to include food organics if covered	- Compost or soil conditioner - Mulch - Blended soil products	Aerated Static Pile Composting	Typical of aerated static pile composting: 2,000-50,000 tpa		Sites are required to have buffers while being close to waste sources and end markets - Secure markets for compost in close proximity - Contamination management and impact on product quality and value - Odour control challenges, particularly during turning and loading activities --Bioaerosol impacts. Micro-organisms can become airborne in fine particles and mist during turning and loading - Experience and existing networks for marketing of products - Product quality control procedures and compliance with AS4454 - Community engagement approach
Gippsland Water, Soil and Organic Recycling Facility [86]	Duston Downs, VIC					- Source separated organics, particularly food and garden organics - Commercial and industrial organics - Food processing waste - Biosolids - Also potential for organics extracted from mixed waste through a MBT process	- Compost - Soil conditioner - Mulch - Blended soil products - Stabilised dried organics into RDF	In-vessel composting			- Secure markets for compost in close proximity - Contamination management and impact on product quality and value - odour control including effectiveness of biofilters - Product quality control procedures and compliance with AS4454 - Community engagement approach

[85] Sustainability Victoria, 2018, Resource Recovery Technology Guide
[86] Sustainability Victoria, 2018, Resource Recovery Technology Guide

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Bulla Organics Recycling Facility[87]	Bulla, VIC	Veolia				- Source separated organics, particularly food and garden organics - Commercial and industrial organics - Food processing waste - Also potential for organics extracted from mixed waste through a MBT process	- Compost - Soil conditioner - Mulch - Blended soil products - Stabilised dried organics into RDF	In-tunnel composting	85,000 tpa		- Secure markets for compost in close proximity - Contamination management and impact on product quality and value - odour control including effectiveness of biofilters - Product quality control procedures and compliance with AS4454 - Community engagement approach
Western Composting Organics Reprocessing Facility[88]	Shepparton, VIC					- Source separated organics, particularly food and garden organics - Commercial and industrial organics - Food processing waste - Also potential for organics extracted from mixed waste through a MBT process	- Compost - Soil conditioner - Mulch - Blended soil products - Stabilised dried organics into RDF	In-vessel composting			- Secure markets for compost in close proximity - Contamination management and impact on product quality and value - odour control including effectiveness of biofilters - Product quality control procedures and compliance with AS4454 - Community engagement approach

[87] Sustainability Victoria, 2018, Resource Recovery Technology Guide
[88] Sustainability Victoria, 2018, Resource Recovery Technology Guide

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Circular Food[89]	Somerton, NSW					- Source separated putrescible organics, particularly food and garden organics - Food processing waste - Pre-composted or digested organics	- Worm castings - Vermi-compost soil conditioner - Liquid fertilisers, worm casting tea - Worms, protein, animal feed	Vermi-composting	Typical: 100-5,000 tpa		- Labour intensive process - Small scale, high land-take - Protection from extreme temperatures and weather - Markets that realise the full value of the product and security of product markets and values - Feedstock limitations - Lack of high temperature pasteurisation
Yarra Valley Water ReWaste[90]	Wollert, VIC					- Source separated putrescible organics, particularly food - Food processing waste	- Biogas - Electricity, heat - Stabilised digestate	Anaerobic Digestion	Typical: 33,000 tpa		- Quality of the digestate - Secure markets for digestate in close proximity when digestate is of adequate quality - Contamination management and impact on process equipment - Biogas quality and compliance with standards - Monitoring, controlling and optimising for biogas production - Odour control - Community engagement approach
Ecolibrium mixed waste facility[91]	Spring Farm, NSW	SUEZ. Originally owned by NSW Government and operated by WSN Environment al Solutions	APBTC[92]	June 2008. Facility is no longer operating	Campbelltown, Camden, Wollondilly and Wingecarribee councils[93]	Mixed household waste and garden organics	- Up to 18,000 t of organic output and mulch 2 MW of electricity Residual material - 18,000 t of recyclable material		- Mixed waste facility capacity is 90,000 tpa - Garden organics facility capacity is 30,000 tpa[94]	Residual kerbside bin	Mixed waste processing facility was decommissioned following SUEZ acquisition of facility.

[89] Sustainability Victoria, 2018, Resource Recovery Technology Guide
[90] Sustainability Victoria, 2018, Resource Recovery Technology Guide
[91] WSN Environmental Solutions, 2008, What Happens at the Macarthur Resource Recovery Park
[92] AP Business Technology Consultancy, year unknown, Tunnel Composting High Performance at Low Cost
[93] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report
[94] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Bedminster[95]	Raymond Terrace, NSW	SUEZ. Originally operated by Environmental Waste Technologies		1999	Port Stephens Council	- Mixed residual waste. - Biosolids	- Low quality compost. - soil conditioner - Recyclable plastic and metals	MBT, rotating drum	- 35,000 tpa mixed residual waste - 2,000 tpa biosolids	Residual kerbside bin - Organics and mixed waste collected from commercial and industrial[96]	- Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control[97]
Bedminster	Cairns, Queensland	SUEZ. Originally operated by Environmental Waste Technologies[98]		2003	Cairns, Douglas and Mareeba	- Mixed residual waste - Biosolids.	- Compost. Compost to Australian Standards. - soil conditioner - Recyclable plastic and metals	MBT, rotating drum	- 90,000 125,000 tpa[99]	Residual kerbside bin - Organics and mixed waste collected from commercial[100]	-Potential future ban of applying MWOO to land Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control[101]

[95] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report
[96] SITA Australia, date published unknown, Resource Recovery and ARRT Credentials
[97] Sustainability Victoria, 2018, Resource Recovery Technology Guide
[98] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report
[99] SITA Australia, date published unknown, Resource Recovery and ARRT Credentials
[100] https://www.suez.com.au/en-au/who-we-are/suez-in-australia-and-new-zealand/our-locations/waste-management-cairns
[101] Sustainability Victoria, 2018, Resource Recovery Technology Guide

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Bedminster [102]	Canning Vale, Perth	SMRC. SUEZ. Originally operated by Environmental Waste Technologies		2003	Seven SMRC member councils in southern Perth.	- Mixed residual waste.	- Compost. Compost to Australian Standards. - soil conditioner - Recyclable plastic and metals	MBT, rotating drum	- 109,200 tpa	Residual kerbside bin	- Potential future ban of applying MWOO to land Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control
Entech Waste to Gas (WtGas)[103]	Port Headland and East Rockingham, WA		New Energy Corporation				Port Headland generates up to 15 MW	- Low temperature gasification - Upfront sorting to remove contaminants and recyclables.	Port Hedland facility capacity from 70,000 to 130,000 tpa		

[102] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report
[103] Confidential source

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Organic Resource Recovery Facility (ORRF)[104]	Port Macquarie, NSW	Remondis.	APBTC[105] Remondis	June 2005	Port Maquarie-Hastings, Kempsey	- Green waste Mixed waste - Food waste From municipal and commercial sources	- High quality compost to Australian standards. Contamination is low. Compost use as soil conditioning.	Tunnel Composting	- 21,000 tpa of municipal solid waste and C&I - 20,000 tpa of separated organics[106]	- Separate bin for garden waste - Weekly organics kerbside collection (30% of community participation)	- Sites are required to have buffers while being close to waste sources and end markets - Secure markets for compost in close proximity - Contamination management and impact on product quality and value - Odour control, particularly during turning and loading activities - Bioaerosol impacts. Micro-organisms can become airborne in fine particles and mist during turning and loading. - Compost needs to be compliant with AS4454 - Community engagement is required - Odour release is an increased risk because of the open process[107]
Tryton[108]	Lismore, NSW	Operated by Tryton Engineering and contracted by Lismore Council		2001 Facility is no longer operating	Lismore City Council	Organics, including food waste, garden waste and paper and cardboard.	- Vermicompost of high quality - Mulch of high quality	Vermicomposting	6,000 -7,000 tpa - Planned nominal capacity of 40,000 tpa. First stage planned for 11,000 tpa	- Kerbside organics in bins. - Self-haul organics - organics from commercial operations	

[104] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report
[105] AP Business Technology Consultancy, year unknown, Tunnel Composting High Performance at Low Cost
[106] Confidential source
[107] Sustainability Victoria, 2018, Resource Recovery Technology Guide
[108] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Vertical in-vessel composting [109]	Moss Vale, NSW	Wingecarribe e Shire Council	VCU Technology.	November 2002 Facility is no longer operating		Range of feedstock including: - Commercial food waste - animal carcasses and abattoir waste - garden waste - grease trap waste - biosolids - WWTP grit and screenings	High quality compost of	- Vertical in-vessel composting - First multi-silo vertical in-vessel composting set up in Australia	3,000 tpa. Each 25 m^3 column has capacity of 1,000 tpa.	N/a	
Windrow composting [110]	- Epping, VIC - Ballan, VIC - Camden, NSW - Lucas Heights, NSW	SUEZ					High quality compost	Windrow composting	- Epping, VIC: 45,000 tpa - Ballan, VIC: 15,000 tpa - Camden, NSW: 50,000 tpa - Lucas Heights, NSW: 50,000 tpa	Garden organics bin from three bin system	Generally, not suitable for food waste and other odourous materials - Capacity can be limited by available site area - Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control[111]

[109] Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report
[110] SITA Australia, date published unknown, Resource Recovery and ARRT Credentials
[111] Sustainability Victoria, 2018, Resource Recovery Technology Guide

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
BioWise[112]	Kwinana, WA	Joint venture between Water Corporation of WA and SUEZ	SUEZ	2001		- Source separated organics from the commercial sector - Biosolids from aged stockpiles at Kwinana Sewage Treatment Plant	Compost of high quality to Australian Standards	- Static pile composting	- 25,000 tpa of feedstock with capability to grow to 100,000 tpa.	N/a	Generally not suitable for food waste and other odourous materials - Capacity can be limited by available site area - Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control[113]
Biomass [114]	Coffs Harbour, NSW	Handy Bins	BEST	2007[115]	- Coffs Harbour Bellingen and Nambucca Councils.	- source separated garden and food waste - mixed residual waste - biosolids		- MSW autoclaved - separated organics - agitated bay	- 20,000 tpa of municipal solid waste - 20,000 tpa of separated organics	Garden organics bin from three bin system	- Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control
Shepparton	Shepparton, VIC	WCT	APBTC	Mar-08		Green organics		Tunnel composting	10,000 tpa		

112 Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report
113 Sustainability Victoria, 2018, Resource Recovery Technology Guide
114 Sustainability Victoria, 2018, Resource Recovery Technology Guide
115 Wright Corporate Strategy, 2008, Alternative Waste Technologies - An Updated Report

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Conporec[116]	Neerabup, WA	SUEZ	BioVision 2000 partnership	2009	500,000 people Seven Mindarie member councils including Joondalup, Perth, Wanneroo, Cambridge, Victoria Park and Vincent.	Mixed solid waste from municipal and commercial and industrial	- 52,000 t of low-grade compost. - Metals[117]	Rotating drum	100,000 tpa	Residual kerbside bin	- Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Odour control[118]
NRS[119]	Dandenong, VIC	Veolia	CR Hudson and Associates			- Garden organics - Food		Natural Recovery Systems In-vessel composting	- 300 m^3 accepted per vessel - Throughput per vessel is 4,000 to 6,000 t		- Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control

[116] SITA Australia, date published unknown, Resource Recovery and ARRT Credentials
[117] Confidential source
[118] SITA Australia, date published unknown, Resource Recovery and ARRT Credentials
[119] Confidential source

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
HotRot Composting Units[120]	- HotRot 1206 in multiple locations in Australia - HotRot 1509 in multiple locations in New Zealand					- HotRot 1206: Food waste from commercial sector - HotRot 1509: Sewage grit, waste from smaller communities HotRot 1811: 'Dirty' organics, fruit and vegetables, source separated kitchen and garden organics - HotRot 3518: large quantities of organic waste	Compost	In vessel composting units with rotating tines	- HotRot 1206: 0.2-0.5 t per day - HotRot 1509: 0.8-1.5 t per day - HotRot 1811: 1.8-2.5 t per day - HotRot 3518: 8-11 t per day		- Changing nature of waste stream compositions during the lifetime of contractual agreements. - Compost quality is tightly controlled by regulations and applications can be limited. Concerns with high risk of contamination with compost. - Incorrect predictions of waste composting resulting in declining organics content in residual waste - Low or negative revenue from compost - Economies of scale favouring larger facilities - Odour control
Bio-Gro Open Windrow composting facility	Mount Gambier, SA	Bio-Gro	Bio-Gro	NA	NA	FOGO, abattoir waste, food waste, paper pulp, timber residue, pine bark saw dust, liquid waste, whey from dairies	organic growing substrates, soil conditioners, mulching mediums, and biological growth stimulants for a range of applications. These are sold to nursery, cut flower, fruit and orchard, turf growing, viticulture, and broad acre industries.	Open Windrow Composting.	Produce approximately 700,000 m3 of product per annum.	NA	
Melbourne Composting Facility	Dandenong South	Sacyr	Sacyr	2018	Services 9 metro Melbourne councils	Mostly FOGO from Councils with some other organics from commercial customers including Woolworths	Compost which is sold to industrial customers	IVC 12 In-vessel tunnels Dimensions: 6x6x30m	100,000 tpa	3-bin FOGO	Bio-degradable or Compostable plastics and things like bamboo weren't really a consideration when it was designed which is now a problem. For example, Some Bio-degradable or Compostable plastics and things like bamboo have about a 12-week processing time, however, GO are normally only 4 weeks. This mean there are certain conditions and specification in the contract about contamination. The facility is slated to operate for 20 years.

[120] HotRot Systems, 2007, HotRot Composting Units, Different units for different applications.

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Berrybank Piggery	Berrybank, Victoria	Berrybank Piggery	Dr. Pietro Andreoli	1989	NA	Waste effluent from 20,000 sow piggery	Electricity Biogas Potting mix and compost	Wet AD	NA	NA	
Phoenix Power Recyclers	Yalata, Queensland	Phoenix Power	NALG Australia	NA	NA	FOGO, GO and grease trap	High- quality compost	IVC	50,000 tpa	Na	
MSM Milling Biomass Fuel Switch Project	Manildra, NSW	MSM Milling	NA	2018	Na	locally sourced renewable wood chips, such as forestry thinnings, offcuts and sawmill by products	Heat in the form of steam	Biomass boiler	5 MW	NA	Replaces current LPG fuelled boilers with a 5 MW biomass fuelled boiler using locally sourced timber residue as a fuel source. Displaces several smaller existing LPG boilers and save around 4,000tCO2-e per annum and over 80,000tCO2-e for the project life. The project will produce 7,147kg/h of steam output at full capacity, to be used in milling and processing operations. The increased capacity to produce steam at a lower cost with a renewable resource will ensure the business can expand its operation without the risk of exposure to volatile LPG price fluctuations.
Logan City Biosolids Gasification Project	Loganholme, Queensland	Logan City Council	Downer Utilities Pty Ltd, WSP Australia Pty Ltd, Cardno (QLD) Pty Ltd, Pyrocal Pty Ltd	2019	300,000 people	34,000 t of biosolids (treated and partially dewatered sewage sludge) each year (90t/day).	biochar	Gasification	NA	NA	

Technology	Location	Owner or Operator	Developer	Year commenced	Population	Inputs	Output	Type of technology	Capacity	Kerbside collection system	Key Issues and Risks
Renergi pyrolysis	Shire of Collie in Western Australia.	Renergi	Shire of Collie, South West Developmen t Commission	2020	Na	MSW and forestry waste	crude pyrolysis/bio-oil for energy applications, and bio-char for land and other applications.	Pyrolysis	4000 t per year of municipal solid waste, and 8000 t per year of forestry waste	NA	
SOilCO IVC tweed heads	Tweed Shire Council	SOILCO	SOILCO	2021	91,371	FOGO	9,100 t compost	IVC	25,000	3 bin FOGO	
Launceston Waste Centre	Launceston Council	Launceston Council	NA	2018	67,449	FOGO	7,300 t per annum (tpa) of compost. Approval is being sort for potential future production capacity of 15,000 tpa	Forced Aerated Floor system, which is a compost aeration system that uses an electrically driven and computer-controlled fan that pushes air through movable perforated pipes underneath the compost pile. This system allows control of oxygen levels minute by minute, allowing the pile to remain aerobic, minimise odours, turning, and the time to produce the final compost product.	Max capacity of 25,000 tpa	3 Bin FOGO	

APPENDIX D

International Processing Technology Examples

Technology	Location	Type of Technology	Capacity (tonnes per year)	Operational costs (AUD per tonne)	Implementation costs (AUD million)	Implementation costs (per tonnes per year or per feed)
Christchurch[121]	Christchurch, New Zealand	Tunnel composting				
Kwantas[122]	Sabah, Malaysia	Palm oil mill waste composting plant	80,000			
Tingkayu[123]	Sabah, Malaysia	Palm oil mill waste composting plant	60,000			
Hannover mechanical residual waste treatment plant[124]	Hannover Waste Treatment Centre (abz), Hannover, Germany	Mechanical residual waste treatment	200,000			
Passavant Roediger	Anlagenbau, Germany	Anaerobic Digestion			$16	$787
Passavant Roediger	Anlagenbau, Germany				$24	$603
BEKON	Munich, Germany	Anaerobic Digestion			$10.20-11.40	$406-457
Ashford	Kent, UK	Anaerobic Digestion			$15	$374
Vaasa	Finland	Anaerobic Digestion		$50	$8	$197
Arrow Bio	Israel	Anaerobic Digestion			$14.60	
Amiens	France	Anaerobic Digestion		$62	$2	$20
Oaktech	United Kingdom	Anaerobic Digestion			$22	$298
Hese	Leicestershire, UK	Anaerobic Digestion			$57	$501
Linde	Madrid, Spain	Anaerobic Digestion			$44	$317
SBI	Heerenveen, Netherlands	Anaerobic Digestion		$113	$48	$220
Ecopark 1	Barcelona	Anaerobic Digestion			$165	$674
Ecopark 2	Barcelona	Anaerobic Digestion			$87	$362
Ecopark 3	Barcelona	Anaerobic Digestion			$75	$287
Farington Waste Recovery Park	Lancashire, UK	Anaerobic Digestion			$178	$584
Vargon	The Netherlands	Anaerobic Digestion		$50	$24	$74
Ipswich	United Kingdom	In vessel composting of source separated organics	17,200		$2.30	$137

[121] AP Business Technology Consultancy, year unknown, Tunnel Composting High Performance at Low Cost
[122] AP Business Technology Consultancy, year unknown, Tunnel Composting High Performance at Low Cost
[123] AP Business Technology Consultancy, year unknown, Tunnel Composting High Performance at Low Cost
[124] Zweckverband Abfallwirtschaft Region Hannover, aha, 2005, The mechanical residual waste treatment plant at Hannover Waste Treatment Centre (abz)

Technology	Location	Type of Technology	Capacity (tonnes per year)	Operational costs (AUD per tonne)	Implementation costs (AUD million)	Implementation costs (per tonnes per year or per feed)
Entsorga	Turtle Q-Ring, Kefallonia Island, Greece	Mechanical-biological treatment with composting in boxes with semi-permeable sheet	20,000		$3.80	$190.30
Horstmann		Tunnel with Refused-derived fuel production	20,000		$2.70	$133.20
Horstmann		Tunnel with Refused-derived fuel production	500,000		$26.10	$53.30
Entsorga	Coccinelle, Italy	Composting in boxes	25,000	$31.70	$9.10	$36.80
SRS	Inverboyndle, UK	In vessel composting	25,000	$67-75	$4.80	$190.30
Vinci Environment	Launay, Lantic, France	Mechanical-biological treatment with open windrow composting	40,000	$38.10	$4.60	$115.50
Horstmann	Osterholz, Germany	Mechanical-biological treatment with Refused-derived fuel production and tunnel composting	45,000	$76.10	$15.20	$338.80
Linde	Linz, Austria	Tunnel composting	50,000		$24.10	$482.20
Alpheco	United Kingdom	Batch tunnel system	50,000		$6.30	$126.90
VKW	Austria	In vessel composting	75,000	$43.10	$19.70	$262.70
VKW	Austria	In vessel composting	150,000	$32.40	$34.30	$228.40
Biodegma	Neumünster, Germany	Closed composting (covered windrows)	85,000			
Linde	Borken, Germany	Tunnel composting	85,000		$18.40	$217.00
Civic	United Kingdom	Vertical composting reactor	90,000		$25-29	$275-317
Larnaka	Cyprus	Mechanical-biological treatment with handpicking, NIR and in vessel composting	176,000		$76.10	$432.70
Biodegma	Pößneck, Germany	Closed composting (covered windrows)	200,000	$29-42		
Bedminster	Edmonton, Canada	Bio-cylinder (aerobic treatment)	247,000	$58.30	$70.90	$286.80
Ecopark 4	Barcelona	Mechanical-biological treatment with advanced recycling and closed composting	300,000		$57.10	$190.30
Kelag	Istanbul	Mechanical-biological treatment with metal recovery, handpicking, Refused-derived fuel production and hall composting	300,000	$8.00	$59.60	$199.20
Kirklees	United Kingdom	Waste to energy	136,000		$48.20	
		Materials recovery facility	27,000			
		Composting	5,000			
South Gloucestershire	United Kingdom	In-vessel composting and four transfer stations	30,000		$48.70	
Surrey	United Kingdom	Two Waste to energy	270,000		$121.50	

Technology	Location	Type of Technology	Capacity (tonnes per year)	Operational costs (AUD per tonne)	Implementation costs (AUD million)	Implementation costs (per tonnes per year or per feed)
		In-vessel composting	112,000			
		Materials recovery facility	40,000			
Central Berkshire	United Kingdom	Materials recovery facility and transfer station	430,000		$52.60	
East London Waste Authority	United Kingdom	Two MBTs, seven Materials recovery facilities, 700 collection points and a road	360,000		$66.80	
Leicester City	United Kingdom	MBT	175,000		$43.80	
		AD	35,000			
West Berkshire	United Kingdom	Materials recovery facility	13,500		$40.50	
		In-vessel composting	32,000			
Cornwall	United Kingdom	Waste to energy	240,000		$64.00	
Nottinghamshire	United Kingdom	Waste to energy	180,000		$54.40	
		Materials recovery facility	85,000			
Lancashire	United Kingdom	Two MBTs	350,000		$127.90	
		Two In-vessel composting units	110,000			
		One Materials recovery facility	50,000			
Northumberland	United Kingdom	Waste to energy extension	136,000		$58.00	
		Transfer station	70,000			
		Three Materials recovery facilities	70,000			
		11 Materials recovery facility extensions	54,000			
		Two transfer station extensions	75,000			
Shropshire Waste Partnership	United Kingdom	In-vessel composting	60,000		$58.00	
		Waste to energy	90,000			
Wakefield Metropolitan District Council	United Kingdom	Mechanical-biological treatment	175,000		$46.90	
		Materials recovery facility	50,000			
		In-vessel composting	40,000			
Greater Manchester Waste Disposal Authority	United Kingdom	Five Mechanical-biological treatments	550,000		$176.90	
		Materials recovery facility	90,000			

Technology	Location	Type of Technology	Capacity (tonnes per year)	Operational costs (AUD per tonne)	Implementation costs (AUD million)	Implementation costs (per tonnes per year or per feed)
		Four In-vessel composting units	175,000			
		Waste to energy (Combined heat and power)	325,000			
Cambridgeshire County Council	United Kingdom	Mechanical-biological treatment	240,000		$49.70	
		In-vessel composting	90,000			
Cheshire County Council	United Kingdom	Mechanical-biological treatment	30,000		$56.80	
		Refused-derived fuel incineration	150,000			
Merseyside Waste Disposal Authority	United Kingdom	Two Mechanical-biological treatments for Refused-derived fuel production	655,000		$127.90	
		Two Refused-derived fuel incinerations	327,000			
North Yorkshire County Council and City of York Council	United Kingdom	Mechanical-biological treatment	145,000		$92.40	
		Waste to energy	180,000			
		Materials recovery facility	40,000			
Leeds	United Kingdom	Waste to energy (Combined heat and power)	160,000		$97.50	
Suffolk	United Kingdom	Waste to energy (Combined heat and power)	245,000		$145.00	
		In-vessel composting	77,000			
		Materials recovery facility	60,000			
Bradford	United Kingdom	Mechanical-biological treatment	251,000		$88.20	
		In-vessel composting	44,000			
		Waste to energy (Combined heat and power)	113,000			
Barnsley, Doncaster and Rotherham	United Kingdom	Waste to energy (Combined heat and power)	152,177		$110.00	
		Mechanical-biological treatment for Refused-derived fuel production	80,371			
South Tyne and Wear	United Kingdom	Waste to energy (Combined heat and power)	20,000		$104.50	
		In-vessel composting for compost-like output production	20,000			
Staffordshire	United Kingdom	Waste to energy (Combined heat and power)	30,000		$173.90	
Leicestershire	United Kingdom	Waste to energy (Combined heat and power)	180,000		$123.10	
South West Devon Waste Partnership	United Kingdom	Waste to energy (Combined heat and power)	225,000		$135.00	
Gloucestershire	United Kingdom	Waste to energy (Combined heat and power)	175,000		$130.70	

Technology	Location	Type of Technology	Capacity (tonnes per year)	Operational costs (AUD per tonne)	Implementation costs (AUD million)	Implementation costs (per tonnes per year or per feed)
Hertfordshire	United Kingdom	Waste to energy (Combined heat and power)	270,000		$163.90	
Norfolk	United Kingdom	Waste to energy (Combined heat and power)	155,000		$129.30	
South London Waste Partnership	United Kingdom	Two Mechanical-biological treatments	213,000		$160.40	
		Waste to energy (Combined heat and power)	106,500			

APPENDIX E

Technical Assumptions for GHG Emissions Calculation

Mass and Energy Balance Assumptions			
Parameter	**Value**	**Units**	**Source**
Electricity consumption of composting facility	0.00416	MWh/tonne of waste composted	*SLR Assumption based on data provided for a 50ktpa FOGO tunnel composting facility (208MWh/year)*
Methane generation rate for food waste	0.074	Nm3 CH4/kg food waste (as received)	*SLR Assumption based on knowledge of food waste characteristics (%TS, %VS, BMP)*
Methane generation rate for garden waste	0.042	Nm3 CH4/kg garden waste (as received)	*SLR Assumption based on knowledge of garden waste characteristics (%TS, %VS, BMP)*
Average ratio of food waste: garden waste	14%		*Based on waste figures from Ballarat (An average composition between 2021-2040 was used to simplify calcs)*
Methane generation rate per tonne of waste (FOGO)	0.042	Nm3 CH4/kg FOGO (as received)	Calculated based on the assumptions above
Methane energy content	35.8	MJ/Nm3 of CH4	
Electricity consumption for IVC facility	0.030	MWh/tonne composted	*SLR Experience*
Gross electricity generated	0.154	MWh/tonne waste sent to dry AD	*SLR Experience*
Net Electricity generation rate for dry AD (incl digestate composting)	0.11	MWh/tonne waste sent to dry AD	*SLR Experience*
Marginal Loss Factor	0.99		*AEMO (2021-2022 MLF)*

GHG Emissions Assumptions			
Methodology/Source:			
Parameter	**Value**	**Units**	**Source**
F_C	1.34		*NGER (Measurement) Determination 2008*
MCF	1.00		*NGER (Measurement) Determination 2008*
$W_{LFG,CH4}$	0.50		*NGER (Measurement) Determination 2008*
W_{LFG}	0.45		*Based on average capture rate for VIC. Carbon Credits (Carbon Farming Initiative - Alternative Waste Treatment) Methodology Determination*
OF_{LF}	0.10		*NGER (Measurement) Determination 2008*
GWP_{CH4}	28.00		*NGAF - August 2021*
$(1-W_{LFG})*(1-OF_{LF})*GWP$	13.86	tCO2-e/tCH4	

Baseline Emissions Assumptions

Food Waste

Degradable organic carbon (DOC)	0.15		
Fraction of degradable organic carbon ($DOC_{F,W}$)	0.84		
Methane generation potential, M_B	0.084	*tonnes CH4/tonne of food waste*	

Garden Waste

Degradable organic carbon (DOC)	0.20		
Fraction of degradable organic carbon ($DOC_{F,W}$)	0.47		
Methane generation potential, M_B	0.063	*tonnes CH4/tonne of garden waste*	

FOGO

Methane generation potential, M_B	0.066	*tonnes CH4/tonne of FOGO*

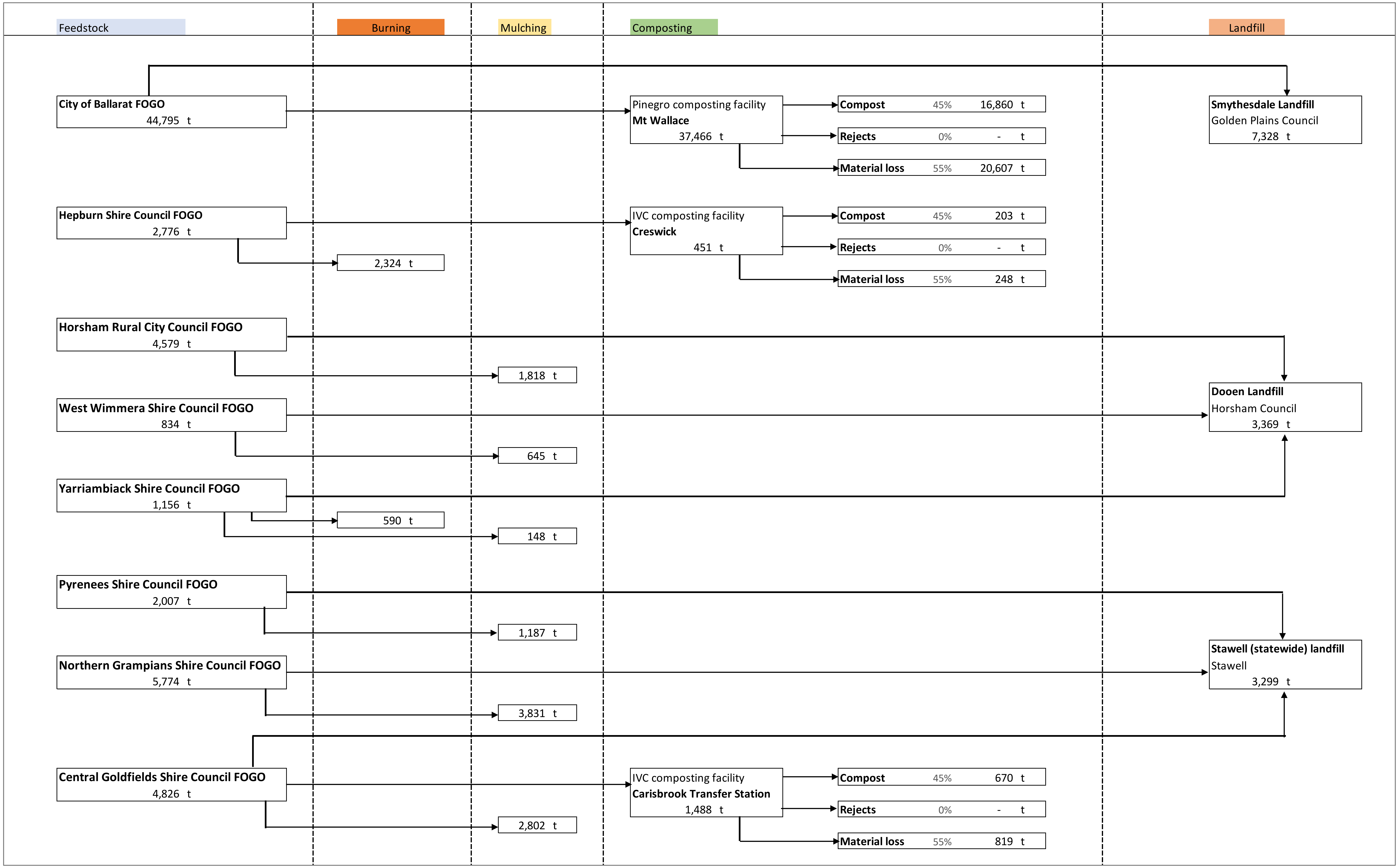
Project Emissions Assumptions

Emissions from fuel			
Quantity of diesel			
Emissions from purchased electricity			
Emissions from purchased electricity	0.96	tonnes CO_2/MWh	*NGAF (2021) - Emission factor for Victoria*
Emissions from composting			
$EF_{COMPOST}$, CH4	0.02	*tonnes CO2-e/tonne of waste*	*NGER (Measurement) Determination 2009*
$EF_{COMPOST}$, Nitrous Oxide	0.03	*tonnes CO2-e/tonne of waste*	
RE	10%		*Carbon Credits (Carbon Farming Initiative - Alternative Waste Treatment) Methodology Determination*
Emissions from AD			
CE	0.98		*Carbon Credits (Carbon Farming Initiative - Alternative Waste Treatment) Methodology Determination*
$M_{sent,h}$		m^3	
gamma	0.019	*tonnes CO2-e/m3 CH4*	*NGER (Measurement) Determination 2009*
Emission factor for AD	0.000388	*tonnes CO2-e/m3 CH4*	*CALCULATED*
Emissions from Combustion Devices			
Conventional Gas Engine			
Methane Energy Content Factor	0.037700	*GJ/m3*	*NGER (Measurement) Determination 2009*
Emission Factor for CH4	6.40	*kg CO2/GJ*	*NGER (Measurement) Determination 2009*
Emission Factor for N2O	0.03	*kg CO2/GJ*	*NGER (Measurement) Determination 2009*
Emission Factor for combustion devices	0.000193	*tonnes CO2-e/m3 CH4*	*CALCULATED*

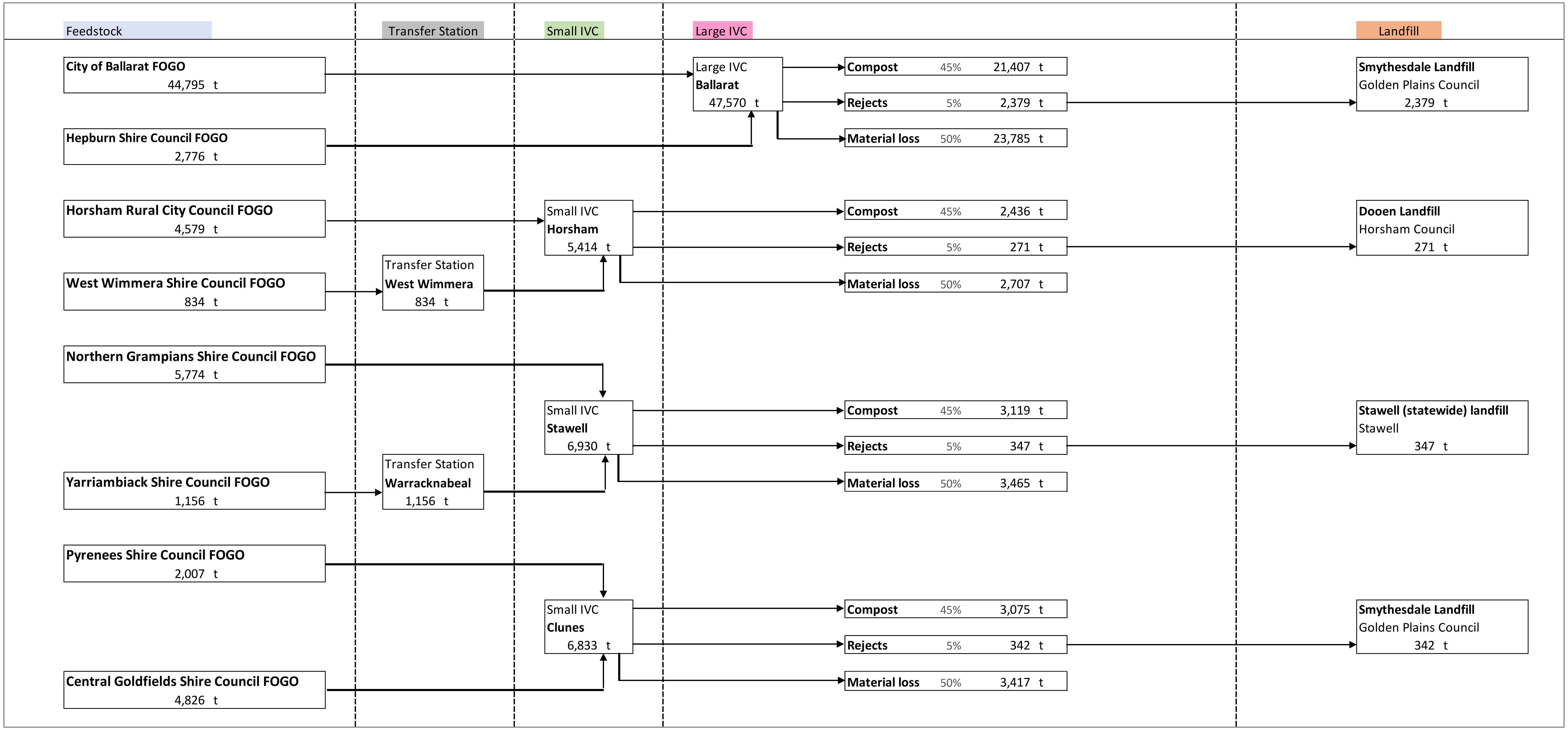
APPENDIX F

Simplified Material Flow Diagrams

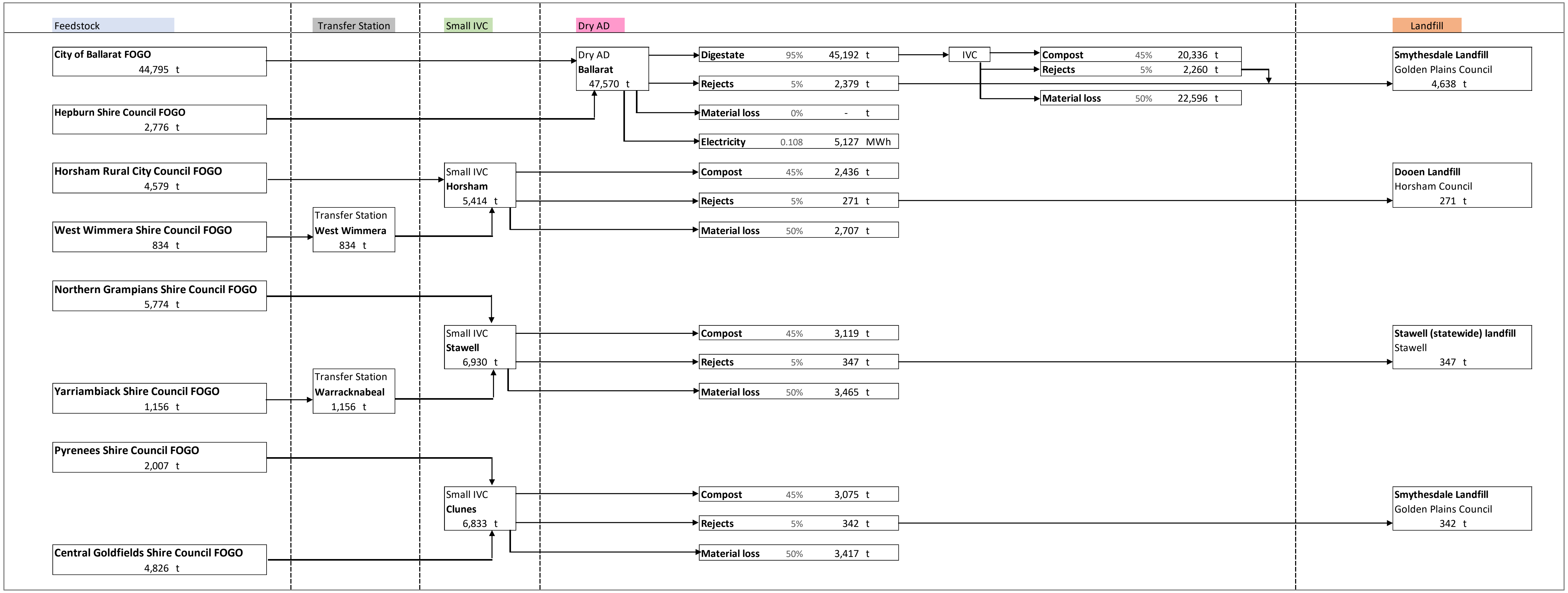
Option 1 – Business as usual



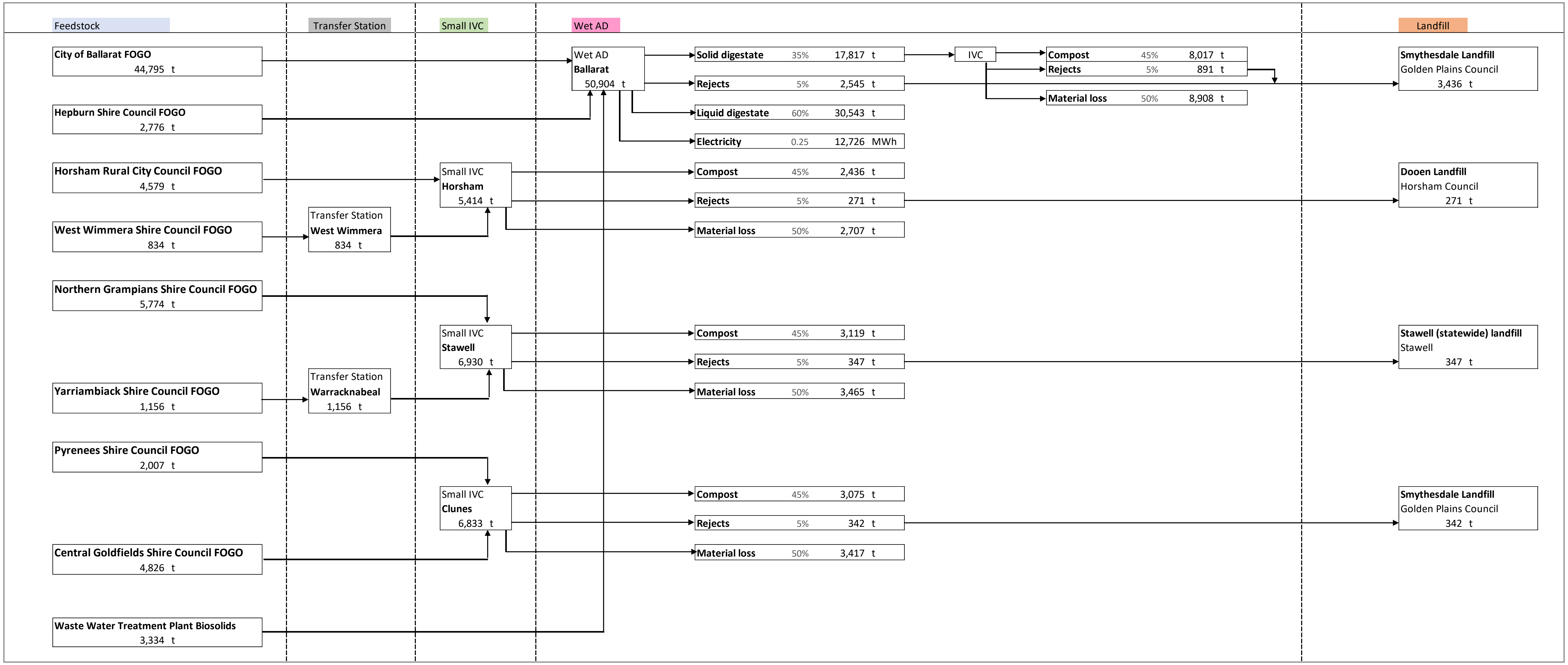
Option 2 - 2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)



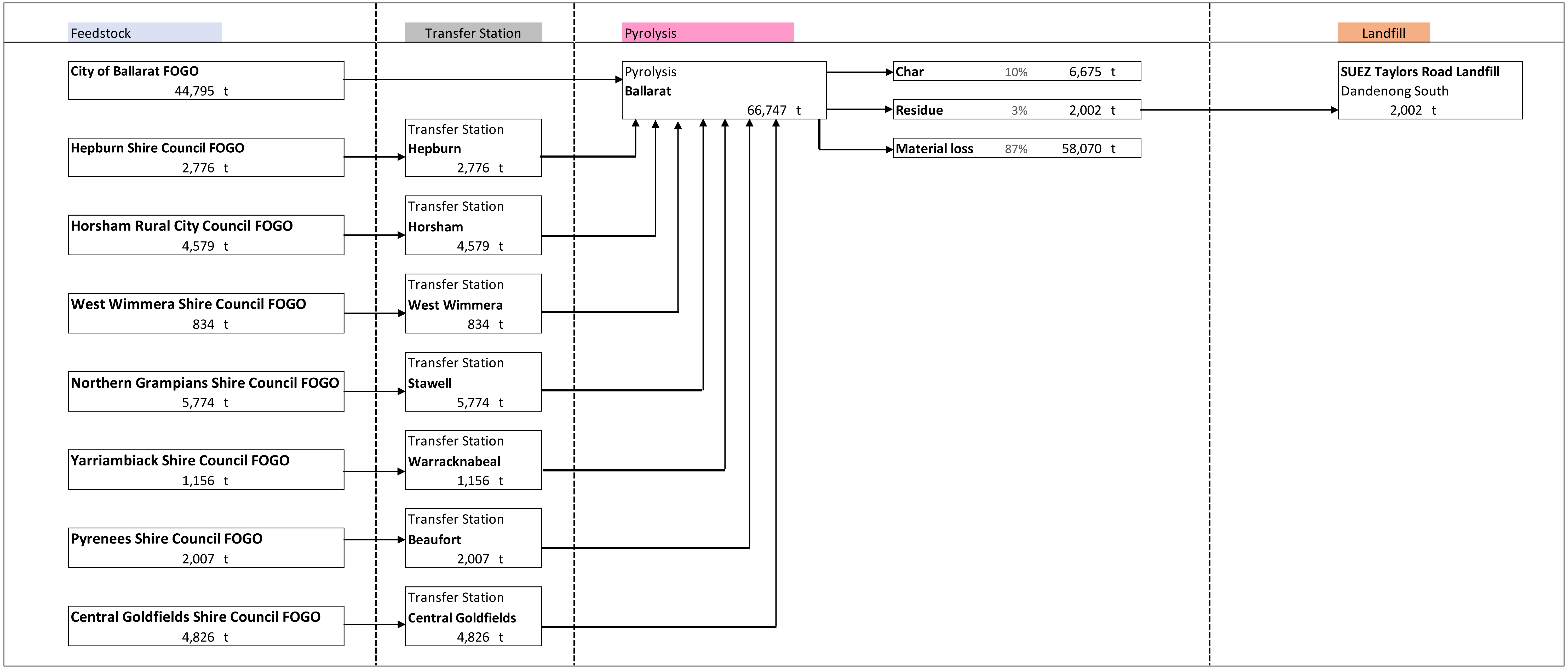
Option 4 - 2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)



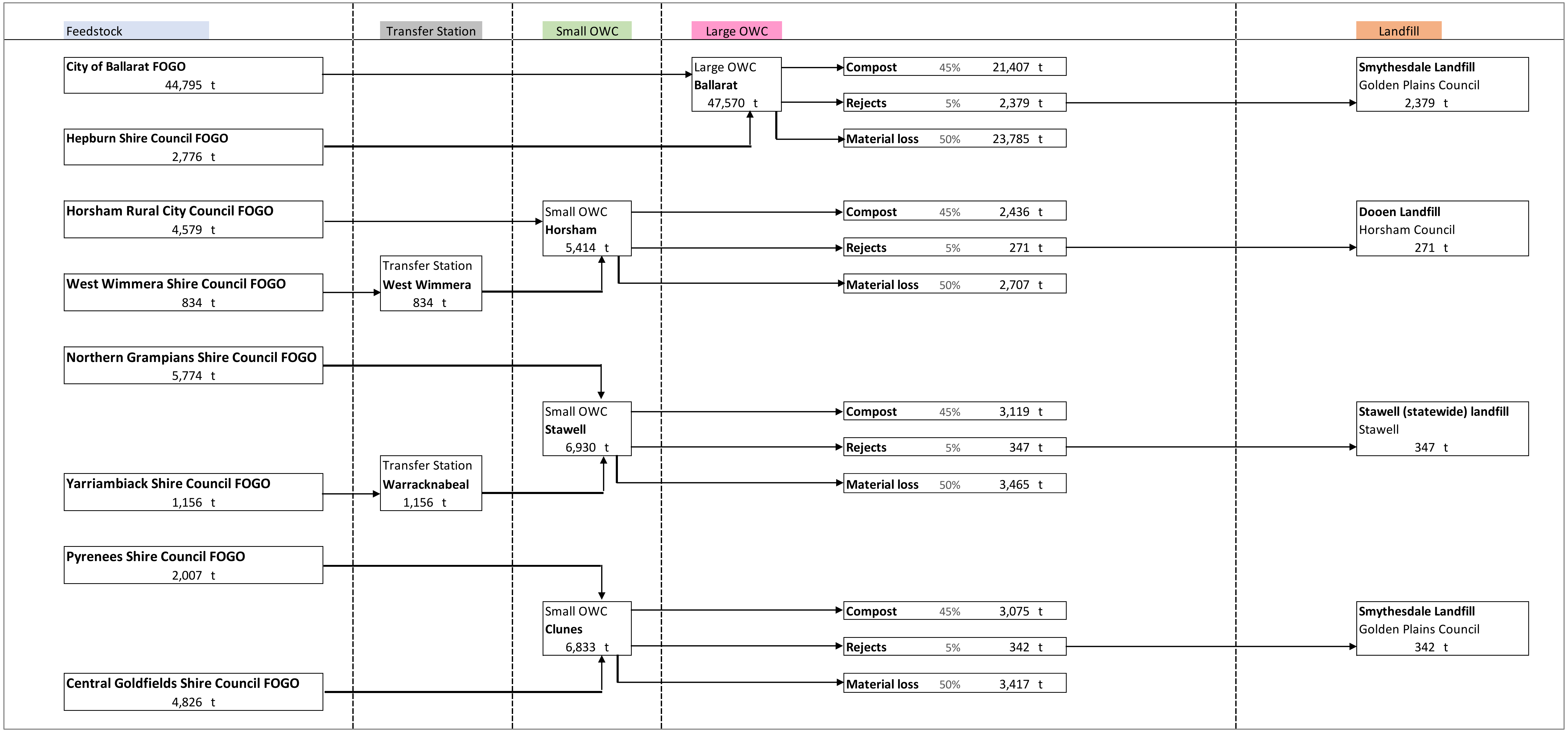
Option 5 - 2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)



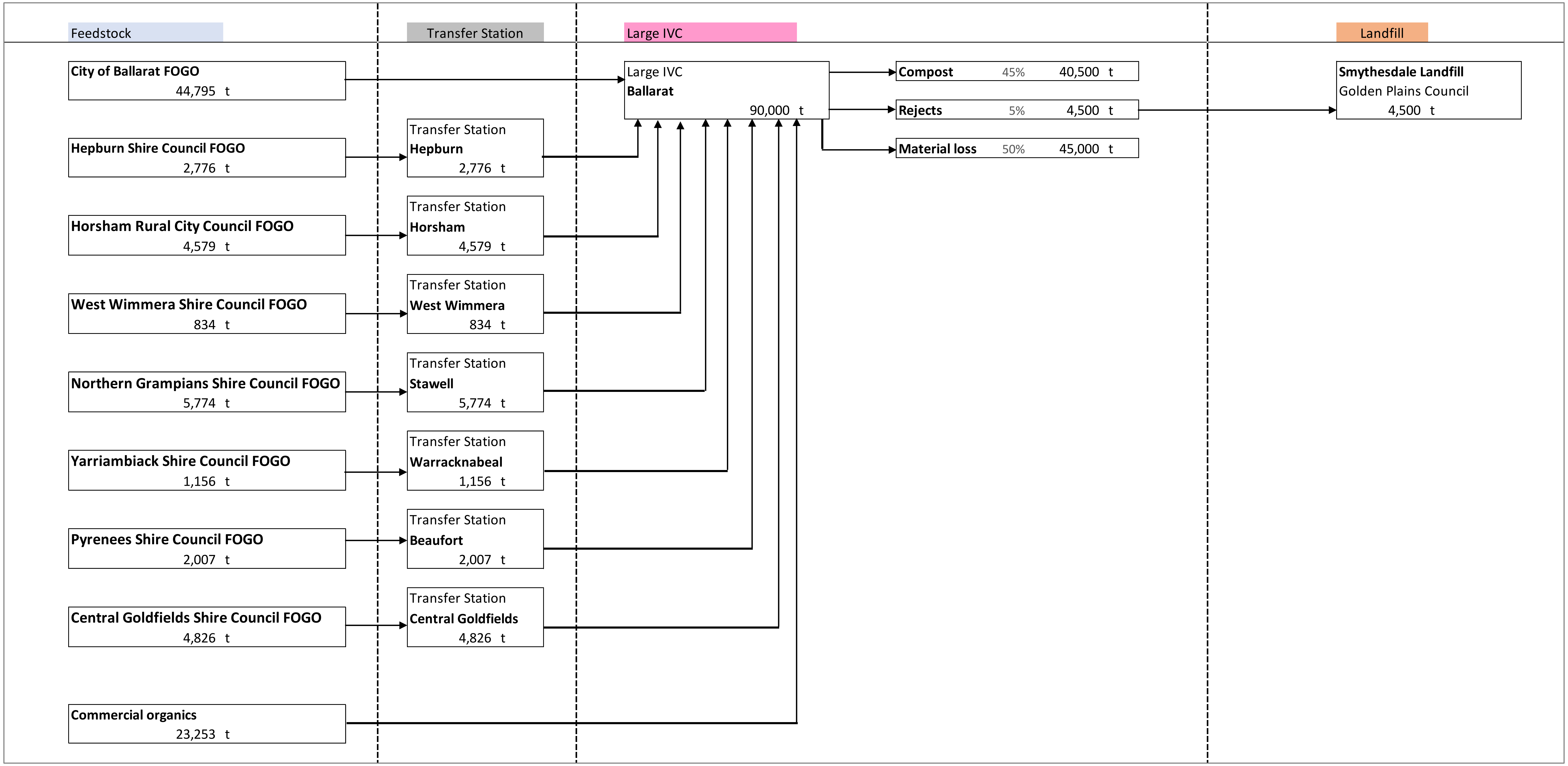
Option 8 - 7 Transfer stations, 1 Pyrolysis plant (FOGO)



Option 11 - 2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)



Option 13 - 7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)



APPENDIX G

Comparative Total Financial Analysis by Year

	Option	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Costs	Option 1	$ -	$ 3,120,807	$ 3,288,306	$ 3,547,060	$ 3,726,985	$ 3,939,359	$ 4,106,858	$ 4,365,612	$ 4,545,537	$ 4,757,911
	Option 2	$ 22,913,334	$ 4,153,397	$ 4,356,454	$ 4,722,810	$ 4,956,991	$ 5,233,001	$ 5,436,059	$ 5,802,415	$ 6,036,596	$ 6,312,606
	Option 4	$ 45,889,844	$ 5,466,637	$ 5,763,741	$ 6,224,144	$ 6,552,370	$ 6,922,428	$ 7,219,532	$ 7,679,934	$ 8,008,161	$ 8,378,218
	Option 5	$ 29,337,412	$ 3,706,147	$ 3,877,316	$ 4,211,783	$ 4,414,074	$ 4,658,197	$ 4,829,366	$ 5,163,833	$ 5,366,124	$ 5,610,246
	Option 8	$ 33,922,543	$ 4,567,119	$ 4,764,376	$ 5,174,592	$ 5,416,451	$ 5,705,526	$ 5,902,783	$ 6,312,999	$ 6,554,858	$ 6,843,933
	Option 11	$ 9,736,755	$ 3,569,527	$ 3,739,873	$ 4,057,218	$ 4,255,413	$ 4,491,568	$ 4,661,913	$ 4,979,258	$ 5,177,453	$ 5,413,608
	Option 13	$ 36,548,816	$ 10,925,949	$ 10,993,286	$ 11,163,967	$ 11,253,894	$ 11,365,007	$ 11,432,344	$ 11,603,025	$ 11,692,952	$ 11,804,065
	Total	**$ 178,348,704**	**$ 32,388,776**	**$ 33,495,046**	**$ 35,554,514**	**$ 36,849,193**	**$ 38,375,727**	**$ 39,481,997**	**$ 41,541,465**	**$ 42,836,144**	**$ 44,362,677**
Income	Option 1	$ -	$ 881,655	$ 937,843	$ 1,018,227	$ 1,085,614	$ 1,147,163	$ 1,203,350	$ 1,283,734	$ 1,351,122	$ 1,412,671
	Option 2	$ -	$ 2,738,847	$ 2,872,173	$ 3,117,992	$ 3,273,908	$ 3,456,539	$ 3,589,866	$ 3,835,684	$ 3,991,600	$ 4,174,231
	Option 4	$ -	$ 2,848,928	$ 2,990,139	$ 3,243,840	$ 3,407,640	$ 3,598,154	$ 3,739,364	$ 3,993,066	$ 4,156,866	$ 4,347,380
	Option 5	$ -	$ 2,983,245	$ 3,134,691	$ 3,398,629	$ 3,572,665	$ 3,773,416	$ 3,924,862	$ 4,188,800	$ 4,362,836	$ 4,563,586
	Option 8	$ -	$ 946,296	$ 992,362	$ 1,077,294	$ 1,131,165	$ 1,194,265	$ 1,240,331	$ 1,325,264	$ 1,379,134	$ 1,442,235
	Option 11	$ -	$ 2,738,847	$ 2,872,173	$ 3,117,992	$ 3,273,908	$ 3,456,539	$ 3,589,866	$ 3,835,684	$ 3,991,600	$ 4,174,231
	Option 13	$ -	$ 20,267,276	$ 19,962,648	$ 19,400,999	$ 19,044,758	$ 18,627,480	$ 18,322,852	$ 17,761,202	$ 17,404,961	$ 16,987,683
	Total	**$ -**	**$ 32,523,439**	**$ 32,824,187**	**$ 33,356,745**	**$ 33,704,044**	**$ 34,106,393**	**$ 34,407,141**	**$ 34,939,700**	**$ 35,286,999**	**$ 35,689,347**
Value of landfill savings	Option 1	$ -	$ 4,289,396	$ 4,553,169	$ 4,918,700	$ 5,213,433	$ 5,513,102	$ 5,776,875	$ 6,142,406	$ 6,437,139	$ 6,736,807
	Option 2	$ -	$ 5,978,735	$ 6,285,134	$ 6,812,502	$ 7,163,274	$ 7,566,521	$ 7,872,920	$ 8,400,288	$ 8,751,060	$ 9,154,307
	Option 4	$ -	$ 5,763,047	$ 6,053,999	$ 6,565,921	$ 6,901,247	$ 7,289,048	$ 7,580,000	$ 8,091,922	$ 8,427,248	$ 8,815,049
	Option 5	$ -	$ 6,192,590	$ 6,514,743	$ 7,057,864	$ 7,424,391	$ 7,843,392	$ 8,165,544	$ 8,708,666	$ 9,075,192	$ 9,494,193
	Option 8	$ -	$ 6,104,603	$ 6,417,452	$ 6,955,923	$ 7,314,080	$ 7,725,816	$ 8,038,665	$ 8,577,136	$ 8,935,293	$ 9,347,029
	Option 11	$ -	$ 5,978,735	$ 6,285,134	$ 6,812,502	$ 7,163,274	$ 7,566,521	$ 7,872,920	$ 8,400,288	$ 8,751,060	$ 9,154,307
	Option 13	$ -	$ 18,324,116	$ 18,322,060	$ 18,280,723	$ 18,270,780	$ 18,251,508	$ 18,249,453	$ 18,208,116	$ 18,198,172	$ 18,178,900
	Total	**$ -**	**$ 48,341,826**	**$ 49,878,522**	**$ 52,485,435**	**$ 54,237,044**	**$ 56,242,806**	**$ 57,779,502**	**$ 60,386,415**	**$ 62,138,024**	**$ 64,143,786**
Net Profit/Loss	Option 1	$ -	$ 2,050,245	$ 2,202,706	$ 2,389,867	$ 2,572,063	$ 2,720,906	$ 2,873,367	$ 3,060,528	$ 3,242,724	$ 3,391,567
	Option 2	-$ 22,913,334	$ 4,564,185	$ 4,800,853	$ 5,207,683	$ 5,480,191	$ 5,790,059	$ 6,026,726	$ 6,433,556	$ 6,706,065	$ 7,015,932
	Option 4	-$ 45,889,844	$ 3,145,338	$ 3,280,397	$ 3,585,618	$ 3,756,517	$ 3,964,775	$ 4,099,833	$ 4,405,054	$ 4,575,953	$ 4,784,211
	Option 5	-$ 29,337,412	$ 5,469,688	$ 5,772,118	$ 6,244,711	$ 6,582,981	$ 6,958,611	$ 7,261,040	$ 7,733,633	$ 8,071,904	$ 8,447,533
	Option 8	-$ 33,922,543	$ 2,483,780	$ 2,645,439	$ 2,858,625	$ 3,028,794	$ 3,214,555	$ 3,376,214	$ 3,589,400	$ 3,759,569	$ 3,945,331
	Option 11	-$ 9,736,755	$ 5,148,055	$ 5,417,434	$ 5,873,276	$ 6,181,769	$ 6,531,492	$ 6,800,872	$ 7,256,713	$ 7,565,207	$ 7,914,930
	Option 13	-$ 36,548,816	$ 27,665,443	$ 27,291,423	$ 26,517,755	$ 26,061,644	$ 25,513,981	$ 25,139,961	$ 24,366,293	$ 23,910,182	$ 23,362,519
	Total	**-$ 178,348,704**	**$ 48,476,489**	**$ 49,207,663**	**$ 50,287,666**	**$ 51,091,896**	**$ 51,973,473**	**$ 52,704,647**	**$ 53,784,650**	**$ 54,588,879**	**$ 55,470,456**
	Cumulative Total		$48,476,489	$97,684,152	$147,971,819	$199,063,715	$251,037,187	$303,741,834	$357,526,483	$412,115,363	$467,585,818
	Net		-$129,872,215	-$80,664,552	-$30,376,885	$20,715,011	$72,688,483	$125,393,130	$179,177,779	$233,766,659	$289,237,114
Option 1	Cost		$2,050,245	$4,252,951	$6,642,817	$9,214,880	$11,935,786	$14,809,153	$17,869,681	$21,112,404	$24,503,971
	Profit/Loss		$2,050,245	$4,252,951	$6,642,817	$9,214,880	$11,935,786	$14,809,153	$17,869,681	$21,112,404	$24,503,971
Option 2	Cost		$4,564,185	$9,365,038	$14,572,721	$20,052,912	$25,842,971	$31,869,697	$38,303,253	$45,009,318	$52,025,250
	Profit/Loss		-$18,349,149	-$13,548,295.89	-$8,340,613	-$2,860,422	$2,929,637	$8,956,363	$15,389,919	$22,095,984	$29,111,916
Option 4	Cost		$3,145,338	$6,425,735	$10,011,353	$13,767,869	$17,732,644	$21,832,477	$26,237,530	$30,813,483	$35,597,694
	Profit/Loss		-$42,744,506	-$39,464,109	-$35,878,492	-$32,121,975	-$28,157,201	-$24,057,368	-$19,652,314	-$15,076,361	-$10,292,150
Option 5	Cost		$5,469,688	$11,241,806.31	$17,486,517	$24,069,498	$31,028,109	$38,289,149	$46,022,782	$54,094,686	$62,542,219
	Profit/Loss		-$23,867,724	-$18,095,606	-$11,850,896	-$5,267,914	$1,690,696	$8,951,737	$16,685,370	$24,757,273	$33,204,807
Option 8	Cost		$2,483,780.10	$5,129,218.75	$7,987,843.51	$11,016,637.17	$14,231,192.55	$17,607,406.48	$21,196,806.52	$24,956,375.46	$28,901,706.12
	Profit/Loss		-$31,438,763	-$28,793,324	-$25,934,699	-$22,905,905	-$19,691,350	-$16,315,136	-$12,725,736	-$8,966,167	-$5,020,837
Option 11	Cost		$5,148,055	$10,565,489	$16,438,764	$22,620,534	$29,152,026	$35,952,898	$43,209,612	$50,774,819	$58,689,749
	Profit/Loss		-$4,588,700	$828,734	$6,702,010	$12,883,779	$19,415,271	$26,216,143	$33,472,857	$41,038,064	$48,952,994
Option 13	Cost		$27,665,443	$54,956,866	$81,474,620	$107,536,264	$133,050,245	$158,190,206	$182,556,499	$206,466,681	$229,829,200
	Profit/Loss		-$8,883,373	$18,408,050	$44,925,805	$70,987,448	$96,501,429	$121,641,390	$146,007,683	$169,917,865	$193,280,384

	Option	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Costs	Option 1	$ 4,925,410	$ 5,184,164	$ 5,364,089	$ 5,576,463	$ 5,743,962	$ 6,002,717	$ 6,182,641	$ 6,395,015	$ 6,562,514	$ 6,821,269
	Option 2	$ 6,515,664	$ 6,882,020	$ 7,116,201	$ 7,392,211	$ 7,595,269	$ 7,961,625	$ 8,195,806	$ 8,471,816	$ 8,674,874	$ 9,041,230
	Option 4	$ 8,675,322	$ 9,135,725	$ 9,463,951	$ 9,834,009	$ 10,131,113	$ 10,591,515	$ 10,919,742	$ 11,289,799	$ 11,586,904	$ 12,047,306
	Option 5	$ 5,781,416	$ 6,115,883	$ 6,318,174	$ 6,562,296	$ 6,733,465	$ 7,067,933	$ 7,270,224	$ 7,514,346	$ 7,685,515	$ 8,019,982
	Option 8	$ 7,041,190	$ 7,451,406	$ 7,693,265	$ 7,982,340	$ 8,179,597	$ 8,589,813	$ 8,831,672	$ 9,120,747	$ 9,318,004	$ 9,728,220
	Option 11	$ 5,583,954	$ 5,901,299	$ 6,099,494	$ 6,335,649	$ 6,505,994	$ 6,823,339	$ 7,021,534	$ 7,257,689	$ 7,428,035	$ 7,745,380
	Option 13	$ 11,871,402	$ 12,042,083	$ 12,132,010	$ 12,243,123	$ 12,310,460	$ 12,481,141	$ 12,571,068	$ 12,682,181	$ 12,749,518	$ 12,920,199
	Total	**$ 45,468,948**	**$ 47,528,416**	**$ 48,823,095**	**$ 50,349,628**	**$ 51,455,899**	**$ 53,515,366**	**$ 54,810,045**	**$ 56,336,579**	**$ 57,442,849**	**$ 59,502,317**
Income	Option 1	$ 1,468,858	$ 1,549,242	$ 1,616,629	$ 1,678,178	$ 1,734,365	$ 1,814,750	$ 1,882,137	$ 1,943,686	$ 1,999,873	$ 2,080,257
	Option 2	$ 4,307,558	$ 4,553,376	$ 4,709,293	$ 4,891,924	$ 5,025,250	$ 5,271,069	$ 5,426,985	$ 5,609,616	$ 5,742,943	$ 5,988,761
	Option 4	$ 4,488,590	$ 4,742,292	$ 4,906,092	$ 5,096,606	$ 5,237,816	$ 5,491,518	$ 5,655,318	$ 5,845,832	$ 5,987,042	$ 6,240,744
	Option 5	$ 4,715,033	$ 4,978,971	$ 5,153,007	$ 5,353,757	$ 5,505,204	$ 5,769,142	$ 5,943,178	$ 6,143,928	$ 6,295,375	$ 6,559,312
	Option 8	$ 1,488,300	$ 1,573,233	$ 1,627,103	$ 1,690,204	$ 1,736,269	$ 1,821,202	$ 1,875,072	$ 1,938,173	$ 1,984,239	$ 2,069,171
	Option 11	$ 4,307,558	$ 4,553,376	$ 4,709,293	$ 4,891,924	$ 5,025,250	$ 5,271,069	$ 5,426,985	$ 5,609,616	$ 5,742,943	$ 5,988,761
	Option 13	$ 16,683,056	$ 16,121,406	$ 15,765,165	$ 15,347,887	$ 15,043,260	$ 14,481,610	$ 14,125,369	$ 13,708,091	$ 13,403,464	$ 12,841,814
	Total	**$ 35,990,096**	**$ 36,522,654**	**$ 36,869,953**	**$ 37,272,302**	**$ 37,573,050**	**$ 38,105,608**	**$ 38,452,907**	**$ 38,855,256**	**$ 39,156,004**	**$ 39,688,563**
Value of landfill savings	Option 1	$ 7,000,580	$ 7,366,111	$ 7,660,844	$ 7,960,513	$ 8,224,286	$ 8,589,817	$ 8,884,550	$ 9,184,218	$ 9,447,991	$ 9,813,523
	Option 2	$ 9,460,706	$ 9,988,074	$ 10,338,846	$ 10,742,093	$ 11,048,492	$ 11,575,860	$ 11,926,632	$ 12,329,879	$ 12,636,278	$ 13,163,646
	Option 4	$ 9,106,001	$ 9,617,923	$ 9,953,248	$ 10,341,050	$ 10,632,002	$ 11,143,923	$ 11,479,249	$ 11,867,050	$ 12,158,003	$ 12,669,924
	Option 5	$ 9,816,346	$ 10,359,467	$ 10,725,993	$ 11,144,995	$ 11,467,147	$ 12,010,269	$ 12,376,795	$ 12,795,796	$ 13,117,948	$ 13,661,070
	Option 8	$ 9,659,879	$ 10,198,349	$ 10,556,506	$ 10,968,243	$ 11,281,092	$ 11,819,562	$ 12,177,719	$ 12,589,456	$ 12,902,305	$ 13,440,775
	Option 11	$ 9,460,706	$ 9,988,074	$ 10,338,846	$ 10,742,093	$ 11,048,492	$ 11,575,860	$ 11,926,632	$ 12,329,879	$ 12,636,278	$ 13,163,646
	Option 13	$ 18,176,845	$ 18,135,508	$ 18,125,565	$ 18,106,293	$ 18,104,238	$ 18,062,901	$ 18,052,957	$ 18,033,685	$ 18,031,630	$ 17,990,293
	Total	**$ 65,680,482**	**$ 68,287,394**	**$ 70,039,004**	**$ 72,044,766**	**$ 73,581,462**	**$ 76,188,374**	**$ 77,939,984**	**$ 79,945,746**	**$ 81,482,442**	**$ 84,089,354**
Net Profit/Loss	Option 1	$ 3,544,028	$ 3,731,189	$ 3,913,385	$ 4,062,228	$ 4,214,689	$ 4,401,850	$ 4,584,046	$ 4,732,889	$ 4,885,350	$ 5,072,511
	Option 2	$ 7,252,599	$ 7,659,430	$ 7,931,938	$ 8,241,805	$ 8,478,473	$ 8,885,303	$ 9,157,811	$ 9,467,679	$ 9,704,346	$ 10,111,176
	Option 4	$ 4,919,269	$ 5,224,490	$ 5,395,389	$ 5,603,647	$ 5,738,705	$ 6,043,926	$ 6,214,825	$ 6,423,083	$ 6,558,141	$ 6,863,362
	Option 5	$ 8,749,963	$ 9,222,555	$ 9,560,826	$ 9,936,456	$ 10,238,885	$ 10,711,478	$ 11,049,749	$ 11,425,378	$ 11,727,808	$ 12,200,400
	Option 8	$ 4,106,989	$ 4,320,175	$ 4,490,344	$ 4,676,106	$ 4,837,764	$ 5,050,951	$ 5,221,119	$ 5,406,881	$ 5,568,540	$ 5,781,726
	Option 11	$ 8,184,310	$ 8,640,151	$ 8,948,645	$ 9,298,368	$ 9,567,748	$ 10,023,589	$ 10,332,083	$ 10,681,806	$ 10,951,186	$ 11,407,027
	Option 13	$ 22,988,500	$ 22,214,831	$ 21,758,720	$ 21,211,057	$ 20,837,038	$ 20,063,370	$ 19,607,258	$ 19,059,596	$ 18,685,576	$ 17,911,908
	Total	**$ 56,201,630**	**$ 57,281,633**	**$ 58,085,862**	**$ 58,967,439**	**$ 59,698,613**	**$ 60,778,616**	**$ 61,582,846**	**$ 62,464,422**	**$ 63,195,596**	**$ 64,275,600**
	Cumulative Total	$523,787,448	$581,069,081	$639,154,944	$698,122,383	$757,820,996	$818,599,612	$880,182,458	$942,646,880	$1,005,842,477	$1,070,118,076
	Net	$345,438,744	$402,720,377	$460,806,240	$519,773,679	$579,472,292	$640,250,908	$701,833,754	$764,298,176	$827,493,773	$891,769,372
Option 1	Cost	$28,047,999	$31,779,188	$35,692,573	$39,754,801	$43,969,490	$48,371,340	$52,955,386	$57,688,275	$62,573,625	$67,646,136
	Profit/Loss	$28,047,999	$31,779,188	$35,692,573	$39,754,801	$43,969,490	$48,371,340	$52,955,386	$57,688,275	$62,573,625	$67,646,136
Option 2	Cost	$59,277,849	$66,937,279	$74,869,217	$83,111,022	$91,589,495	$100,474,798	$109,632,610	$119,100,288	$128,804,634	$138,915,811
	Profit/Loss	$36,364,516	$44,023,945	$51,955,883	$60,197,689	$68,676,161	$77,561,464	$86,719,276	$96,186,954	$105,891,300	$116,002,477
Option 4	Cost	$40,516,963	$45,741,453	$51,136,842	$56,740,489	$62,479,194	$68,523,120	$74,737,945	$81,161,028	$87,719,169	$94,582,531
	Profit/Loss	-$5,372,882	-$148,392	$5,246,997	$10,850,644	$16,589,349	$22,633,275	$28,848,101	$35,271,184	$41,829,325	$48,692,687
Option 5	Cost	$71,292,182	$80,514,737	$90,075,563	$100,012,019	$110,250,904	$120,962,382	$132,012,131	$143,437,509	$155,165,316	$167,365,716
	Profit/Loss	$41,954,769	$51,177,325	$60,738,151	$70,674,606	$80,913,492	$91,624,970	$102,674,718	$114,100,096	$125,827,904	$138,028,304
Option 8	Cost	$33,008,695.33	$37,328,870.65	$41,819,214.87	$46,495,320.81	$51,333,085.29	$56,384,035.89	$61,605,155.39	$67,012,036.61	$72,580,576.37	$78,362,302.25
	Profit/Loss	-$913,847	$3,406,328	$7,896,672	$12,572,778	$17,410,543	$22,461,493	$27,682,613	$33,089,494	$38,658,034	$44,439,760
Option 11	Cost	$66,874,059	$75,514,210	$84,462,855	$93,761,223	$103,328,971	$113,352,560	$123,684,643	$134,366,449	$145,317,634	$156,724,661
	Profit/Loss	$57,137,304	$65,777,455	$74,726,100	$84,024,469	$93,592,216	$103,615,805	$113,947,888	$124,629,694	$135,580,880	$146,987,907
Option 13	Cost	$252,817,700	$275,032,531	$296,791,251	$318,002,309	$338,839,346	$358,902,716	$378,509,974	$397,569,570	$416,255,146	$434,167,054
	Profit/Loss	$216,268,884	$238,483,715	$260,242,435	$281,453,493	$302,290,531	$322,353,900	$341,961,159	$361,020,754	$379,706,330	$397,618,238

APPENDIX H

Scoring Criteria and Guidance

Assessment Criteria	Sub-Criteria	Criteria Number	Scoring Criteria (Out of Five)		Requirement	Scoring Guidance
Facility and Technology Criteria						
Speed of process (including planning, approval, and construction)		1	1	> 24 months	Lower approval and construction period	Scoring was based on the likely implementation timescales, following Council's confirmed commitment on its future direction. Options that require more time for planning, approval and construction were scored lower.
			2	19-24 months		
			3	13-18 months		
			4	6-12 months		
			5	< 6 months		
Technical complexity		2	1	Extremely complex	Simpler technology is preferrable	Complex technologies were scored lower.
			2	Complex		
			3	Neither simple nor complex		
			4	Simple		
			5	Simpler		
Management and resource complexity		3	1	High management and resources	Low management and resource are preferrable	Options that require significant management and resources, like new staffs, new sites, and time, were scored lower.
			2	Moderate to high management and resources		
			3	Moderate management and resources		
			4	Low to moderate management and resources		
			5	Low management and resources		
Total footprint - Space required to process current and future quantities, as well as storage for compost maturation		4	1	Very large additional space required	Less space is preferrable	Options that require larger new space to process current and future quantities of organics, and to store produced products were scored lower.
			2	Large additional space required		
			3	Medium additional space required		
			4	Small additional space required		
			5	No additional space required		
	Compost	5	1	No compost		
			2	< 200,000 tonnes compost		

Assessment Criteria	Sub-Criteria	Criteria Number	Scoring Criteria (Out of Five)		Requirement	Scoring Guidance
Proportion of output, for example, compost, digestate or mulch, each option produces			3	200,000-299,999 tonnes compost	Higher compost production over 20 years	Scoring was based on Section 10 estimation for the total compost production over 20 years.
			4	300,000-500,000 tonnes compost		
			5	> 500,000 tonnes compost		
	Mulch	6	1	No mulch	Higher mulch production over 20 years	Scoring was based on Section 10 estimation for the total mulch production over 20 years.
			3	1-500,000 tonnes mulch		
			5	> 500,000 tonnes mulch		
	Char	7	1	No char	Higher char production over 20 years	Scoring was based on Section 10 estimation for the total char production over 20 years.
			3	1-500,000 tonnes char		
			5	> 500,000 tonnes char		
	Electricity	8	1	No electricity	Higher electricity generation over 20 years	Scoring was based on Section 10 estimation for the total electricity generation over 20 years.
			2	1-25 GWh electricity		
			3	26-50 GWh electricity		
			4	51-100 GWh electricity		
			5	> 100 GWh electricity		
Effectiveness of technology		9	1	No new technology	Highly effective technology	This is based on the technological robustness in terms of proven and effective technology to be used for relevant organic waste management.
			2	Not effective		
			3	Neither effective nor not effective		
			4	Effective		
			5	Highly effective		
Ability to process feedstock		10	1	Very unlikely	Higher ability to process feedstock	This is based on the ability of the process to manage the type and quantity of proposed feedstock.
			2	Unlikely		
			3	Neither likely nor not likely		
			4	Likely		
			5	Highly likely		
Technological maturity		11	1	No new technology	Matured technology	This is based on the maturity of the technology to be used for the future management of available organic waste.
			2	New technology		
			3	Immature technology		
			4	Mature technology		

Assessment Criteria	Sub-Criteria	Criteria Number	Scoring Criteria (Out of Five)		Requirement	Scoring Guidance
			5	Highly mature technology		
Scalability		12	1	Not scalable	Highly scalable	Highly scalable technologies were scored higher.
			3	Scalable		
			5	Highly scalable		
Technical and General						
Feasibility and practicality of solution		13	1	Lowest feasibility and practicality	Feasible and practical solution is preferrable	This is based on the feasibility and viability of the options having new facilities.
			2	Low to moderate level of feasibility and practicality		
			3	Moderate level of feasibility and practicality		
			4	High to moderate level of feasibility and practicality		
			5	Highly feasible and practical		
Match with proposed collection methods		14	1	Highly unmatched	Highly matched	This is based on the applicability of the collected feedstock for proposed options.
			2	Unmatched		
			3	Neither matched nor unmatched		
			4	Matched		
			5	Highly matched		
Compliance with State Government waste management goals and policy objectives		15	1	Highly uncompliant	Comply with State Government waste management goals and policy objectives	Options that can reduce the quantity of organic material going to landfill between 2020 and 2030 by 50% tend to score higher as these options more directly comply with the State Government waste management goals and policy objectives.
			2	Uncompliant		
			3	Neither compliant nor uncompliant		
			4	Compliant		
			5	Highly compliant		
Availability of markets for products and use of products		16	1	No markets	Wider available markets for products to maximise use of products	Options that can produce or generate compost and electricity that can be used by ready markets were scored higher.
			3	Limited markets		
			5	Wider markets		

Assessment Criteria	Sub-Criteria	Criteria Number	Scoring Criteria (Out of Five)		Requirement	Scoring Guidance
Potential impacts on resources of participating councils		17	1	Highest potential impacts	Minimise impacts on Council Resources	Options that require significant effort and time by Council staffs such as finding new sites for facilities, and spending time for planning and approval were scored down.
			2	Moderate to high potential impacts		
			3	Moderate potential impacts		
			4	Low to moderate potential impacts		
			5	Lowest potential impacts		
Benefits from regional partnering		18	1	Significant damage	Significant benefits from regional partnership	The options developing better regional partnership by processing all organics collected from eight councils into one larger facility were scored higher.
			2	Minor damage		
			3	Neither benefit nor damage		
			4	Minor benefits		
			5	Significant benefits		
Financial						
Risks and benefits of increases in landfill levy	Landfill savings value	19	1	No landfill saving	Higher landfill savings over 20 years	Scoring was based on Section 10 estimation for the total value of landfill savings over 20 years.
			2	$1-100 million		
			3	$101-150 million		
			4	$151-200 million		
			5	> $200 million		
Net present value		20	1	< $0 million - 1	Higher NPV over 20 years	Scoring was based on results of the cost benefit analysis.
			2	$1-24 million - 2		
			3	$25-49 million - 3		
			4	$50-100 million - 4		
			5	> $100 million - 5		
Social						
Consistency with strategic directions of participating councils and GCWWRRG		21	1	Highly Inconsistent	Comply with strategic directions of participating councils and GCWWRRG	Options that result in increased resource recovery and market development, and improved infrastructure and operations tend to score higher as these options more directly comply with the strategic directions of participating councils and GCWWRRG.
			2	Inconsistent		
			3	Neither consistent nor inconsistent		
			4	Consistent		
			5	Highly consistent		
Employment opportunities		22	1	No new job opportunities		

Assessment Criteria	Sub-Criteria	Criteria Number	Scoring Criteria (Out of Five)		Requirement	Scoring Guidance
			2	1-14 new job opportunities	Increase in local employment would boost to local economy	This is based on additional permanent full-time job creations. Each option was scored based on the total new staff requirements, with higher score for higher staff numbers.
			3	15-29 new job opportunities		
			4	30-35 new job opportunities		
			5	> 35 new job opportunities		
Community acceptance and benefits		23	1	High level of public objection	High level of community support and benefit	This considers community acceptance or objection in terms of community support for the new facilities.
			2	Low level of public objection		
			3	Neither acceptance nor objection from community		
			4	Low level of community support and benefit		
			5	High level of community support and benefit		
Quality of community's living environment		24	1	Significant deterioration in quality	Enhanced improvement in quality of community's living environment	This considers social impact on quality living, due to the interdependencies of Council and its community.
			2	Minor deterioration in quality		
			3	Neither improvement nor deterioration in quality		
			4	Minor improvement in quality		
			5	Significant improvement in quality		
Environmental						
Environmental impact – dust, noise, odour, and pollution		25	1	Significant negative impact	No negative environmental impact	Options that result in more pollution or negative impact were scored lower.
			3	Minor negative impact		
			5	No negative impact		
		26	1	No derived material		Scoring was based on Section 10 estimation for the total quantity of material derived from landfill over 20 years.
			2	1-500,000 tonnes derived material		

Assessment Criteria	Sub-Criteria	Criteria Number	Scoring Criteria (Out of Five)		Requirement	Scoring Guidance
Quantity and quality of material diverted from landfill - resource reuse and recovery.			3	500,001-750,000 tonnes derived material	Higher quantity diverted materials from landfill over 20 years to maximise resource recovery	
			4	750,001-1,000,000 tonnes derived material		
			5	> 1,000,000 tonnes derived material		
Carbon impact from LCA		27	1	> 0.01 t CO_2-e per tonne of project waste per year	Lower global warming potential	Options with lower global warming potential were scored higher. Scoring were based on Section 9 estimation for life cycle assessement.
			2	0.005 to 0.01 t CO_2-e per tonne of project waste per year		
			3	-0.004 to 0.004 t CO_2-e per tonne of project waste per year		
			4	-0.005 to -0.015 t CO_2-e per tonne of project waste per year		
			5	< -0.015 t CO_2-e per tonne of project waste per year		

APPENDIX I

Organic Waste Option Scoring

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
1	5	4	3	3	4	4	4	Options that require more time for planning, approval and construction were scored down. It is expected that the options with anaerobic digestion would take more planning and construction time than the options with pyrolysis and composting facility.
2	3	4	2	2	1	4	4	Complex technologies were scored down. Option 11 was scored highest for a very simple process involved in open windrow composting facility. Compare to the open windrow composting, in-vessel composting and pyrolysis is slightly complex, hence Option 2, Option 8, and Option 13 were scored slightly lower. Option 4 and Option 5 were scored lowest for the more complicated process involved in anerobic digestion, compare to the other processes.
3	5	2	1	1	1	3	3	Options that require significant management and resources, like new staffs, new sites, and time, were scored down.
4	5	3	4	4	4	3	3	Options that require larger new space to process current and future quantities of organics, and store produced products were scored down. It is expected that the options with anaerobic digestion and pyrolysis would take less space than the options with in-vessel composting and open windrow composting facilities to process the available quantities of organics.

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
5	3	4	4	3	1	4	5	Scoring was based on the total compost production over 20 years: Option 1 - 230,706 tonnes Option 2 - 414,164 tonnes Option 4 - 399,554 tonnes Option 5 - 231,373 tonnes Option 8 - 0 tonnes Option 11 - 414,164 tonnes Option 13 - 769,500 tonnes
6	3	1	1	1	1	1	1	Scoring was based on the total mulch production over 20 years: Option 1 - 130,717 tonnes Option 2 - 0 tonnes Option 4 - 0 tonnes Option 5 - 0 tonnes Option 8 - 0 tonnes Option 11 - 0 tonnes Option 13 - 0 tonnes

Criteria Number	Option 1 Business as usual	Option 2 2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	Option 4 2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	Option 5 2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	Option 8 7 Transfer stations, 1 Pyrolysis plant (FOGO)	Option 11 2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	Option 13 7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	Commentary
7	1	1	1	1	3	1	1	Scoring was based on the total char production over 20 years: Option 1 - 0 tonnes Option 2 - 0 tonnes Option 4 - 0 tonnes Option 5 - 0 tonnes Option 8 - 92,036 tonnes Option 11 - 0 tonnes Option 13 - 0 tonnes
8	1	1	4	5	1	1	1	Scoring was based on the total electricity generation over 20 years: Option 1 - 0 GWh Option 2 - 0 GWh Option 4 - 69.99 GWh Option 5 - 173.67 GWh Option 8 - 0 GWh Option 11 - 0 GWh Option 13 - 0 GWh

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
9	1	5	4	2	2	4	5	In-vessel composting technology is a highly effective technology to process food and green organics; hence, Option 2 and Option 13 were scored highest. Open windrow composting and dry anaerobic digestion are also effective, but not as effective as in-vessel composting; hence, Option 4 and Option 11 were scored slightly lower. Option 8 with pyrolysis is an unproven technology for food organics processing, while Option 5 with wet anaerobic digestion is not an effective technology for green organics processing.
10	2	5	4	2	2	4	5	In-vessel composting has the highest ability to process organic feedstocks; hence, Option 2 and Option 13 were scored highest. Open windrow composting, dry anaerobic digestion, and pyrolysis also have the ability to process feedstock; hence, Option 4, Option 8, and Option 11 were scored slightly lower. Option 1 and Option 5 do not have any ability to process current and future quantities of food and green organics; hence, these options were scored lowest.
11	1	5	4	3	3	5	5	Composting is a proven matured technology to process both food organics and green organics (FOGO); hence, Option 2, Option 11 and Option 13 were scored highest. Compared to composting, dry anaerobic digestion and pyrolysis are unproven technologies for FOGO; hence Option 4 and Option 8 were scored slightly lower. Wet anaerobic digestion is still an immature technology for green waste processing.

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
12	1	5	3	3	3	5	5	Composting is one of the highly scalable technologies; hence, Option 2, Option 11 and Option 13 were scored highest. Anaerobic digestion and pyrolysis are also scalable but need to have additional planning and approval; hence Option 4, Option 5, and Option 8 were scored slightly lower.
13	3	5	4	2	2	5	5	Option 2, Option 11, and Option 13 seem to be highly feasible and practical solutions due to the proven composting technology using organic materials. Option 4 was scored slightly lower due to the extended process involved in dry anaerobic digestion using organics. Option 1 (business as usual) and Option 8 seem to be moderately feasible, while Option 5 seems to be least feasible to process green organics in wet anaerobic digestion.
14	3	5	4	2	2	2	5	The proposed collection methods are highly matched with Option 2 and Option 13 having large in-vessel composting facility. Option 4 and Option 8 were scored slightly lower due to the lengthy process involved in dry anaerobic digestion and pyrolysis. Option 5 and Option 11 were scored lowest due to the collection of green organics for wet anaerobic digestion facility and food organics for open windrow composting facility which are not the proper feedstocks for the facilities. Option 1 would not require matching with the proposed collection system.

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
15	2	5	5	5	4	4	5	Options 2, 4, 5 and 13 were scored highest, as these appear to comply with the State Government waste management goals and policy objectives to halve the quantity of organic material going to landfill between 2020 and 2030. Although Option 8 and Option 11 meet waste management goals for increased diversion, these were scored slightly lower as there are some public health and environmental risks associated with emission from pyrolysis, and odour and leachate issues from open windrow composting using food waste. Option 1 (business as usual) was scored lowest because it does not fit with State Government goals for waste diversion.
16	3	5	5	5	3	5	5	Options that can produce or generate compost and electricity that can be used by ready markets were scored higher.
17	5	4	2	2	2	3	4	Options that require significant effort and time by Council staffs such as finding new sites for facilities, and spending time for planning and approval were scored down.
18	3	4	4	4	5	4	5	Option 2, Option 4, Option 5 and Option 11 were scored high for developing regional partnership to receive benefits. Option 8 and Option 13 were scored highest for developing better regional partnership due to process all organics (residual and green), collected from eight councils, into one larger facility. Option 1 was scored lowest, as there is no regional partnership in business as usual.

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
19	3	4	4	4	4	4	5	Scoring was based on the total value of landfill savings over 20 years: Option 1 - $133.7 million Option 2 - $181.2 million Option 4 - $174.5 million Option 5 - $188.0 million Option 8 - $185.0 million Option 11 - $181.2 million Option 13 - $345.1 million
20	3	3	2	4	2	4	5	Scoring were based on total expected NPV over 20 years: Option 1: $31.2 million Option 2: $43.4 million Option 4: $1.3 million Option 5: $50.6 million Option 8: $4.6 million Option 11: $64.0 million Option 13: $196.8 million

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
21	2	5	5	5	2	2	5	Options that result in increased resource recovery and market development, and improved infrastructure and operations tend to score higher as these options more directly comply with the strategic directions of participating councils and GCWWRRG. Option 2, Option 4, Option 5, and Option 13 were scored highest, as these options appear to comply directly with the strategic directions of participating councils and GCWWRRG. Option 1, Option 8 and Option 11 were scored lowest because the business as usual case do not fit with strategic directions for waste management and resource recovery infrastructure, and pyrolysis and open windrow composting have some public health and environmental risks due to emission, odour and leachate issues.
22	1	4	5	5	3	3	3	Each option was scored based on the total new staff requirements, with higher score was for higher staff numbers. Considering 2 new staffs for each transfer station, 5 staffs for each small open windrow composting (OWC), 6 staffs for each small in-vessel composting (IVC), 8 staffs for large open windrow composting (OWC), 10 staffs for large in-vessel composting (IVC), 10 staffs for pyrolysis and 15 staffs for anaerobic digestion (AD), the total number of required staffs for Option 1, Option 2, Option 4, Option 5, Option 8, Option 11 and Option 13 were 0, 32, 37, 37, 24, 27 and 24 respectively.

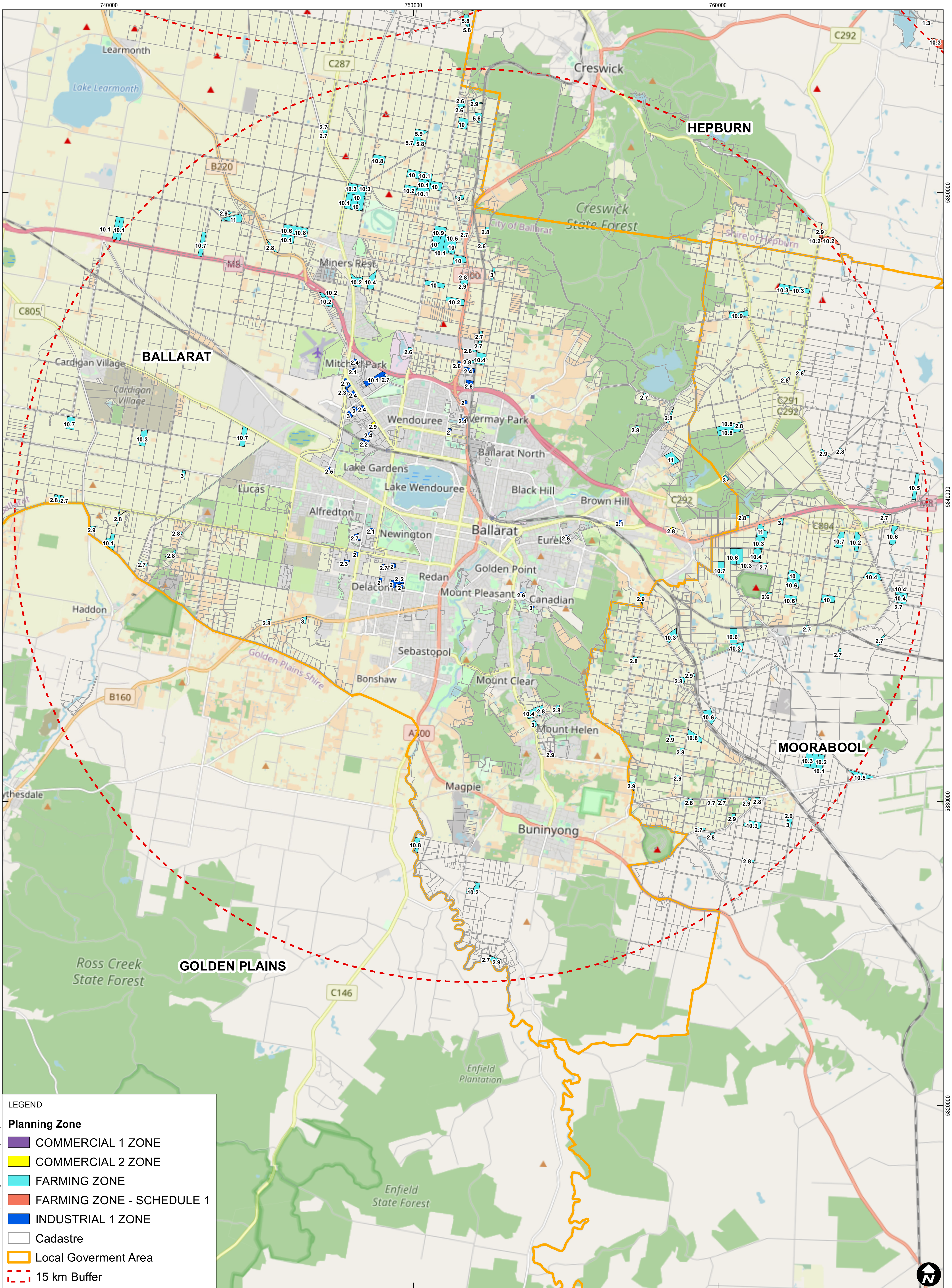
Criteria Number	Option 1 Business as usual	Option 2 2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	Option 4 2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	Option 5 2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	Option 8 7 Transfer stations, 1 Pyrolysis plant (FOGO)	Option 11 2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	Option 13 7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	Commentary
23	2	5	4	4	2	2	5	Option 2 and Option 13 were scored highest due to the possibility of high level of acceptance for large in-vessel composting facilities by the community, followed by Option 4 and Option 5 due to the possibility of low level of acceptance for anaerobic digestion. Option 8 and Option 11 were scored lowest due to the possibility of low level of public objection for either emission from pyrolysis or odour and leachate generation from open windrow composting for food waste processing.
24	3	5	5	5	2	2	5	All new options (including Option 2, Option 4, Option 5, and Option 13) were scored highest due to their significant contribution on quality improvement, except Option 8 and Option 11 which might have minor deterioration in quality of community's living environment.
25	3	5	5	5	3	1	5	Options that result in more pollution or negative impact were scored lower. Option 11 was scored lowest due to the negative impact of odour and leachate generated from open windrow composting associated with food waste processing. Option 8 also might have some potential emission from pyrolysis plant. Options 2, 4, 5 and 13 were scored highest, as no negative impact was expected from these options.

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
26	3	4	4	4	4	4	5	Scoring was based on the total material diverted from landfill over 20 years: Option 1: 643,282 tonnes Option 2: 823,453 tonnes Option 4 : 794,043 tonnes Option 5: 854,906 tonnes Option 8: 840,788 tonnes Option 11: 823,453 tonnes Option 13: 1,624,500 tonnes
27	1	3	4	4	5	2	3	Scoring were based on the life cycle assessement results: Option 1: 0.012 t CO2-e per tonne of project waste per year Option 2: 0.0002 t CO2-e per tonne of project waste per year Option 4: -0.007 t CO2-e per tonne of project waste per year Option 5: -0.0133 t CO2-e per tonne of project waste per year Option 8: -0.0193 t CO2-e per tonne of project waste per year Option 11: 0.0061 t CO2-e per tonne of project waste per year Option 13: 0.0005 t CO2-e per tonne of project waste per year
Weighted Score	2.41	3.48	3.10	3.20	2.38	3.14	4.02	Total weightings determined by multiplying the criteria weighting provided in Table 46 with the criteria score, to enable an indicative comparison among different options.

Criteria Number	Option 1	Option 2	Option 4	Option 5	Option 8	Option 11	Option 13	Commentary
	Business as usual	2 Transfer stations, 3 Small IVCs, 1 Large IVC (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Dry AD (FOGO)	2 Transfer stations, 3 Small IVCs, 1 Wet AD (FOGO plus biosolids)	7 Transfer stations, 1 Pyrolysis plant (FOGO)	2 Transfer stations, 3 Small OWCs, 1 Large OWC (FOGO)	7 Transfer stations, 1 Large IVC (FOGO plus commercial organics)	
Rank	6	2	5	3	7	4	1	Ranking based on total weighting

APPENDIX J

Site Identification Maps



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Date Drawn: 21-Apr-2022
Project Number: 610.30578

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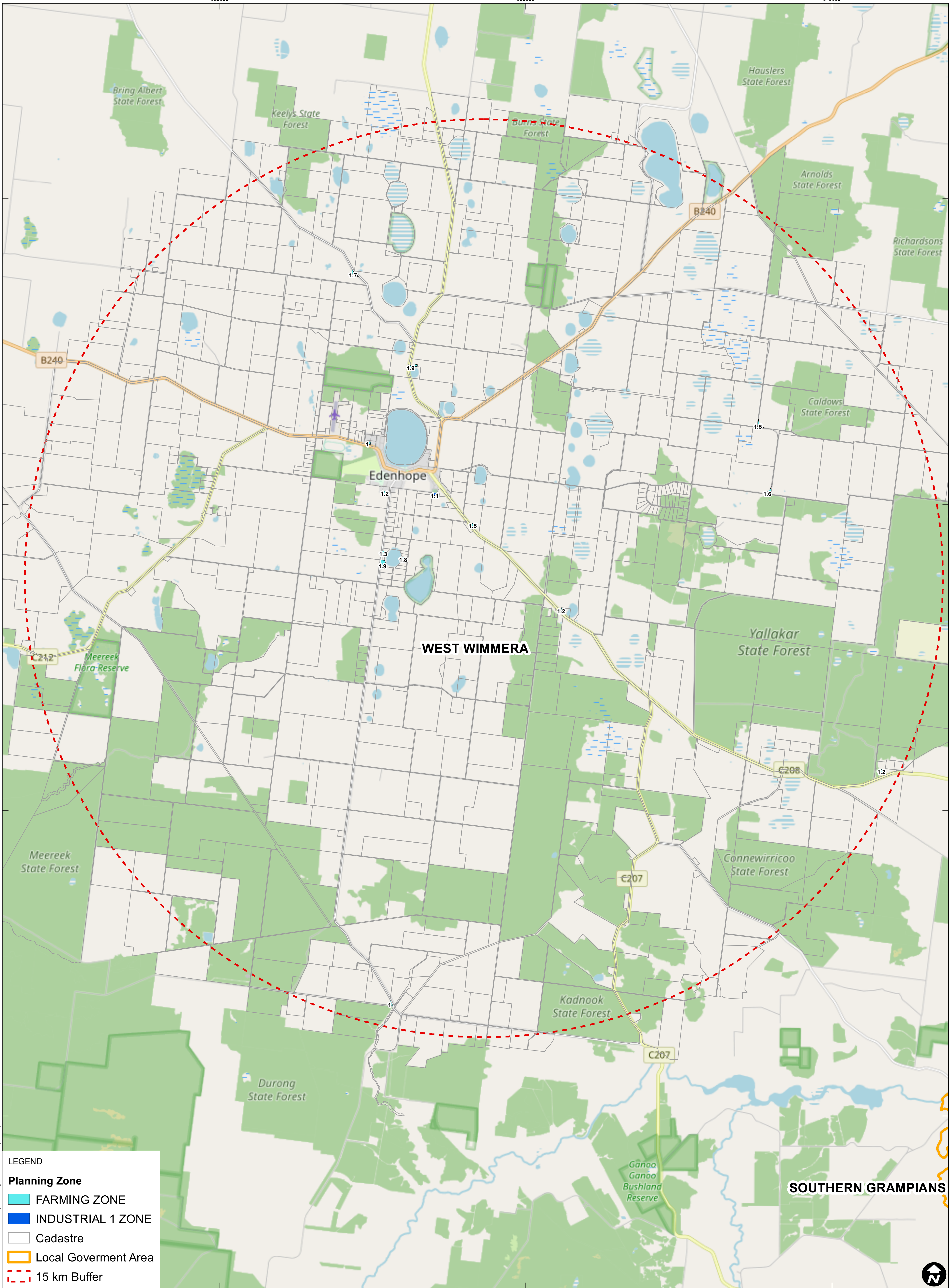
Ballarat Sites



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Date Drawn: 21-Apr-2022
Project Number: 610.30578

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West Wimmera Sites

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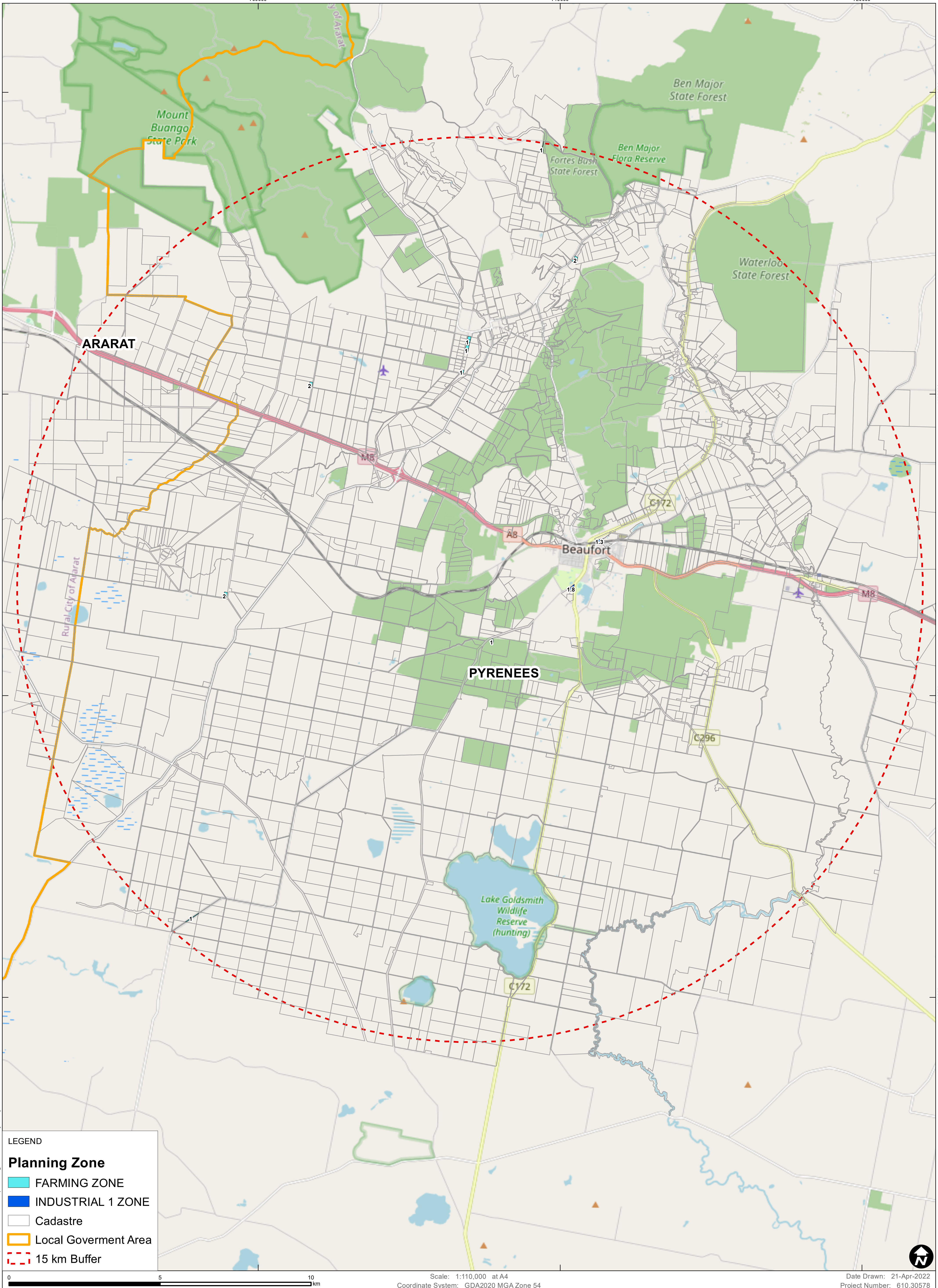

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Project Number: 610.30578

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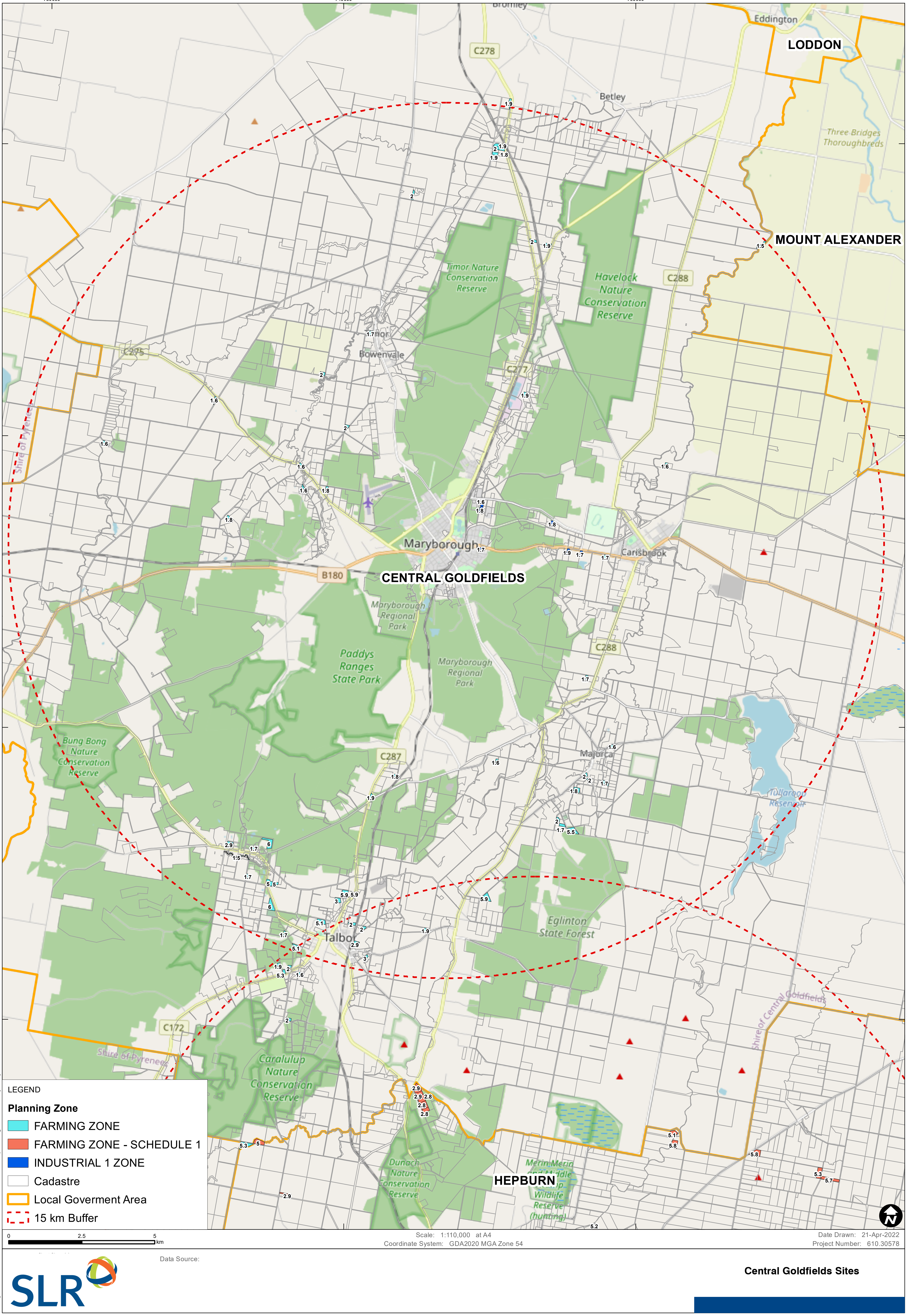

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LODDON
MOUNT ALEXANDER
CENTRAL GOLDFIELDS
HEPBURN
Shire of Pyrenees
Shire of Central Goldfields
Maryborough
Carisbrook
Talbot
Majorca
Betley
Eddington
Bowenvale
Timor Nature Conservation Reserve
Havelock Nature Conservation Reserve
Maryborough Regional Park
Paddys Ranges State Park
Bung Bong Nature Conservation Reserve
Eglinton State Forest
Caralulup Nature Conservation Reserve
Dunach Nature Conservation Reserve
Merin Merin and Middle Swamp Wildlife Reserve (hunting)
Tullaroop Reservoir
Three Bridges Thoroughbreds
C278
C288
C277
C275
C287
C172
B180
LEGEND
Planning Zone
FARMING ZONE
FARMING ZONE - SCHEDULE 1
INDUSTRIAL 1 ZONE
Cadastre
Local Goverment Area
15 km Buffer
0
2.5
5
km
Scale: 1:110,000 at A4
Coordinate System: GDA2020 MGA Zone 54
Date Drawn: 21-Apr-2022
Project Number: 610.30578
Data Source:
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Central Goldfields Sites
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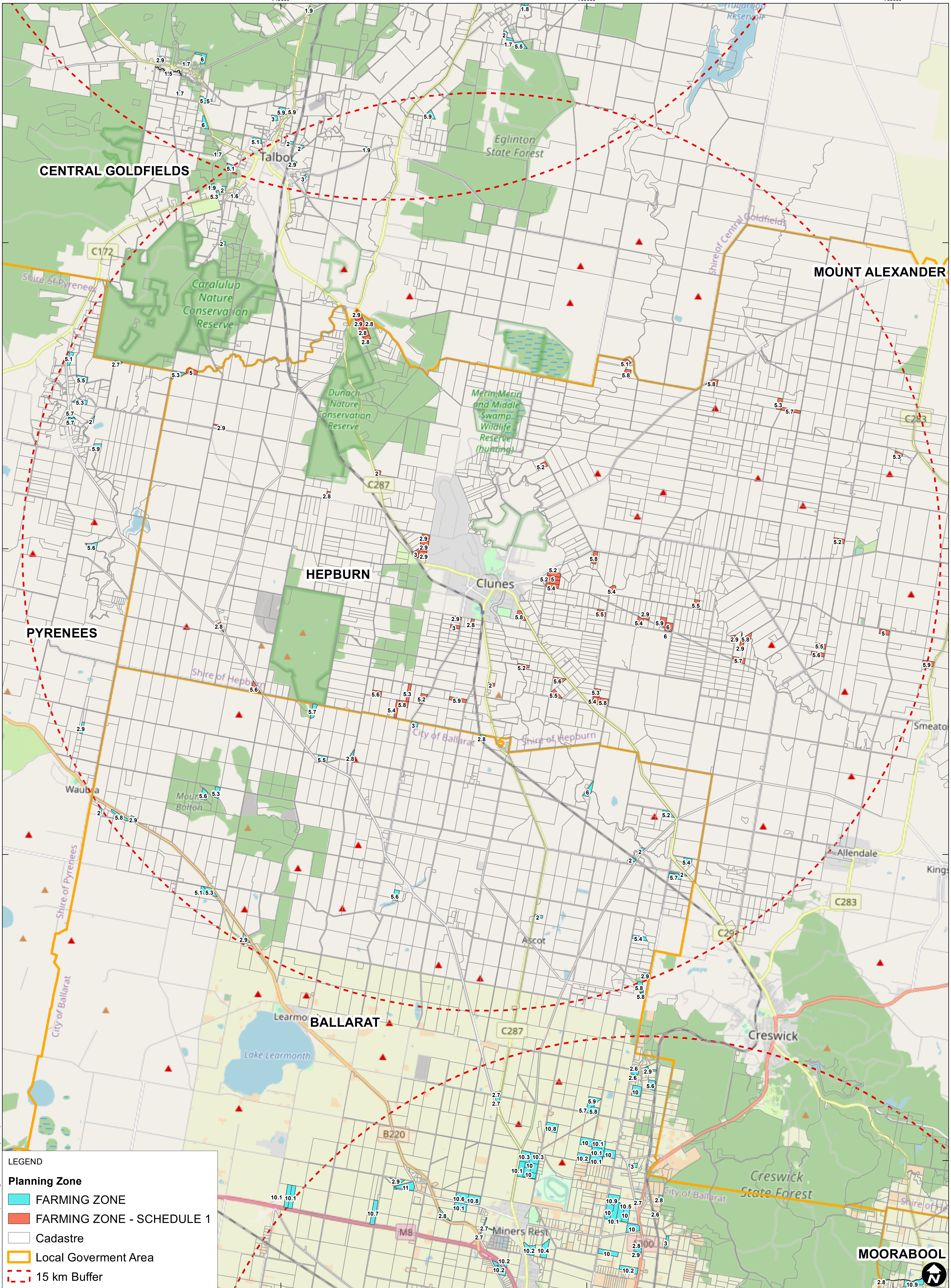

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Date Drawn: 21-Apr-2022
Project Number: 610.30578

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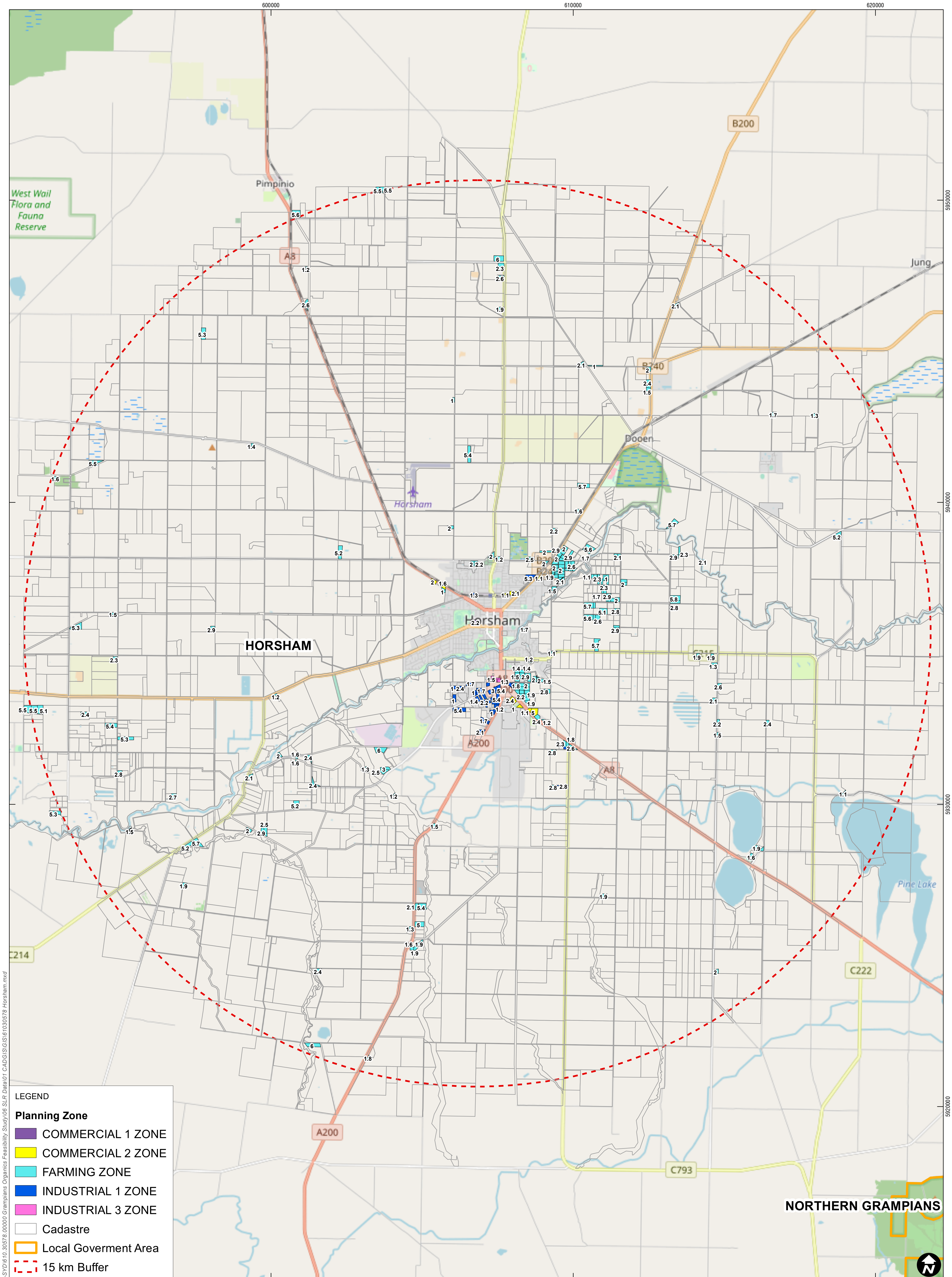
SLR

Data Source:

Clunes Sites



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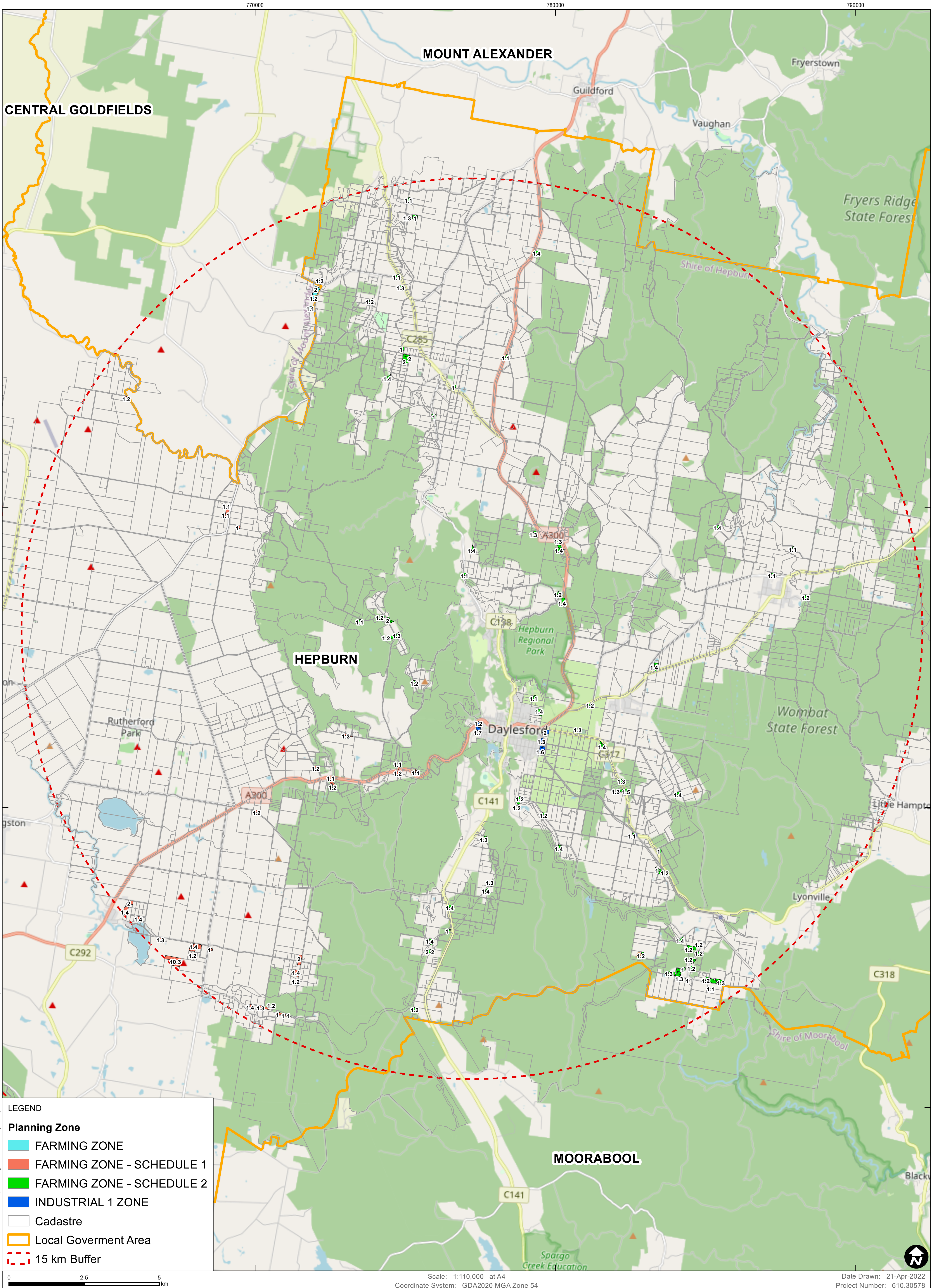
Coordinate System: GDA2020 MGA Zone 54

Date Drawn: 21-Apr-2022
Project Number: 610.30578

Data Source:

SLR

Horsham Sites



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Date Drawn: 21-Apr-2022
Project Number: 610.30578

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SLR

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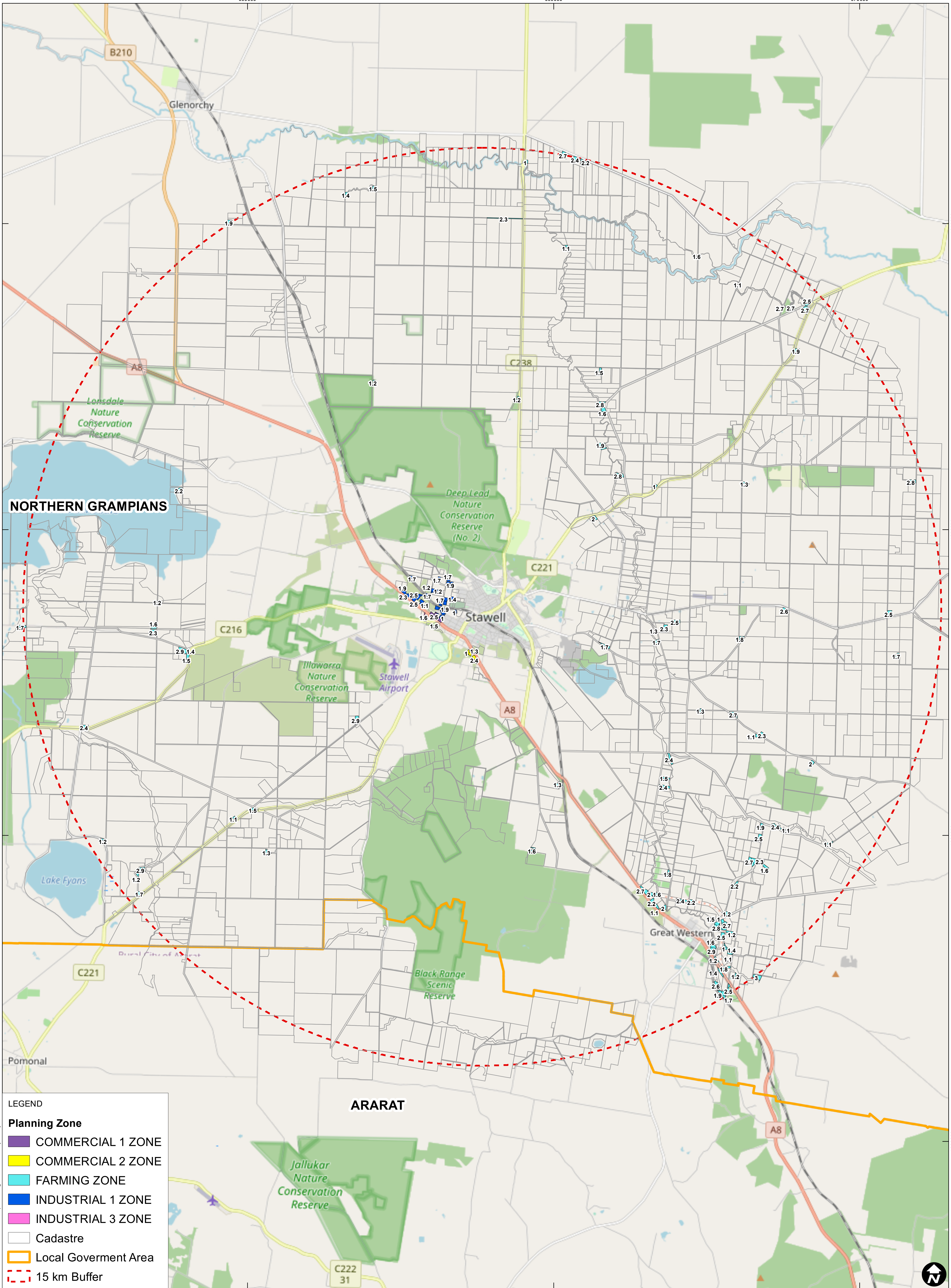
Hepburn Sites



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Date Drawn: 21-Apr-2022
Project Number: 610.30578

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SLR

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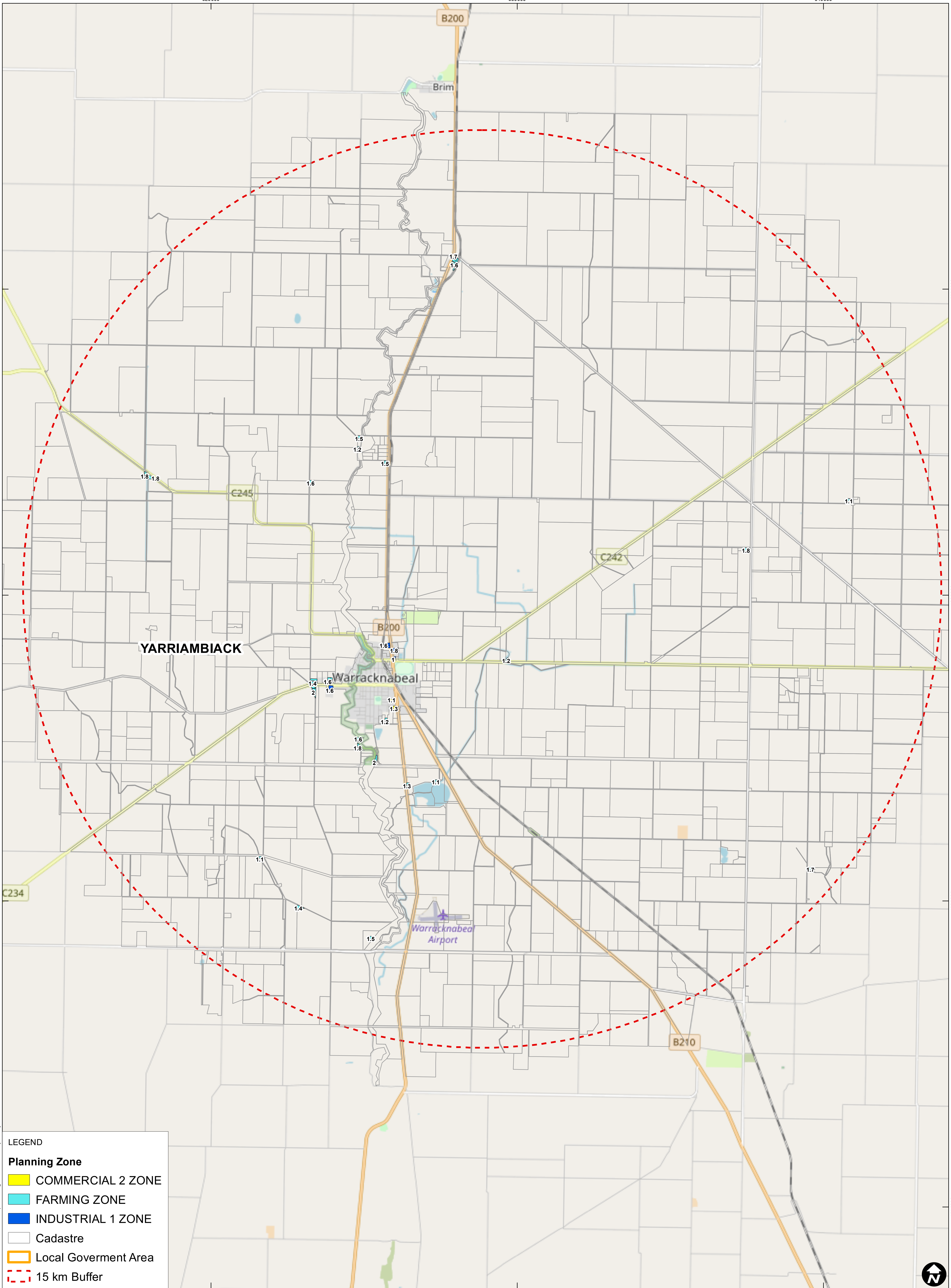

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Project Number: 610.30578

Data Source:

Warracknabeal Sites

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