Gladstone Regional Council

Waste Management and Resource Recovery Strategy

Final Report

November 2019

Executive summary

Introduction

GHD Pty Ltd (GHD) was commissioned by Gladstone Regional Council (GRC) to develop a Waste Management and Resource Recovery Strategy for the region that aligns with the objectives of both the *Queensland Waste Management and Resource Recovery Strategy 2019* and Gladstone Regional Council's *Corporate Plan 2018-2023*. This Strategy is based upon the principles of the waste and resource management hierarchy and signals that Gladstone Regional Council consider waste as a resource. It has a primary focus on infrastructure and service opportunities and challenges for the existing waste streams. Council intends that the priorities identified in this strategy will be implemented over a 10 year period. The priorities will be reviewed from time to time and updated and adapted as required in response.

Situational analysis

A situational analysis of the region was undertaken to review current waste generation data and trends, recovery rates and existing waste management infrastructure and services. On the basis of the available data, approximately 13,000 tonnes of Commercial and Industrial (C&I) waste, 5,900 tonnes of Construction and Demolition (C&D) waste and 38,000 tonnes of Municipal Solid Waste (MSW) were handled by Gladstone Regional Council in 2017/2018. Approximately 29,000 tonnes of this waste was disposed of at the Benaraby Regional Landfill. It is important to note that this data does not account for commercial and industrial wastes that are not collected by GRC or disposed of at Council facilities.

It was identified that while GRC already undertake a number of resource recovery activities, a significant volume of material is disposed to landfill each year. In addition, there is a considerable amount of C&I and C&D waste generated within the region that is not handled by Council. The volume of these waste streams cannot currently be quantified.

Regional collaboration

A number of larger industrial waste generators were consulted by GHD in an attempt to gain an understanding into their current waste generation, management and the opportunity for collaboration with GRC for future waste infrastructure and services. This identified that private waste management contractors typically handle waste generated at these industrial facilities, with general waste likely being transported to South East Queensland (SEQ), and a mix of localised recycling arrangements and transport of recyclables to SEQ. While the types of industry prevalent in the region produce relatively minor organic waste when compared to other regions, collaboration options do exist and would be worth further exploring.

Other Councils in the Fitzroy region were also consulted to further develop an understanding of regional waste services and infrastructure, waste generation and flows in and out of the region. This included contact with Livingstone Shire Council, Isaac Regional Council, Banana Shire Council, Central Highlands Regional Council and Rockhampton Regional Council. From the waste data available, it was concluded that Rockhampton Regional Council was the largest domestic waste generator in the region followed by Gladstone Regional Council. The opportunity for collaboration on waste management was welcomed by Central Highlands Regional Council and Livingstone Shire Council however, the small quantities of waste and available resources are to be considered when assessing the potential for regional collaboration and new infrastructure planning.

Waste processing technology

A range of waste processing infrastructure options were reviewed to assist in achieving the GRC's strategic corporate objectives for waste management. The options assessed focused primarily on thermal Energy from Waste (EfW) and biological treatment technologies. When considering the role of EfW in the Gladstone region it is important to consider the relevant policy framework, funding opportunities, community support and feedstock options. EfW facilities are only appropriate for materials in the waste stream that cannot be beneficially reused or recycled (residual waste). They are a legitimate waste recovery solution however are only one step higher than landfill disposal of the waste and resource management hierarchy, which is ranked at the bottom.

The potential biological and thermal technologies initially considered for waste management in Gladstone were:

- Open windrow composting
- In-vessel composting
- Anaerobic digestion (dry)
- Anaerobic digestion (wet)
- Direct combustion
- Gasification
- Pyrolysis
- Hydrothermal liquefaction (HTL)
- Mechanical Biological Treatment (MBT)

For the purpose of the assessment a nominal feedstock of 50,000 tonnes per annum was assumed for each technology. Noting though, that for thermal treatment technologies, this is substantially lower than typically targeted feedstock volumes to prove a project financially viable. However it was chosen as it was closer to potential feedstock volumes available in the Gladstone region. Therefore all scoring and ranking of thermal technologies must be considered in this context.

Multi Criteria Analysis

Based on the constraints, opportunities, maturity and applicability to the Gladstone region, five technologies from the considered technologies were chosen for further assessment in the Gladstone region via a Multi Criteria Analysis (MCA). The technologies subject to a MCA were:

- In-vessel composting
- Anaerobic digestion (wet)
- Anaerobic digestion (dry)
- Direct combustion
- Gasification

The MCA was developed by GHD with consultation from GRC and stakeholders, and assessed the technology against the following categories:

- Financial performance – 40%
- Technical performance – 25%
- Social and environmental – 20%

- Risk/Uncertainty – 15%

Each category was broken down into relevant criteria, with each assigned different weightings. The criteria and weightings were discussed with a Council stakeholder group prior to assessment. Each technology was assessed against the defined criteria using a 5 point scoring system. A higher score represented a more favourable assessment and/or alignment with the overall objectives of the waste strategy and technology suitability.

In-vessel composting received the highest overall score and therefore was ranked the most suitable potential waste infrastructure technology in the Gladstone region. In-vessel composting is a lower cost treatment option compared to other technologies with a viable market demand for the end product, compost. There is believed to be a reliable supply of the feedstock, food and garden organics (FOGO), as a result of the predicted increase in population.

Multiple examples in regional New South Wales and Victoria exist where in-vessel composting of food and garden organics has been led by the local government as asset owner, in varying delivery models. Currently in Queensland, it has been more common for composting facilities to be run as a merchant (private) facility, where local government negotiate a fee for the acceptance of feedstock.

Direct combustion ranked the second highest however this thermal treatment option requires significant capital investment and is highly unlikely to be scalable at an economic level for the volumes of feedstock available in Gladstone and surrounding regions. At this juncture it is not considered a viable option for Gladstone within the planning timeframe.

Dry anaerobic digestion and wet anaerobic digestion ranked third and fourth, respectively, with both technologies scoring very similar in all categories. Anaerobic digestion has a relatively lower capital investment and operating costs compared to thermal treatment options and is more readily scalable at this point in time. Based on the current market and policy situation, the progression of a wet or dry anaerobic digestion option for Gladstone could become viable in a future scenario.

Gasification was ranked the lowest overall score of all technologies evaluated in the MCA. The technology is a complex process with limited commercial examples operating in Australia, and that requires highly specialised staff for operation, relatively high capital investment and high operating costs. As for direct combustion, gasification is not considered a viable option for Gladstone within the next 5 – 10 years.

Strategy priorities

From the issues and opportunities identified in the situational analysis, key priority areas emerged that provided a framework for the Gladstone Regional Council Waste Management and Resource Recovery Strategy. The priorities and their objectives align with the different aspects of the waste hierarchy and are summarised below.

Priority	Objective
Priority 1 – Waste education	Reduce household waste generation and litter and illegal dumping in the region Build community support for any changes to waste management services and infrastructure
Priority 2 – Reuse of recovered material in local projects	Amend GRC procurement process to drive resource recovery and reuse of recovered material in the region Ensure that GRC takes a leadership role in supporting the development of markets for recycled and recovered materials

Priority	Objective
Priority 3 – Landfill diversion through recycling	Increase recycling recovery rates from all waste streams
Priority 4 – Optimisation of existing infrastructure	Optimise GRC waste services and infrastructure to support efficient waste management
Priority 5 – Organics processing infrastructure	Develop a plan to drive the reduction in organics disposed to landfill, aligned to GRC and State government targets
Priority 6 – Regional collaboration	Explore waste management opportunities at a regional level
Priority 7 – Data collection and management	Standardise waste data collection

Key priorities

On the basis of the analysis conducted at this point in time, it is not considered viable to proceed with detailed planning for new waste management infrastructure. Until such time that the Queensland Government publishes the 30 year Waste and Resource Recovery Infrastructure Plan and its Energy from Waste Policy, both due by the end of 2019, considerable uncertainty remains for a regional council such as Gladstone to proceed with planning. That being said, it is recommend that the key priorities for Gladstone Regional Council for waste management and resource recovery are to focus on organics recycling and diversion of organics from landfill, together with actions to reduce contamination in recycling and adapt Council activities to drive the uptake of recycled content. Specific recommendations to support these priorities are summarised below:

- Explore the introduction of a three bin system for food and garden organics (FOGO), or each stream individually. This will include changes to collection service contracts, delivery models for collection and processing, and consideration of market approach, which may include:
  - Interim use of local operators for composting of organics from Gladstone region
  - Development of a business case for Council to lead the development of in-vessel composting (either individually or in collaboration with other regional partners)
  - Longer term consideration of other technologies for source separated organics at a regional level such as anaerobic digestion with biogas recovery, electricity generation, compost production, and appropriate end use for digestate.
- Appointment of a waste and recycling education officer to drive programs to reduce litter and contamination of recyclables, and also to develop an appropriate program to engage with the community and build community support for changes in waste and recyclables collections and processing.
- Once the EfW Policy and Waste and Resource Recovery Infrastructure Plan are released, these documents are to be reviewed to inform a realistic pathway forward for Gladstone, considering a Central Queensland regional approach.
- Explore market led opportunities for dry residual waste unable to be recycled, to be utilised for waste to fuel production facilities (i.e. waste derived fuels).
- Improve data collection to inform decision making, noting that this will in large be driven by the State Government.
- Play a lead role in supporting local market development for recycled content and local reuse, as a result of the Commonwealth's decision to ban waste exports.

- Identify opportunities for Council to drive change in procurement and specification processes in relation to the use of goods and products containing recycled and recyclable content.

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Appendix B – Gladstone Regional Council Waste Data
Appendix C – EfW Technology Information
Appendix D – Multi Criteria Analysis

Abbreviations

AD	Anaerobic digestion
C&D	Construction and demolition
C&I	Commercial and industrial
DES	Department of Environment and Science
EfW	Energy from waste
FOGO	Food organics and garden organics
GPC	Gladstone Ports Corporation
GRC	Gladstone Regional Council
HTL	Hydrothermal liquefaction
IVC	In-vessel composting
LFG	Landfill gas
LGAQ	Local Government Association of Queensland
MBT	Mechanical biological treatment
MCA	Multi Criteria analysis
MRF	Material recovery facility
MSW	Municipal Solid Waste
PEF	Process Engineered Fuel
QAL	Queensland Alumina Limited
QTC	Queensland Treasury Corporation
RDF	Refuse derived fuel
RRIDP	Resource Recovery Industry Development Program (RRIDP)
SRF	Solid recovered Fuel
WWTP	Wastewater treatment plant

1. Introduction

1.1 Background

GHD Pty Ltd (GHD) was commissioned by Gladstone Regional Council (GRC) to develop a Waste Management and Resource Recovery Strategy (Strategy) for the region that aligns with the objectives of both the *Queensland Waste Management and Resource Recovery Strategy 2019* and Gladstone Regional Council's *Corporate Plan 2018-2023* (GRC, 2018).

The development of the Strategy required a situational analysis of the Gladstone region and surrounds, a review of existing infrastructure in the region, constraints and opportunities for waste management, an options assessment and development of recommendations, and a 10 year implementation plan to assist council in achieving the strategies goals and objectives.

1.2 Objectives

GRC is dedicated to maximising and improving its recycling and resource recovery rates for the Gladstone Region. With the Council's commitment to minimise the amount of waste disposed to landfill, as well as the recent commencement of the State's waste levy, a comprehensive Waste Management and Resource Recovery Strategy presents significant benefits to the region.

The desire to target zero waste to landfill, increased recycling and reduced CO_2 emissions are three key elements of Gladstone Regional Council's *Corporate Plan 2018-2023* (GRC, 2018) and frame the principal objectives for Gladstone's Waste Management and Resource Recovery Strategy. This is consistent with the *Queensland Waste Management and Resource Recovery Strategy* and the State's latest publication of the waste hierarchy for Queensland.

The Gladstone Waste Management and Resource Recovery Strategy therefore seeks to develop a realistic pathway to a zero waste to landfill future, based on the principles of the waste hierarchy with a particular focus on infrastructure and services for the existing waste streams as outlined in the RFQ. Council intends that the priorities identified in this strategy will be implemented over a 10 year period. The priorities will be reviewed from time to time and updated and adapted as required in response.

1.3 Scope

The key elements of the strategy development included:

- Summary of the situational analysis conducted by GHD and presented in the *GRC Waste Strategy Phase 1 and 2 Interim Report (*GHD, 2019), which should be read in conjunction with this report.
- Options review and assessment for potential Energy from Waste (EfW) thermal or biological processing infrastructure.
- Consultation with local government and industries in the region investigating potential collaboration in future waste management and infrastructure.
- Recommendations and key actions in the form of priorities, based on the key issues and opportunities identified in the situational analysis.
- 10 year implementation plan for the key actions of each priority.

1.4 Purpose of this report

The purpose of this report is to define the Gladstone Regional Council Waste Management and Resource Recovery Strategy and its objectives and actions. The report documents the

development of the coordinated plan which considered a regional approach based on the waste hierarchy.

The report also includes a summary of waste data for the region and the issues and opportunities identified in the Interim Report (GHD, 2019).

This strategy report aims to provide recommendations and key objectives of an implementation plan for actions required to realise the waste management and resource recovery opportunities in the region, and overcome challenges, issues and constraints.

1.5 Limitations

This report has been prepared by GHD for Gladstone Regional Council and may only be used and relied on by Gladstone Regional Council for the purpose agreed between GHD and the Gladstone Regional Council as set out in this report.

GHD otherwise disclaims responsibility to any person other than Gladstone Regional Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Gladstone Regional Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.6 Assumptions

This report relies upon information accessed from public sources and/or provided by Gladstone Regional Council. It is assumed that the information supplied is true and accurate to the best of GHD's knowledge. Where Council did not provide information to GHD, only a limited analysis and conclusions could be provided in the report.

2. Strategic drivers for waste management

The Australian Government is responsible for national legislation, strategy and policy frameworks for waste however, the management of waste lies primarily with States and Territories. It is the responsibility of state and territory governments to regulate and manage waste in accordance with respective state legislation, policies and programs. Local governments are mainly responsible for the provision of household waste collection and recycling services, managing operational landfill sites and transfer stations and promoting awareness and education.

Detailed discussion of strategic drivers including national, state and local strategic framework, regulations and legislations is included in the *GRC Waste Strategy Phase 1 & 2 Interim Report* (GHD, 2019). The following section provides a summary of the key strategic drivers for the GRC Waste Management and Resource Recovery Strategy.

2.1 National Waste Policy

Australia's *National Waste Policy 2018* provides a nationally recognised framework for action by governments, businesses, waste and resource recovery industries, and communities to achieve sustainable waste management. The policy identifies the following five principles that underpin waste management, recycling and resource recovery in a circular economy. These include:

1. Avoid waste
2. Improve resource recovery
3. Increase use of recycled material, and build demand and market for recycled products
4. Better manage material flows to benefit human health, the environment and the economy
5. Improve information to support innovation, guide investment and enable informed consumer decisions

The Commonwealth together with state and territory governments are currently working to develop a roadmap to define the required actions to support behaviour and system changes associated with the key policy principles. It is expected that by December 2019 this roadmap will be available.

2.2 Queensland Waste Management and Resource Recovery Strategy

At a state level the Queensland *Waste Management and Resource Recovery Strategy 2019* (QLD Waste Strategy) presents a strategic plan for improved management of Queensland's waste. The QLD Waste Strategy seeks to provide benefits through economic growth, increasing the amount of material recovered and increasing the value of those recovered materials. It is supported by the recent levy applied to all waste disposed to landfill in Queensland. The QLD Waste Strategy is based upon the principles of the waste hierarchy which is enshrined in the *Waste Reduction and Recycling Act 2011*, as depicted in Figure 2-1 below.

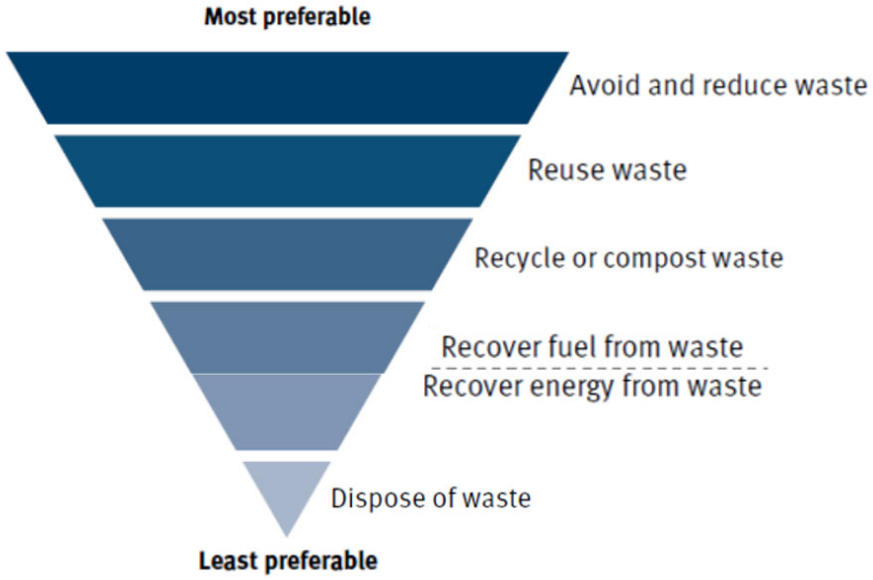

Figure 2-1 Waste and resource management hierarchy (Source: Qld Government, 2019)

The three strategic priorities defined in the QLD Waste Strategy are aimed at driving a fundamental shift in how Queensland manages waste and to support the transition to a zero-waste society. The strategic priorities and actions for local governments are included in Table 2-1.

Table 2-1 QLD Waste Strategy strategic priorities and actions for local government

Strategic Priority	Actions for local government
1. Reducing the impact of waste on the environment	• Support and contribute to targets and actions under Litter and Illegal Dumping: A plan for Queensland[1] • Deliver litter and illegal dumping interventions within local communities and at targeted hot spots • Support delivery of waste education through existing networks • Improve of close redundant landfill facilities
2. Transitioning to a circular economy for waste	• Optimise waste collection services • Improve community understanding about recycling and waste avoidance • Develop consistent messaging in delivery of services between councils
3. Building economic opportunity	• Collaborate with state government planning on provisions to optimise land use and transport planning • Take a regional approach to infrastructure planning and collaboration

Strategic Priority	Actions for local government
	• Collaborate across councils to create economies of scale and meet multiple infrastructure needs • Invest in improved infrastructure and standards for council run facilities • Rationalise waste facilities

Notes:

1. The development of the Litter and Illegal Dumping: A plan for Queensland is listed as a government action.

2.3 Queensland Resource Recovery Industries 10 Year Roadmap and Action Plan

The *Queensland Resource Recovery Industries 10 Year Roadmap and Action Plan* (Draft for Discussion, April 2019) (Roadmap) is a key action plan under the QLD Waste Strategy. The Roadmap sets out a plan to support industry growth and job creation in resource recovery industries, over the next 10 years. The Roadmap provides an overview of the plan to enhance the resource recovery sector and support new technologies.

2.4 Gladstone Regional Council Corporate Plan 2018-2023

Gladstone Regional Council's *Corporate Plan 2018-2023* has a stated vision to "Connect, Innovate, Diversify". The plan includes a strategic goal (strategy goal 2) for "Healthy, environment, healthy community". The key elements of this goal relating to waste management and resource recovery are summarised in Table 2-2 below.

Table 2-2 GRC Corporate Plan 2018-2023

Element	Description
Commitment	• Take a leadership role in protecting the environment, using resources efficiently and improving the health and safety of the community
2023 Targets	• Reduced reliance on non-renewable energy • Waste management plans in place to decrease reliance on landfills
Key activities	• ***Target zero waste to landfills*** • Minimise our environmental impact, focus on becoming an energy neutral council
Key performance indicators 2023	• 20% reduction in CO_2 emissions compared to 2018/2019 baseline • 30% reduction in fossil fuel reliant energy consumption compared with 2017/2018 baseline • ***20% increase in waste recycling rate compared with 2017/2018 baseline***

3. Current position

A detailed description of current waste generation, recovery rates and existing waste management infrastructure and services was provided in the *GRC Waste Strategy Phase 1 & 2 Interim Report* (GHD, 2019). Constraints and opportunities for GRC's waste infrastructure and services were developed from this as the basis for considering strategic options. This section summarises the situational analysis.

3.1 Gladstone region population and demographics

The Gladstone region is located in Central Queensland, approximately 100 km south-east of Rockhampton. The region covers 10,500 square kilometres and is an industrial hub that also incorporates residential and rural-residential areas. The key employment sectors in the region are manufacturing, construction, retail trade, education, accommodation and food services, and health care.

Population data from the Queensland Government *Local government areas snapshot* (QGSO, 2015), indicates there was an estimated residential population of 63,000 in 2016.

QGSO population projections to 2041 are presented in Figure 3-1, illustrating that in the high growth scenario there would be an estimated population of 83,000 compared to 67,000 in the low growth scenario.

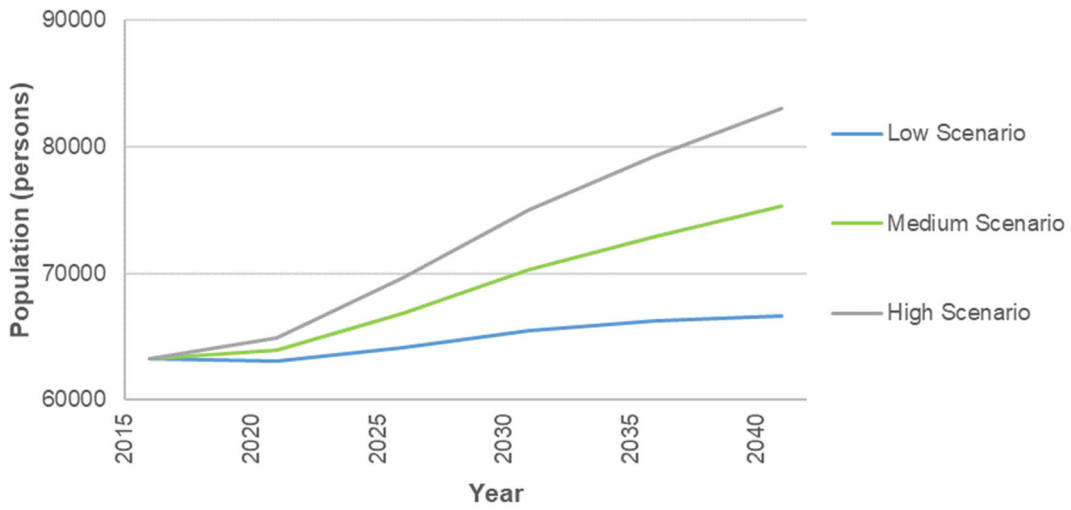

Figure 3-1 Gladstone population projections

3.2 Waste generation

It is useful to consider waste generation by three major headline waste streams: Commercial and Industrial (C&I), Construction and Demolition (C&D) and Municipal Solid Waste (MSW). According to data provided by GRC, in 2017/2018 approximately 13,000 tonnes of C&I waste, 5,900 tonnes of C&D waste and 38,000 tonnes of MSW were generated in the Gladstone region, as depicted in Figure 3-2 below.

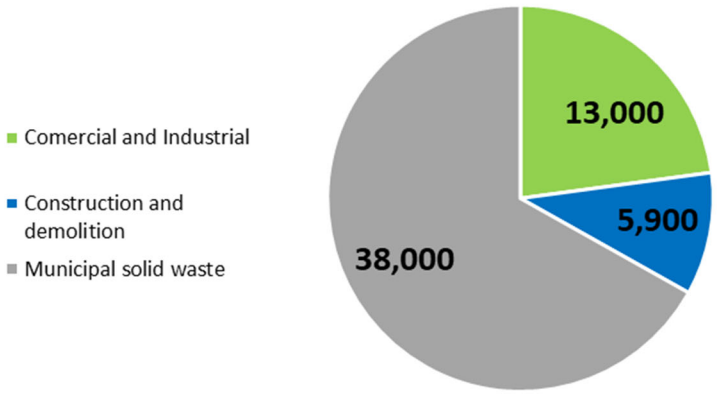

Figure 3-2 20107/2018 waste generation

It is however noted that this data only represents waste and recyclables collected by Council administered contracts and/or disposed or recycled at Council facilities. On this basis an estimated 570 kg of MSW was generated per person per annum[1].

The principal sources of waste in Gladstone can be categorised into household, council waste, commercial waste, construction waste and other industrial sources not currently handled by Council.

On the basis of the data provided by Council, an overview of the waste flows in the Gladstone region is illustrated below in Figure 3-3. This shows the relative size of the key waste streams, together with the recovery and disposal infrastructure and fate of each element of the waste stream.

[1] Based on data provided by Gladstone Regional Council annual return (GRC, 2019).

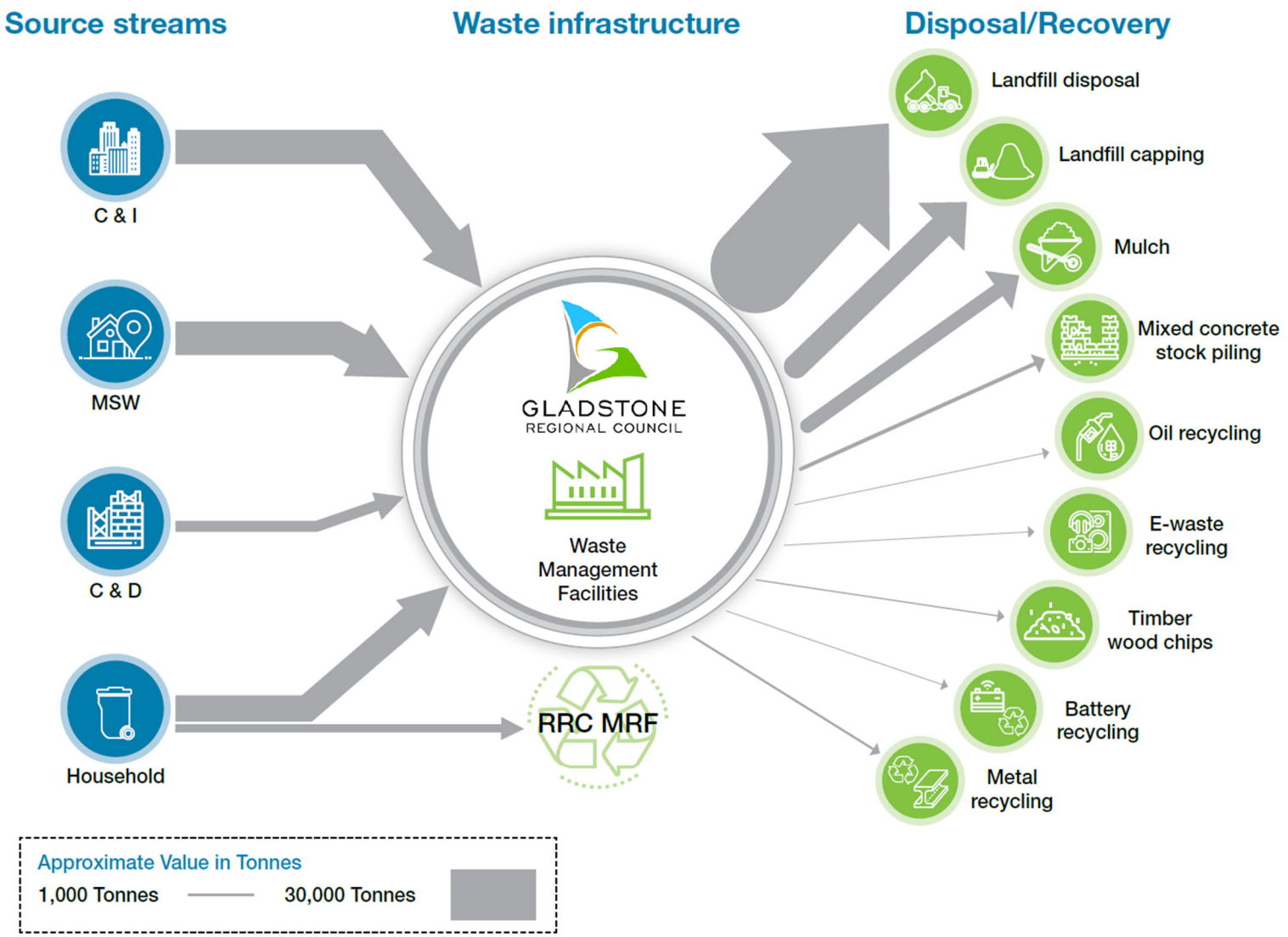

Figure 3-3 GRC Waste Flow Overview

Household waste

In 2017/2018, GRC provided kerbside waste and recycling collection service to 25,173 households. Approximately 600 kg of domestic residual waste (red lid bin) per household was collected.

A breakdown of household waste generation in GRC is provided in Figure 3-4.

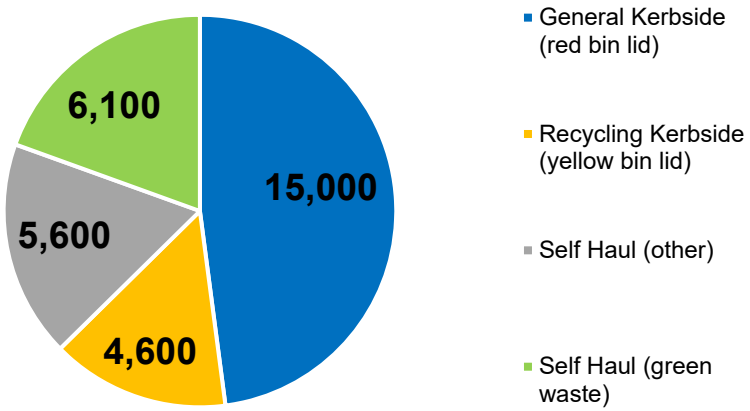

Figure 3-4 Household waste received by GRC in 2017/2018

All household domestic waste is disposed of at the Benaraby Regional Landfill, while the kerbside recyclables are processed at the Rockhampton Regional Council Materials Processing Facility (MRF), which is currently operated by Kriaris Recyclables Processing. The household recycling bin accepts glass, paper, cardboards, steel, aluminium, and plastics.

Green waste generated at residential properties is collected at all GRC transfer stations and the Benaraby Landfill via self haul.

Commercial and Industrial waste

GRC provides kerbside commercial waste services to smaller commercial entities with 240 L wheelie bin services. This service handles approximately 21,000 tonnes of commercial and industrial waste annually.

Construction and Demolition waste

GRC receives an average of 6,500 tonnes per annum of construction and demolition waste. The council has not previously received any construction and demolition waste from other councils.

Green waste

GRC receives an average of 6,100 tonnes per annum of self-hauled green waste delivered to its transfer stations and/or the Benaraby landfill. This includes residential self haul and green waste generated by commercial organics businesses (tree loppers, lawnmowing contractors etc) and green waste generated by GRC's parks department.

3.3 Waste services and infrastructure

The Gladstone Regional Council provides a range of MSW services for the community including:

- Kerbside residual waste collection (residential and small commercial)
  - Red lid bin collected weekly
  - Materials are disposed of at Benaraby Regional Landfill
- Kerbside dry recycling collection (residential and small commercial)
  - Yellow lid bin collected fortnightly
  - Collected materials are processed at the Rockhampton Regional Council Material Recovery Facility
- One landfill, the Benaraby Regional Landfill
  - Waste recovery for steel, timber, batteries, waste oil, e-waste, drum muster, cardboard, PVC/HDPE, paint, tyres, cooking oil, white goods (fridges and air conditioning)
    - Wire stripping of mattresses and other appliances
  - Green waste hardstand and onsite mulching with WWTP biosolids
  - Glass bunker (not currently operational)
  - Two tip shops
  - Crushed concrete and asphalt milling stockpiles
  - LFG collection and combustion to generate electricity, currently operated by LGI
    - Approximately 40 years of airspace capacity remaining
    - Operated in-house by GRC
- 13 transfer stations located throughout the region, all accepting green waste, domestic waste and recyclables (operated under contract by Rabco Pty Ltd)

The location of existing GRC waste infrastructure is shown in Figure 1, Appendix A.

There are no known privately operated waste disposal facilities in the Gladstone region. However it can be reasonably expected that a significant portion of the commercial and industrial waste stream and some construction and demolition waste is transported out of the region for disposal or recovery.

3.4 Resource recovery

Resource recovery is undertaken within the Gladstone region, from a number of household, Council, C&I and C&D waste streams. Based on the three years of annual data provided by GRC from 2015/2016 to 2017/2018, waste recovery and landfill diversion within the region has followed an increasing trend, and is likely to continue as further resource recovery initiatives and technologies are introduced.

A breakdown of materials recovered is presented in Figure 3-5.

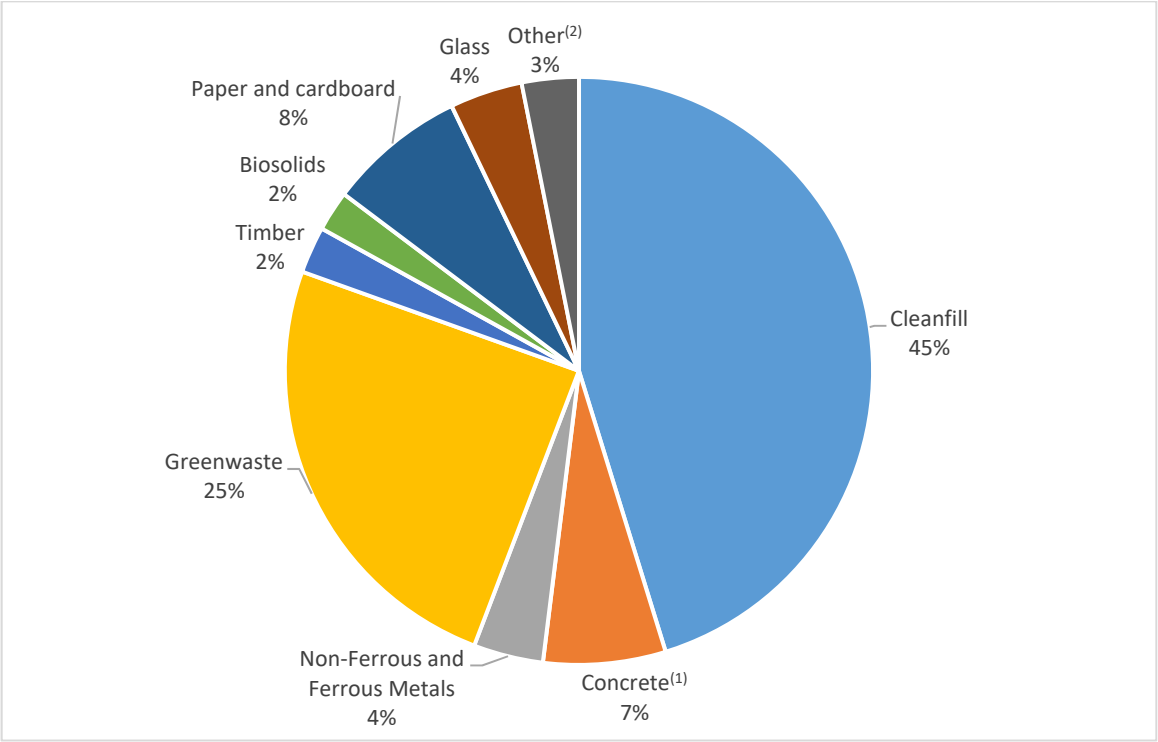

Figure 3-5 Recovered material breakdown

Notes:

(1) Asphalt, brick and tile recovery have not been itemised under a waste type and have been included in the value for concrete.

(2) 'Other' includes the following waste streams: steel cans, aluminium cans, mineral oil, salvaged items, contaminated soil, lead batteries, E-waste, chemicals, tyres and plastics. It should be noted that council does not accept waste chemicals; the chemicals recovered were concealed in other waste and have been recovered prior to being sent to landfill.

4. Key issues and opportunities

4.1 Services

As outlined in Section 3.3, current waste and resource recovery management services in the Gladstone region present both opportunities and constraints to increasing landfill diversion. A summary of the key issues and opportunities with current waste services are outlined below.

Constraints	Opportunities
• Current two bin kerbside collection service does not allow for source separated recovery of garden organics and/or FOGO	• Moving operation of transfer stations in-house at end of current contracts • It is estimated that 20-30% of waste in kerbside red lid bins is green waste, and a further 20-30% is food waste. Explore viability of additional kerbside services to promote source separation of organics • Working with local industry and businesses to improve recycling

4.2 Benaraby Regional Landfill

The Benaraby Regional Landfill is the only operational landfill in Gladstone Regional Council, and current operations at the landfill are outlined in Section 3.3. Constraints and opportunities are summarised below.

Constraints	Opportunities
• Current EA does not include ERA 62 (Transfer station) • Potential decrease in landfill gas generation if organic material were to be diverted from landfill	• Landfill airspace availability for expansion, stockpiling, landfill gas infrastructure and potential future resource recovery facilities • Accessibility of landfill site due to location on transport network and heavy vehicle routes • Construction of the 'Precinct upgrade' to improve resource recovery and landfill diversion

4.3 Energy from Waste

The *Queensland Waste and Resource Recovery Strategy* and associated initiatives are creating a more supportive investment environment for consideration of both EfW and organics processing facilities. This highlights an opportunity for GRC to increase landfill diversion for wastes that cannot otherwise be recycled or recovered. Constraints and opportunities for establishing Energy from Waste infrastructure in the region are outlined below.

Constraints	Opportunities
• Low volumes of municipal-sourced feedstock produced in region may be insufficient for viable standalone EfW (thermal or biological treatment) • Market volatility surrounding feedstock and products	• Regional collaboration opportunities provide flexibility in market approach • Multiple sources of Government funding to assist project delivery • Increased waste diversion from landfill

Constraints	Opportunities
• High capital investment requirements with long payback periods • Community perception of health and environmental risks • Energy recovery from waste is positioned at the lower end of the waste hierarchy (though above landfill) • Smaller EfW plants can have high unit processing costs and low net energy efficiency • Lengthy planning approvals • Limited commercial maturity of EfW technologies in Australia (few operating examples) • Market availability for by-products • More efficient operation may require source or mechanical separation of organic waste (additional cost)	• Direct combustion can process most residual municipal waste with limited pre-treatment required • Advanced thermal treatment technologies can produce a diverse range of products, though generally require pre-treatment/preparation or source separation of feedstock • Collaboration with private sector to explore solid fuel manufacturing opportunities (e.g. RDF) from suitable high calorific value waste streams

4.4 Organics processing infrastructure

With the recent introduction of the landfill levy together with Council's own waste diversion goals, there is an opportunity to target the recovery of food organics and garden organics (FOGO) in residential and commercial waste streams. With increasing landfill disposal costs (levy driven), source separation of domestic organic waste streams, together with implementing processing technologies is becoming a more economically viable option across Queensland, presenting both opportunities and constraints to GRC. These are outlined below.

Constraints	Opportunities
• Current kerbside collection service does not allow for source separation of organics • Behavioural change aspect associated with additional organics bin, requires careful planning and implementation • If garden organics (GO) only, collection is typically fortnightly, but if food organics collection introduced (FOGO), FOGO bin is typically collected weekly and red-lid bin becomes fortnightly. • Education program required for contamination management • Processing or treatment technology chosen needs to be able to handle variable quantity and quality of feedstock • Current population base and regional distribution may result in significantly higher per capita collection and treatment costs, without regional or commercial collaboration • Potential uncertainty regarding emerging contaminants such as PFAS	• Regional collaboration opportunities provide flexibility in market approach • Multiple sources of Government funding to assist project delivery • Increased waste diversion from landfill and contribution to recycling targets • Options ranging from composting to digestion (or in combination) may be suitable • Biogas generation and opportunities for energy recovery or fuel generation • Potential to co-locate at either Benaraby landfill, or develop AD facility at the GRC WWTP (co-location synergies) • Depending on processing technology chosen, potential for utilisation of biosolids and green waste currently stored at the landfill • Working with research bodies investigating priority waste streams such as organics, specifically food and other biomass

Constraints	Opportunities
in waste derived composts and/or digestate • Composting requires sufficient land and buffer distances and typically can only process food organic and/or garden organic waste • Demand for products recovered from organic waste may take time to develop • Processing requirements for the reuse of digestate (policy, market, costs)	• Composting is considered recycling on the waste hierarchy and is therefore positioned higher than EfW • AD implemented in conjunction with composting can produce energy and recycle organics (subject to market constraints)

4.5 Other resource recovery initiatives

From the situational analysis, a number of existing services or facilities were identified with potential to improve resource recovery. The constraints and opportunities to other resource recovery initiatives are summarised below.

Constraints	Opportunities
• All recyclables are processed outside of the region at the Rockhampton Regional Council Materials Recovery Facility • Contamination rates in kerbside recyclables bins	• Incorporate recycled material specifications into procurement processes • Utilisation of glass bunker at Benaraby Landfill to store, reprocess and reuse recycled material • Potential use of crushed recycled glass in pipe bedding applications

4.6 Supporting infrastructure

In considering local GRC or regional infrastructure options to support a zero waste to landfill future (such as organics processing or Energy from Waste), the supporting infrastructure and equipment must also be considered. A summary of the constraints and opportunities associated with the supporting infrastructure are summarised below.

Constraints	Opportunities
• Current two bin (red lid and yellow lid) kerbside service • Visibility of C&I waste data • Operating 13 transfer stations comes at a significant ongoing costs	• Benaraby Landfill airspace availability • Operational efficiency review of transfer station network to determine whether all sites are viable to continue operations, whether reduced operating hours may be possible, and identify opportunities to drive recycling rather than just waste disposal

4.7 Waste data management

Lack of consistent and reliable waste data provided by GRC was highlighted as a significant limitation during the development of the Waste Strategy. The constraints and opportunities with waste data management in GRC are outlined below.

Constraints	Opportunities
• Inconsistencies in current waste data set	• Development of a standard data collection system and reporting template

Constraints	Opportunities
• Ability to use current data to benchmark performance across region and set accurate and achievable targets	• Include the provision of data in electronic format in contracts with waste service providers

4.8 Education and engagement

Waste education is a critical driver in the implementation of behavioural changes that lead to an overall increase in landfill diversion and recycling reuse rates. The constraints and opportunities for education and engagement within the region are summarised below.

Constraints	Opportunities
• Currently no education officer within Council	• Development of an engagement and education program • Reduce litter and illegal dumping • Decreasing contamination rates in household kerbside recycling bins

4.9 Gladstone collaboration opportunities

Local industry collaboration

The Gladstone region hosts many industrial operations, with the Port of Gladstone and the declared Gladstone State Development Area representing key attracting factors. Each industry has differing waste management requirements and practices. Key industry includes (but is not limited to):

- Gladstone Ports Corporation (GPC)
- Curtis Island gas plants
- Alumina refining at Rio Tinto Alcan Yarwun and Queensland Alumina Limited (QAL)
- Orica, with nitric acid, ammonia nitrate and sodium cyanide processing
- Boyne Smelters, aluminium smelting
- NRG Gladstone Power Station
- Northern Oil / Southern Oil, recycling waste lube oil and a pilot plant for biofuels (JJ Richards are affiliated with Northern Oil).

There are also proposed industrial projects, including Australia Future Energy (with opportunities for coal, gas and biomass), and abattoir and solar projects.

Different companies have varying environmental and/or sustainability policies and procedures, with each having aims or commitments (either directly or indirectly) to increase reuse and recycling, and to minimise waste disposal at landfills. Waste management at the sites is typically contracted to waste management contractors, for example Orica contracts Cleanaway and QAL contracts Veolia for waste services.

It was communicated that at QAL, Veolia operate a site transfer station to assist with waste segregation (including separating contaminated material). Typically these waste contractors are disposing of waste outside the Gladstone region. Where practical, industry reuse material on site. Key examples of this are crushed clean concrete for internal roads and mulched green waste for erosion/dust control. Organic waste (that is not used on site) is transported to facilities outside the Gladstone region, such as Orica transporting green waste to Gracemere or Emerald, and GPC transporting quarantine waste to Brisbane.

In addition to day-to-day waste management, at times the industrial sites have construction and/or demolition works occurring. For such works the designated construction contractor is usually responsible for waste management and they are likely to further subcontract waste management services to another party. In these cases, the waste contractor would determine their own disposal or recycling arrangements which may or may not include use of GRC waste facilities.

As well as industrial waste generators in the region, there are public utility entities of Gladstone Area Water Board, Queensland Rail/Aurizon and the Department of Transport and Main Roads.

Depending upon the waste management options to be implemented in the region, there is opportunity for greater collaboration with industry and utility providers, either directly, or with specific waste management contractors.

The types of industry in the region produce relatively minor organic waste when compared to other regions that have intensive agriculture, meatworks, and the like. However, collaboration options exist and can potentially be further developed.

Local government collaboration

Elected representatives and waste managers from eight CQ Councils (Banana Shire Council, Bundaberg Regional Council, Central Highlands Regional Council, Gladstone Regional Council, Isaac Regional Council, Livingstone Shire Council, Mackay Regional Council and Rockhampton Regional Council) as well as representatives from the Queensland Treasury Corporation (QTC) came together in early 2019 to discuss the potential for adopting a regional approach to waste management in the region. GRC reported that the proposed next steps from this workshop were:

1. Regional Education
   – Recommendation 1: Participating in the development of a Draft Regional Waste Education Plan with the aim of delivering a suite of consistent, best practice waste education resources and strategies to meet the needs of our region.
2. Mapping Regional Waste Flows
   – Recommendation 2: Participating in a join project to map regional waste data as a means to inform better decision making on a regional basis.
3. CQ Regional MRF Contract Negotiations
   – Recommendation 3: Participating in negotiations with Kriaris Recycling for the provision of co-mingled recycling processing services commencing January 2021
   – Recommendation 4: Participating in the tender process for the long-term provision of co-mingled recycling processing services commencing January 2022 or 2023
4. Regional Waste Management Group Governance Structure
   – Recommendation 5: Participating in investigating the options to facilitate improved waste management at a regional level, the collaborative opportunities and the governance requirements.

To follow on from this workshop and gain a further understanding of the current position of the Councils in regards to waste management, the surrounding local governments in the Fitzroy region were consulted by GHD to discuss the following topics:

- Current waste management and services
- Current waste data for headline streams
- Likely future waste management focus specifically around additional kerbside services for FOGO/Green/FO waste and infrastructure

- Interest in regional collaboration for future waste management and their potential level of involvement.

The councils consulted included Livingstone Shire Council, Isaac Regional Council, Banana Shire Council, Central Highlands Regional Council and Rockhampton Regional Council. The approximate distances from each council to Benaraby Regional Landfill are included in Table 4-1.

Table 4-1 Approximate distances to Benaraby Regional Landfill

Council	Approximate distance to Benaraby Landfill (km)
Rockhampton Regional Council	120
Livingstone Shire Council	160
Banana Shire Council	220
Central Highlands Regional Council	390
Isaac Regional Council	530

From the limited waste data provided by Isaac Regional Council and Banana Shire Council, other Councils and publically available figures (Queensland Waste Data System, 2019), it can be concluded that Gladstone Regional Council and Rockhampton Regional Council are the largest domestic waste generators in the region. A breakdown of the domestic waste collected in each region is provided in Figure 4-1.

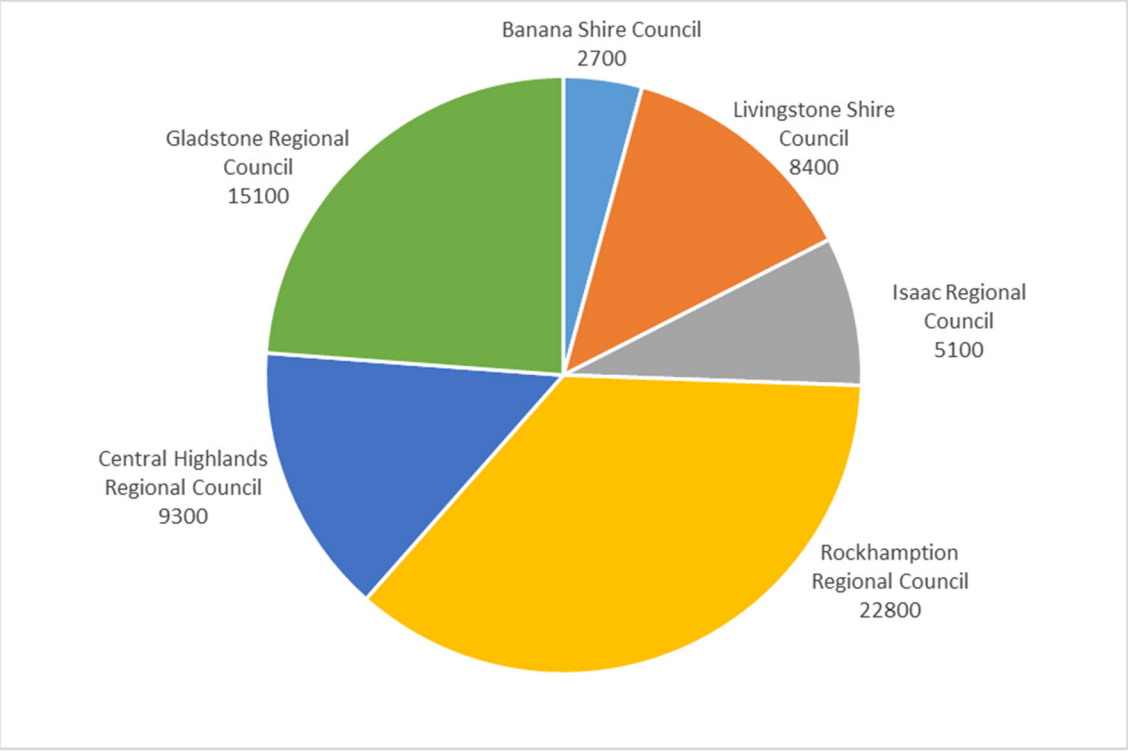

Figure 4-1 Fitzroy Region tonnage of domestic waste collected 2017/2018

The opportunity for regional collaboration on waste management was welcomed by Central Highlands Regional Council and Livingstone Shire Council. However, the small quantities of domestic waste produced, the distance between councils and existing waste management

infrastructure should be considered in assessing potential for regional collaboration and new infrastructure planning.

A representative of the Central Queensland University (CQU) Research division was also contacted on the recommendation of the Gladstone Regional Council. CQU are currently conducting research in various areas of food waste management including community education and awareness, digestion technologies and biofuel/biodiesel. There is an opportunity for potential research collaboration with CQU.

5. Strategy objective and priorities

This Waste Management and Resource Recovery Strategy is based upon the principles of the waste and resource management hierarchy and signals that Gladstone Regional Council consider waste as a resource. Council will invest in reducing the generation of waste in the Gladstone region, and improving resource recovery to extract value from materials in the waste stream, before considering landfill disposal. It has a primary focus on infrastructure and service opportunities and challenges for the existing waste streams.

The implementation plan underpinning the Strategy is based on the principles of the waste and resource management hierarchy, as depicted in Figure 2-1. The hierarchy is the framework used to shape the *Queensland Waste Management and Resource Recovery Strategy*, guiding the order of preference for managing waste. GRC is committed to managing waste at the highest practical level of the hierarchy in order to achieve the best outcome for both the environment and future generations.

From the issues and opportunities identified, key priority areas emerged that provided a framework for the Waste Management and Resource Recovery Strategy. The priorities and their objectives align with the different aspects of the waste hierarchy. The identified priorities are set out in Table 5-1, including a cross reference to relevant areas of the waste hierarchy.

Table 5-1 Gladstone Regional Council Waste Strategy priorities

Waste strategy priorities	Waste and Resource Management Hierarchy				
	Avoidance and waste reduction	Reuse	Recycle or compost	Recover fuel or energy	Dispose
Priority 1 – Waste education	✓	✓	✓	✓	✓
Priority 2 – Reuse of recovered material in local projects	✓	✓			
Priority 3 – Landfill diversion through recycling	✓	✓	✓		
Priority 4 – Optimise existing infrastructure			✓		✓
Priority 5 – Organics processing	✓		✓	✓	
Priority 6 – Regional collaboration	✓		✓	✓	
Priority 7 – Data collection and management	✓	✓	✓		✓

6. Potential waste processing options

A range of waste processing infrastructure options are available to assist in achieving the GRC's strategic corporate objectives for waste management. This section presents a summary of the waste processing technologies reviewed. Following consultation with GRC, the options assessment focused primarily on thermal Energy from Waste and biological treatment technologies. Biological treatment refers to the recovery of resources from organic waste streams (with or without energy recovery) while thermal treatment typically involves thermal conversion to harvest energy. Mechanical processing can be applied to certain waste streams to produce refuse derived fuel (RDF), sometimes otherwise referred to as processed engineered fuel (PEF) or solid recovered fuel (SRF).

The Queensland Government recognises a waste hierarchy where EfW technologies with anaerobic digestion (biological EfW) are considered recycling as the process preserves nutrients that can be returned to the soil, as well as producing biogas.

Energy from Waste technologies can play a role in improving waste management in accordance with the Queensland Waste and Resource Management Hierarchy. However the options of fuel or energy recovery from waste (via thermal processing) should only be explored for residual waste that is unsuitable for higher order activities on the waste hierarchy, and would otherwise be destined for landfill.

On the waste hierarchy, the recovery of solid or liquid fuels from waste is more desirable than EfW technologies that recover energy from waste through combustion and thermal treatment. Due to the feedstock specifications for processes recovering fuels from waste, the separation of recyclable materials should be supported and the potential for conflicts with current and future recycling be reduced (Department of Environment and Science, 2019).

When considering the role of EfW in the Gladstone region, there are a number of matters to be addressed, including:

- Future composition and availability of feedstocks for EfW
- Ensuring the chosen technology is supported by the community and can effectively obtain and maintain a "social licence to operate"
- Appropriate technologies for the type and quantity of feedstock available
- How to ensure security and consistency of feedstock, without compromising recycling efforts
- Other resource recovery activities that could achieve reduction in landfilling without the scale of capital investment
- The availability of grid connections for power offtakes, and the time taken to receive approval from the Commonwealth government
- The relative merits of considering a market lead proposal for EfW infrastructure as opposed to being driven by Council
- Consideration of project delivery and operational models

Most of these factors also apply to other waste processing infrastructure as well.

6.1 Queensland Waste and EfW Policy framework

The Department of Environment and Science (DES) released a discussion paper on Energy from Waste in July 2019. This paper, which is the initial step towards policy development

supports the implementation of the *Queensland Waste Management and Resource Recovery Strategy* by identifying options for the estimated 15% of waste in Queensland that would otherwise go to landfill by 2050, under the Strategies goals and targets for waste reduction and recycling. When considering the role of Energy from Waste in the Gladstone region, future and current feedstock availability and consistency requires further review, as currently available data does not provide sufficient certainty upon which to make a decision. It is further noted that efforts to secure consistent feedstock must not compromise recycling efforts.

The QLD Waste Strategy has defined targets to recycle 50% of household waste by 2025, and 75% by 2050. It also seeks to divert 90% of waste from landfill by 2050. It is proposed that EfW can support achieving landfill diversion targets by recovering value from residual waste.

The discussion paper will inform the development of a policy which will outline the key principles to guide implementation of EfW as Queensland transitions to a circular economy for waste. Based on advice from DES, development of the EfW policy will consider the following:

- Accommodation of both established and emerging technologies.
- Maintain integrity of higher order waste reduction, reuse and recycling programs.
- For thermal EfW technologies, promote genuine energy recovery over incineration without energy recovery.
- Promote understanding the importance of the social license to operate.
- Ensure human and environment health is protected from EfW facilities.

6.2 Funding opportunities

A number of funding opportunities are available to assist with the delivery of waste management and resource recovery infrastructure. The key avenues currently available are summarised below.

Emissions Reduction Fund

The Emissions Reduction Fund provides incentives for Australian businesses, farmers, landholders and others to adopt new practices and technologies to reduce greenhouse gas emissions.

Under the Emission Reduction Fund eligible emissions reduction activities are included in ‘methodology determinations’, or ‘methods’ for short. Emissions reduction methods set out the rules for estimating emissions reductions from different activities.

Under the Emissions Reduction Fund, the government has implemented the:

- Source Separated Organic Waste method
- Alternative Waste Treatment method
- Landfill Gas method

These allow funding for projects that reduce the amount of organic waste in landfill, through diversion to composting and resource recovery, capturing methane from landfills and producing electricity. Compost can also be used to reduce the rate of soil carbon loss in agriculture

Queensland Resource Recovery Industry Development Program (RRIDP)

The RRIDP is a $100 million fund the Queensland Government established in September 2018 which will be implemented over the next three years. The program aims to support resource recovery industries. Funding is available to local governments, waste recovery businesses, not-for-profits and other associations to encourage employment of proven technology along the

entire supply chain, from collection and transfer to sorting, re-manufacturing and waste to energy. To enable this and support a wide range of projects, the funding has been split into three streams, described in the *Resource Recovery Industry Development Program Guidelines produced by The Department of State Development, Manufacturing, Infrastructure and Planning* (2018):

- Stream One – Resource recovery grants fund

  Capital grants stream with dollar-for-dollar grants available from $50,000 to $5 million to provide funding for infrastructure projects which will enhance or build new facilities or for capital investments in new processing and technological capabilities that align with the RRIDP and its objectives.

- Stream Two – Resource recovery project fund

  Broader financial incentives to attract or expand major resource recovery projects in Queensland. A project supported under Stream Two will deliver significant landfill diversion and resource recovery outcomes. Stream Two is well suited to projects which have the potential to result in significant benefits to Queensland, relative to the State's contribution. Applications will be considered on a case by case basis, with a successful project rated as of exceptional merit relative to the key objectives of RRIDP.

- Stream Three – Resource recovery investment pipeline fund

  Funding for studies for proposed projects seeking to deploy demonstrated technology but require further detailed technical and professional investigations to assist with resource recovery infrastructure investment decisions in Queensland.

Australian Renewable Energy Agency (ARENA)

The Australian Renewable Energy Agency (ARENA) is a Commonwealth agency that can provide project funding for bringing renewable energy technologies to market. One of ARENA's specific focus areas is improving the long-term cost competitiveness of the renewable energy sector when providing funding support for bioenergy and EfW projects. In particular ARENA looks for projects that demonstrate or address issues with the use of bioenergy and EfW in industrial processes, using technologies such as biomass or biogas boilers. Funding may be available under the Advancing Renewables Program (or other programs in future) however, technology readiness must be demonstrated as per the program guidelines.

Clean Energy Finance Corporation (CEFC)

The Clean Energy Finance Corporation (CEFC) is a Commonwealth government entity and statutory authority that was established to facilitate increased flows of finance into the clean energy sector. It is responsible for investing $10 billion in clean energy projects on behalf of the Australian Government. CEFC has invested by way of loan facilities in a number of EfW and resource recovery projects including bioenergy from waste, composting facilities, resource recovery activities and the production of a process engineered fuel from dry commercial and industrial waste.

Private funding

Typically, EfW projects are delivered by a project consortium that would include multiple investors including government funding (examples provided above), private and debt equity partners.

6.3 Social licence to operate

When considering a fundamental change to waste processing infrastructure, it is increasingly important to have community support for the change in order to build what is referred to as the "social licence to operate". Whilst generally speaking, communities are much more aware of the impacts of consumption and waste generation than in the past, it can still be difficult and complex to contemplate change especially when considering where to locate waste and resource recovery sites and moving from reliance on landfills to other industrial processes for waste management.

It is therefore critical that local government or any project developer, engage with the community to understand their perceptions about waste, expectations and concerns regarding waste infrastructure, and to build community support around proposed system changes. This should include consideration of those directly and indirectly impacted or standing to benefit from the change. A community engagement program should be developed for any waste servicing and infrastructure changes that is tailored to the scale and nature of system, and behavioural changes, potential impacts and benefits to the community.

6.4 Feedstock options

The main categories of feedstock available for EfW or waste processing technologies in the Gladstone region include the following:

Garden organics

Garden organics are currently collected through residential and commercial self-haul at transfer stations and the Benaraby Landfill in the region. The availability of garden organics in the region varies depending on influences in the region (i.e. construction projects and natural disaster "events"). It is important that the potential EfW facility has capacity to receive and process fluctuations in feedstock quantity.

Food organics

Food waste includes food waste scraps from preparation, discarded food and food waste from manufacturing, food services and retail. As GRC does not currently provide separate food organics services for household or commercial waste, limited information can be provided regarding availability of food organics. The use of food organics as a suitable feedstock would require the introduction of a kerbside food organic and/or garden organic (FOGO) service to allow for source separation.

Timber and wood waste

Timber and wood waste are suitable as feedstock for composting and thermal treatment technologies. Some timber and wood waste is currently recovered at the Benaraby Regional Landfill where it is chipped and used on site. The volumes of timber and wood waste recovered are however considered relatively low and also fluctuate month to month in terms of available quantities. Timber and wood waste can also be processed into a refuse derived fuel.

Biosolids

Biosolids produced from the Gladstone WWTPs in the region are received at the Benaraby Regional Landfill where they are mixed with green waste to produce mulch that is stockpiled at the landfill, and available free of charge to residents. While biosolids can provide moisture and nutrients to the waste treatment process, they may require special treatment to remove pathogens. Furthermore, incorporation of biosolids in biological treatment methods, may also complicate approvals.

Municipal solid waste

Municipal solid waste (MSW) includes all domestic kerbside residual waste (red) bin and can provide feedstock for both biological and thermal processing options. As stated above, it is important that for MSW to be used in thermal technologies, all readily recoverable material should be removed and feedstock should only consist of residual material that cannot be recycled.

Plastics

To align with the principles of the Waste Management Hierarchy, the recovery and recycling of materials should be supported in the first instance, before recovery of fuel or energy from the waste is considered. Currently, recyclables, including plastics are separated at the RRC MRF. There may be potential for the processing of contaminated plastics that cannot be recycled and would otherwise be disposed of to landfill.

6.5 Biological and thermal treatment technologies

The potential biological and thermal technologies being considered for waste management in Gladstone are outlined in Table 6-1, summarising the key constraints and opportunities of each technology. Additional details on the technology options are included in Appendix C.

Table 6-1 Thermal and biological treatment technologies

Technology	Process description	Constraints	Opportunities
Biological Treatment			
Composting – open windrow	The process whereby organic materials are microbiologically transformed under controlled aerobic conditions to achieve pasteurisation and a specified level of maturity. Open windrow composting incorporates long rows of raw organic feedstock material including vegetation, garden organics, commercial and domestically sourced food wastes and in some cases liquid wastes. The windrows are regularly turned by front end loaders or dedicated windrow turners. This technology can include mechanical aeration systems to enhance the biodegradation of materials, (known as aerated static pile or mobile aerated floors/piles).	• Increased risk of odour release/nuisance • Requires significant footprint and buffer zone • Generally not suitable for processing highly odorous waste streams (dependant on location) • May produce leachate that requires managing • Market demand for compost • High rainfall events can complicate/constrain operations • Operating costs typically higher than in-vessel (enclosed) systems due to labour and plant costs	• Relatively low capital investment • Can be established at small to large scales • Tolerant of some fluctuations in feedstock quantity • Relatively easy to expand/scale provided sufficient buffers to sensitive land uses (such as residential, health care, education, childcare and recreation) are in place
Composting – in-vessel	In-vessel composting (IVC) is a more advanced composting system where the process is contained completely within a vessel or building, and closely controlled to accelerate the composting process. Air is supplied into the composting vessels to enhance the process. For larger facilities a biofilter or chemical scrubbing	• Can be an energy intensive process (dependant on adopted system) • Extracted air requires treatment • Odour treatment systems can be challenging to maintain (effectiveness)	• Suitable for a wide range of odorous organic feed stocks (biosolids, manure, liquid organic waste, garden organics) • Can be established at small to large scales • Commercially mature process

Technology	Process description	Constraints	Opportunities
	system is required to treat the exhaust air prior to release to the atmosphere.		• Relatively low capital investment (compared with thermal processing) • Tolerant of some fluctuations in feedstock quantity
Anaerobic Digestion (dry)	Anaerobic digestion (AD) is the biological decomposition of organic waste in the absence of oxygen. Dry AD systems are used for drier (higher solids content) feedstocks that are generally not soluble. Digestion can involve recirculation of leachate over the feedstock, or solids recirculation (for mixing).	• No high solids digestion plants currently operating in Australia • Requires heat input • Digestate requires further aerobic processing to stabilise • Digestate can be highly odorous • If process is mesophilic (<40 deg C), pasteurisation of digestate may be required (depending on end use) • Regulatory policy around digestate reuse is currently unclear	• Processed organic fraction removed from mixed waste, or source-separated waste • Can include feedstock with high lignin content (e.g. garden organics) • Digestate is in solids phase • Possibility for modular design • Low emissions • Biogas can be used for on site energy requirements, and surplus exported (as gas or electricity)
Anaerobic Digestion (wet)	Wet AD systems are designed for wet and soft (low solids) feedstocks such as biosolids and food waste. Digestion occurs in a closed tank that is continuously mixed to optimise contact between the microbes and the waste. This option considers potential for upgrade of the existing sludge treatment arrangements at the Gladstone WWTP to introduce a wet AD system with capacity	• Requires heat input • Feedstock may require the addition of water to increase moisture content • Digestate requires dewatering and may require stabilisation • Requires source separation of feedstock • If process is mesophilic (<40 deg C), pasteurisation of digestate may be required (depending on end use)	• Some low solids anaerobic digestion plants already operating in Australia • Digestion of biosolids and food waste • Can process wet and soft (low solids) feedstocks including industrial slurries and manures • Low emissions

Technology	Process description	Constraints	Opportunities
	for digestion of food waste and waste water treatment sludge (biosolids).	• Regulatory policy around digestate reuse is currently unclear	• Biogas can be used for on site energy requirements, and surplus exported (as gas or electricity)
Thermal Treatment			
Direct combustion	Combustion involves burning of waste in an excess supply of oxygen (from air) in a furnace to generate heat that can be recovered through steam. Mass-burn combustion plants are designed to process mixed residual waste with little or no pre-processing. It relies upon effective recycling systems and separation of organics. Without this, additional pre-processing is required.	• Requires gas cleaning and monitoring systems • By-products may need to be handled as hazardous waste • Power generation is only possible by raising steam through a turbine • Low energy efficiency • Possible risk of corrosion due to nature of feedstock • No current plants in operation in Australia	• Diversion of materials from landfill • Heat and electricity generation • Potential use for incinerator bottom ash an aggregate substitute • Relatively mature and proven technology (globally) • Tolerates a range of feedstock
Gasification	Gasification involves burning of waste in an environment with limited oxygen, partially combusting or oxidising the waste to produce heat and a combustible gas, called syngas.	• Range of acceptable feedstock properties is narrower than for direct combustion • Pre-treatment of feedstock requires some energy input • High capital costs for infrastructure/construction	• Syngas has potential to be used as a versatile fuel • Limited experience operating gasifiers with MSW feedstock • Limitations on feedstock

Technology	Process description	Constraints	Opportunities
		• Few operating example plants using complex feedstocks with >2 yrs continuous operating history	
Pyrolysis	Pyrolysis is an advanced thermal technology that involves the thermal decomposition of carbonaceous waste or biomass in the absence of oxygen. The feedstock is heated in an oxygen free environment, where the carbon content is broken down to a combustible gas, syngas. The syngas is cooled and condensed to produce oil products.	• Typically requires intensive feedstock pre-processing • Limited local experience with waste pyrolysis • Disposal of by-products • Limited commercial operating experience using MSW • Pyrolysis oil is not generally suitable for direct use, and requires further refining	• Pyrolysis oil can be refined into fuel • Potential to recover/convert organic fraction of material as liquid biofuel (i.e methanol)
Hydrothermal Liquefaction (HTL)	Hydrothermal liquefaction (HTL) is the process where wet biomass feedstocks are exposed to moderate temperatures and high pressures, breaking the organic solids into liquid components. The breakdown of the solids converts the carbon into bio-crude, a liquid that can be further refined.	• Bio-crude requires processing to remove oxygen prior to distillation • Very low commercial maturity in Australia	• Feedstock does not need to be dried before treatment • Tolerant to some fluctuation in feedstock quality
Mechanical Biological Treatment (MBT)	Mechanical Biological Treatment (MBT) is a combination of waste processing infrastructure, generally combining mechanical processing to recover recyclables and extracting organics and the biological processing of the recovered	• High capital investment • Difficult to secure viable market for outputs/products • Low revenue potential • Generally low grade products	• Can be designed to suit local requirements • Can treat a wide range of waste streams • Does not require source separation

Technology	Process description	Constraints	Opportunities
	organic fraction through composting or anaerobic digestion.	• Increasing regulatory constraints on end uses for products of mixed waste origin	

Notes:

1. Other biomass includes timber and agricultural residues

The options were initially evaluated on their potential constraints, opportunities, maturity and most importantly their applicability to the Gladstone region. The treatment technologies outlined in Table 6-2 were chosen as the most relevant for further assessment in the Gladstone region and were subjected to a Multi Criteria Analysis (MCA).

Table 6-2 Technology options assessed against the MCA

Technology	Accepted feedstock						
	Food organics	Garden organics	Biosolids	Other Biomass[2]	MSW	Plastic[3]	C&I
In-vessel composting	✓	✓	✓	✓			
Anaerobic digestion (wet)	✓		✓				
Anaerobic digestion (dry)	✓	✓		✓			
Direct combustion			✓[1]	✓	✓	✓	✓
Gasification				✓	✓	✓	✓

Notes:

1. Biosolids can be co-combusted with other residual waste but net energy contribution is low.

2. Other biomass includes timber and agricultural residues

3. Assumed to be non-recyclable residual waste plastic

6.6 Other resource recovery activities

Northern Oil Biofuels

Southern Oil have recently opened the Northern Oil Advanced Biofuels Pilot Plant at the Northern Oil Refinery in Yarwun. The pilot plant uses biomass material including green waste, waste tyres, prickly acacia and bagasse to produce bio-crude oil that can be refined into saleable fuel products.

The plant includes a high temperature pyrolysis process.

Gladstone WWTP

From information provided by GRC, the Gladstone WWTP currently operates two dedicated sludge treatment trains with one of the two digesters being approximately described as a mesophilic anaerobic digester. The plant is being upgraded to combine the biosolids treatment to include a primary anaerobic digester that utilises the biogas in a sludge heating system and a biogas flare for any excess.

According to information provided by the GRC Manager Asset Planning, the Gladstone WWTP does not have spare capacity for the treatment of food waste, however there is an opportunity to upgrade the sludge treatment at the WWTP to allow for the co-digestion of food waste.

Refuse derived fuels

There are a number of operators in Australia producing or developing projects to produce refuse derived fuels (RDF), also referred to as process engineered fuel (PEF), or solid recovered fuel

(SRF). These are used as an alternate fuel for fossil fuels in intensive operations such as cement kilns. Such operations target either biomass (timber and wood waste) or other dry residual wastes 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.

Gladstone is home to the largest cement kiln in Australia. GHD is aware of a number of entities actively exploring opportunities for RDF production in Queensland. One of the active players in this market is ResourceCo who have developed waste to fuel facilities in South Australia and New South Wales. With the introduction of the landfill levy in Queensland, it is possible that these types of facilities will become viable in Queensland. Gladstone Regional Council could keep a watching brief for collaboration with similar private sector entities in this market sector. It is considered that the appropriate position for a local government with this type of facility would be as a feedstock supplier, rather than asset owner or operator.

6.7 Delivery and ownership models

Project delivery and operational models for major waste processing infrastructure can be led by private companies, government entities or a combination of the two. The most common delivery models include the following.

Merchant/private facility

- A private company or consortium develop a facility, and secure feedstock with various parties (such as local government), under a gate fee or fee for service arrangement.
- This is the most common approach in the UK and in some parts of Europe for major waste facilities. It is also the approach that has been adopted in Western Australian and Victoria for the major EfW facilities proposed. In Queensland, the proposed Remondis Green Energy and Recycling Park is also an example. It is also the most common approach for composting in Queensland and South Australia, and there are numerous examples of this for anaerobic digestion of specific organic waste streams in South Australia and Western Australia together with the more sizable Earthpower food waste to energy facility in Sydney.

Design and build

- Local council remains as the asset owner and operator, but externally sources the design and construction of the facility. This option requires appropriate allocation of risk in terms of process control. But local government retains feedstock and product rights, and carries responsibility for all aspects of operation.

  This approach has been utilised by some regional councils for open or covered composting in Australia.

Design, build, operate

- This option has become common for regional councils in Australia, that do not wish to take on process control risk for in-vessel composting but have a desire to maintain ownership of feedstock, assets and the compost products. It is also a common approach through North America and Europe for composting facilities. Operating terms can range from as short as 1 year, though this is uncommon. More typically operating terms are between 3 and 8 years for composting and 10-15 years for more sophisticated technologies.

7. Options assessment

As discussed in Section 6 a number of biological and thermal treatment options (a summary description is provided in Table 6-1 and Table 6-2) were evaluated using a Multi Criteria Analysis (MCA) developed by GHD with consultation from GRC and stakeholders.

The following key assumptions were made for the purpose of the assessment:

- The rankings allocated to each technology are based on publically available information and are indicative only. Technologies that have limited commercial experience and/or demonstrated operating history in Australia have a higher degree of uncertainty in rankings.
- For the purpose of the assessment a nominal feedstock of 50,000 tonnes per annum was assumed for each technology. Noting though, that that for thermal treatment technologies, this is substantially lower than typically targeted feedstock volumes to prove a project financially viable. However it was chosen as it was closer to potential feedstock volumes available in the Gladstone region. Therefore all scoring and ranking of thermal technologies must be considered in this context.

7.1 Criteria and weighting

The thermal and biological waste treatment options were assessed against the following parameters.

7.1.1 Financial Performance

Financial performance of the technologies was assessed against the criteria outlined in Table 7-1. Financial performance was allocated the highest total weighting of 40% as the economic viability of any option for implementation consideration is a fundamental constraint for GRC in assessment of the available waste management technology options.

Table 7-1 Financial performance criteria and weightings

Criteria		Weighting		Question
1	Operational cost	12.5%	40%	What is the relative scale of operational costs of the technology?
2	Capital cost (relative to competing options)	10.0%		What is the typical capital investment required for the technology?
3	Ability to generate revenue	10.0%		Can the technology generate revenue to offset energy consumption costs?
4	Market availability for end products	3.75%		Is there a viable market demand/availability for end products over life of facility?
5	Market availability for by-products	3.75%		Is there a viable market demand/availability for by-products over life of facility?

7.1.2 Technical performance

The technical performance of each technology was evaluated against the criteria outlined in Table 7-2. Technical performance considered the maturity of the technology, operation and ability to process feedstock. Technical performance was allocated an overall weighting of 25% given that operational reliability and degree of complexity have a significant bearing on assessing the suitability of any waste processing infrastructure.

Table 7-2 Technical performance criteria and weightings

Criteria		Weighting		Question
6	Proven technology	10.0%	25%	Is the technology proven and reliable for the waste stream/material under consideration?
7	Operational complexity	7.5%		Does the technology have operational simplicity in its process that capitalises on existing regional skill base?
8	Treatable components of MSW and C&I stream	2.5%		Does the technology readily treat multiple components of the waste stream?
9	Feedstock pre-treatment requirements	2.5%		What level of pre-treatment of feedstock is required for the technology?
10	Feedstock quantity flexibility	2.5%		Is the technology able to handle variation in waste input quantity with little additional expenditure?

7.1.3 Social and environmental

The social and environmental assessment category assessed the impact each technology has on the environment and society. The social and environmental criteria are outlined in Table 7-3 and were allocated a total weighting of 20%. This category assessed the highest number of individual criteria (9).

Table 7-3 Social and environmental criteria and weightings

Criteria		Weighting		Question
11	Scale of community behaviour change	3.0%	20%	What level of behaviour change is required of residents as part of the implementation of the infrastructure option?
12	Employment opportunities	3.0%		Does the technology create new job opportunities within GRC?
13	Greenhouse gas reduction	3.0%		Does the technology reduce greenhouse gas emissions compared to landfill disposal?
14	Alignment with GRC Corporate Plan	2.0%		Does the technology contribute with the GRC Corporate plan goal to decrease reliance on landfill, target zero waste to landfill and reduce fossil fuel reliant energy consumption?

Criteria		Weighting		Question
15	Community acceptance	2.0%		What is the likely level of community support for the proposed technology?
16	Approvals pathway - statutory and environmental	2.0%		How long will it take and level of complexity in process required to get approval?
17	Ongoing environmental compliance requirements	2.0%		What is the level of complexity and cost of ongoing environmental compliance for the technology?
18	Potential air quality impacts	2.0%		What degree of engineering controls are required to manage potential impacts on air quality, including odour?
19	Landfill reduction potential	1.0%		To what extent does the technology divert waste from landfill?

7.1.4 Risk/Uncertainty

The risk and uncertainty category assesses the perceived risks and uncertainties associated with the technology. This category was allocated a total weight of 15%, with further details on the criteria for this category outlined in Table 7-4.

Table 7-4 Risk/uncertainty criteria and weightings

Criteria		Weighting		Question
20	Supply chain	5.0%	15%	How reliable is the feedstock supply?
21	Volatility of market for end products	5.0%		Is there a secure market/take off for products and by-products?
22	Susceptibility to competition	3.0%		What is the potential for the technology to be disrupted by other competitors (feedstock, products)?
23	Policy/governance changes	2.0%		How resilient is the technology to policy changes?

7.2 Scoring and ranking

Each technology was assessed against the defined criteria by assigning a score based on a 5 point scoring system (-2 to +2). A higher score represented a more favourable assessment and/or alignment with overall objectives of the waste strategy and technology suitability. As an example, the assessment criteria definition for each score/rating for Criteria 15 (Community acceptance) is included below (refer Table 7-5). The score definitions for each criteria assessed in the MCA are included in Appendix D.

Table 7-5 Example MCA points allocation against definitions

2	Likely high level of community support
1	Likely moderate level of community support
0	Likely community acceptance (neutral)
-1	Likely moderate level of community objection/opposition
-2	Likely high level of community objection/opposition

For the total scoring of each technology, the allocated score for each criteria was multiplied by the respective weighting and summed to provide an overall total score. Each technology was assigned a ranking based on its total MCA score with 1 being the highest rank and 5 being the lowest. A breakdown of each technologies' ranking for each category as well as the overall ranking is included in Table 7-6. It should be noted, technologies are assigned the same ranking in a category if they receive the same score. The results for each category are discussed below. Full MCA details and results of the analysis are detailed in Appendix D.

Table 7-6 Technology ranking

	In-vessel composting	Anaerobic Digestion (dry)	Anaerobic Digestion (wet)	Direct combustion	Gasification
Financial performance	1	3	2	4	5
Technical performance	1	3	4	2	5
Social and Environmental	1	2	4	5	3
Risk/uncertainty	1	3	5	2	4
Overall ranking	**1**	**3**	**4**	**2**	**5**

7.3 Conclusion

7.3.1 In-vessel composting

In-vessel composting was ranked the most suitable technology and potential waste infrastructure in the Gladstone region. This technology was ranked the highest in all four categories.

Primary reasons for this result were that in-vessel composting scored the highest scores for market availability of by-products, proven technology, operational complexity, landfill reduction potential and supply chain. In-vessel composting is a lower cost treatment option compared to other technologies with a viable market demand for the end product, compost. There is believed to be a reliable supply of the feedstock, food and garden organics, as a result of the predicted increase in population.

In-vessel composting received scores of less than 0 for a number of criteria including the technologies alignment with the GRC Corporate Plan for which the technology was scored -1. This score was allocated due to the fact that the technology produces a compost and not energy, therefore is not able to contribute to GRC's goals of reducing fossil fuel reliant energy consumption. While in-vessel composting was ranked most favourably for risk/uncertainty it is important to note the potential for the technology to be disrupted by other competitors (such as other regional councils or private companies establishing similar facilities). For this criteria a score of -1 was allocated as the technology can be relatively tolerant of competition if it is well managed and products are sold to reliable markets.

In addition, process control over feedstock is important for any biological treatment process to ensure that markets for the end products remain viable and products are not susceptible to impact by contamination that could be associated with acceptance of some waste streams. For

in-vessel composting this includes potential issues with both physical contaminants in the feedstock (e.g plastic, glass, metal, asbestos etc.) and chemical contaminants that would not be destroyed by the treatment process such as PFAS. This can be most effectively controlled through strict quality control procedures for acceptance of waste at the facility. Where liquid waste streams or more industrial waste streams are added to the process this can increase the risk of contamination of end products.

In-vessel composting of food and garden organics at a regional municipal scale is considered viable, and there are multiple examples in regional New South Wales and Victoria where this has been led by the local government as the asset owner, in varying delivery models. At present in Queensland, it has been more common for composting facilities to be run as a merchant (private) facility, where the local government would negotiate a fee for the acceptance of the organics waste stream with the operator. Progressing the uptake of in-vessel composting would likely need to be accompanied by a third bin for food and/or garden organics or the establishment of additional pre-sorting facilities. Both of these must be considered when developing a business case for in-vessel composting.

7.3.2 Direct combustion and gasification

Direct combustion and gasification were the two thermal treatment options assessed against the MCA and were ranked the lowest respectively and the second lowest, respectively.

Both technologies reported similar social and environmental performance scores, with the lowest score (-2) given for approvals pathway and environmental compliance requirements. The implementation of direct combustion and gasification would likely require lengthy regulatory approval processes, which are still developing in Queensland. There are currently no similar existing facilities for MSW and C&I residual waste operating in Queensland, however a merchant facility is being proposed by Remondis in South East Queensland targeting up to 500,000 tonnes per annum of feedstock (including biomass).The facility has not yet received any approval or confirmation of the appropriate pathway to approval.

It is important to note that while direct combustion can treat a wider range of waste components in the MSW and C&I waste stream, compared to biological treatment technologies, the introduction of source separation of FOGO and/or GO will reduce the volume of available feedstock. An increase in recyclable recovery and circular economy initiatives also has the potential to impact the feedstock availability over the lifetime of a small EfW plant in Gladstone. To this point, the policy settings in Queensland (which is consistent with other Australian states and territories) for thermal EfW is such that these types of technology are only considered to be suitable for those materials in the economy that cannot be recycled or reused. Under the Queensland Waste Strategy this means that only 15% of the waste stream would be considered suitable for processing by thermal EfW technologies. In the case of Gladstone, this further reduces the available feedstock for such a facility, which further compromises the economic viability.

Direct combustion and gasification were both allocated the most favourable score for scale of community behaviour change required by residents, when compared to the other technologies. The implementation a biological treatment technology would require the implementation of a third kerbside bin for source separation of organics, and therefore at the household level behavioural changes would be significant. Whilst the organic fraction of the waste stream would be separated ahead of the thermal treatment technologies, this could either be done through source separation (i.e. third bin) or through pre-processing at a centralised facility (e.g. dirty MRF) or as a first step at a large scale thermal facility, such that behavioural change at the household level may not be required.

While direct combustion was allocated the highest score (2) for a number of financial, technical and social and environmental performance criteria, this thermal treatment option requires significant capital investment and is highly unlikely to be scalable at an economic level for the volumes of feedstock available in Gladstone and surrounding regions. There are numerous factors that would require careful evaluation in order to progress development of this type of waste management infrastructure and at this juncture, it is not considered that this is a viable option for Gladstone within the next 5-10 years, without additional feedstock.

Gasification ranked the lowest of all technologies evaluated in the MCA with the key differentiators being capital cost, operation complexity and the maturity of the technology at the required scale. While the technology does have the potential to treat multiple components within the MSW and C&I stream while reducing greenhouse gas emissions and creating employment opportunities within the region, the technology is a complex process with limited commercial examples operating Australia. It also requires highly specialised staff for operation, relatively high capital investment and high operating costs. As for direct combustion it is not considered to be a viable option for Gladstone within the next 5-10 years.

7.3.3 Anaerobic digestion

Dry anaerobic digestion and wet (low solids) anaerobic digestion ranked third and fourth, respectively. Both technologies scored very similar in all categories with relatively lower capital and operating costs compared to the thermal treatment options and can provide more readily scalable technology options at this point in time.

Both low and high solids digestion produce digestate as a by-product that requires some treatment before it can be used in land application, which may hinder the ability of the plant to generate revenue. Dry AD can treat food organics and some garden while wet AD can only treat food organics and accordingly, was allocated the lowest score (-2) for its ability to treat multiple components of the MSW and C&I waste streams. As wet AD requires soft organics like slurries it is likely that additional feedstock would have to be sourced from commercial and industrial operations such as food and drink manufacturing, or other sources of high strength trade wastes. To address the dryer organics component of the waste stream, it is recommended that should a wet AD option be progressed, that it be accompanied by some form of composting to drive organics diversion from landfill disposal, in line with Council's corporate plan and the Queensland waste strategy.

It is important to note that wet AD is a more mature technology in Australia and the implementation of a wet AD system at the existing Gladstone WWTP presents an opportunity to reduce the additional footprint disturbance.

At present regulatory and policy settings around the reuse of digestate are currently unclear in Queensland. Digestate from AD typically requires dewatering and stabilisation prior to being suitable for use as a soil conditioner or as an addition to compost. One of the reasons for the uncertainty is the potential risk of contamination by the emerging contaminant group, PFAS, which is becoming more widely detected in waste derived products which have previously been utilised to improve soil condition. While the science around the health and environmental risks of PFAS continues to develop, most jurisdictions are taking a conservative approach where by the application of waste derived products (composts) is being increasingly regulated and in some cases limited.

An AD option could be progressed with or without further energy recovery, electricity or fuel production. Energy recovery could be as simple as flaring of the biogas, electricity generation or further refinement of the gas to biomethane (also known as renewable natural gas), an emerging alternative fuel suitable as a replacement to natural gas. However each additional step creates additional complexity, capital and operating costs. For the foreseeable future it is

considered that biomethane production is unlikely to be economical in Queensland without significant subsidisation.

On the basis of the current market and policy situation, progression of wet or dry AD option for Gladstone could become viable in a future scenario. However the regulatory position requires further clarity and if AD were progressed for food organics, it should be accompanied by composting of dryer garden organics and vegetation.

8. Waste Strategy priorities

This Waste Management and Resource Recovery Strategy is a guidance document for Gladstone Regional Council to address issues of waste management and inform future planning. In the following section the strategies objectives and key actions across seven key priority areas are discussed. The purpose of the priorities is to work towards achieving the targets outlined in the *Queensland Waste Management and Resource Recovery Strategy 2019* and the *Gladstone Regional Council Corporate Plan 2018-2023.*

8.1 Priority 1 – Waste education

Education is a critical driver in the success of any proposed service and infrastructure changes and realisation of waste avoidance and reduction targets. The *Queensland Waste Management and Resource Recovery Strategy* highlights supporting the delivery of waste education as one of the key actions for local government under Strategic Priority 1 – reducing the impact of waste on the environment.

It has been established that litter and illegal dumping is an issue costing the Gladstone Regional Council approximately $200,000 a year. Queensland's *Litter and Illegal Dumping Action Plan* addresses the issues of litter and illegal dumping within the state with education, engagement and awareness raising is one of the five core programs that form the basis of the action plan.

The purpose of this priority is to use education and engagement to reduce household waste generation and litter and illegal dumping in the region. The waste education priority aligns with all waste hierarchy principles.

Avoidance and waste reduction	Reuse waste	Recycle or compost waste	Recover fuel or energy from waste	Dispose of Waste
✓	✓	✓	✓	✓

Objectives

The objectives of Strategic Priority 1 are to:

- Reduce household waste generation and litter and illegal dumping in the region.
- Build community support for any changes to waste management services and infrastructure.

Actions for delivery

The key actions and associated time frames for delivery for this Strategic Priority are outlined below.

Action	Timeframe
Appointment of a waste and recycling education officer	1 – 2 years
Development of a Gladstone region waste and recycling education plan, in consultation with other Central Queensland councils where appropriate	1 – 2 years
Update and action existing GRC *Litter and Illegal Dumping Prevention Strategy 2014*	1 – 2 years
Development of a community engagement and education program for proposed waste service and infrastructure changes	Ahead of proposed changes

8.2 Priority 2 – Reuse of recovered material in local projects

The reuse of recovered materials Strategic Priority focuses on the higher levels of the waste hierarchy. The reuse of recovered material in local projects prevent the waste from being disposed, as well as meeting the reuse waste hierarchy principle. By also specifying the use of recyclable and recoverable materials in the procurement process, waste generation is reduced and in some instances avoided.

Avoidance and waste reduction	Reuse waste	Recycle or compost waste	Recover fuel or energy from waste	Dispose of Waste
✓	✓			

Objectives

The objectives of Strategic Priority 2 are:

- Amend GRC procurement processes to drive resource recovery and reuse of recovered material in the region.
- Ensure that GRC takes a leadership role in supporting the development of markets for recycled and recovered materials.

Actions for development

The key actions and associated time frames when the actions will be delivered for this Strategic Priority are outlined below.

Action	Timeframe
Review contract conditions and procurement policies to identify barriers and opportunities to incorporating requirements for recycled content in Council procurement of goods and products	1 – 2 years
Implement contract and policy changes to increase recycled content in Council procurement of goods and products	3 – 5 years
Review Council engineering specifications to identify barriers and opportunities to drive the take up of recycled content in Council works programs (major and minor works)	1 – 2 years
Update Council engineering specifications to drive the take up of recycled content in Council works programs (major and minor works)	3 – 5 years
Review and update GRC procurement processes, where practicable, to incorporate the use of materials that are able to be reused or recycled at the end of their initial product lifecycle	3 – 5 years
Maintain active presence in Gladstone region industrial and business communities to stay abreast of emerging resource recovery and reuse opportunities and barriers	Ongoing
Collaborate with local industry to develop a plan to support the development of local and regional markets for recovered materials	Ongoing

Action	Timeframe
Consider the development of a Recovered Resources database or repository to foster trade of recovered materials such as clean fill, concrete, aggregate and other demolition products	1 – 2 years
Maintain active relationships with State Government and Local Government Association of Queensland (LGAQ) to stay abreast of policy changes and funding opportunities to support market development	Ongoing

8.3 Priority 3 – Landfill diversion through recycling

A number of opportunities were identified in Section 4 where landfill diversion could be increased through improved reuse and recycling initiatives. This priority focuses on increasing landfill diversion by maximising the amount of waste that is recycled and recovered. Increasing recycling rates involves significant community and business engagement and education, as well as service improvements to residents, local business and industry.

The contamination of recoverable waste streams hinders the ability to recover the material and ultimately, it must be disposed in landfill. In the Gladstone region, the main sources of contamination occur in the kerbside and public recycling bins, and asbestos containing material in soil/fill material. An average contamination rate of 20% has been reported for the kerbside recycling bins, compared to a state-wide average of 16%.

The provision of waste services play a key role in resource recovery and recycling. A kerbside residual waste bin audit conducted in the region revealed that green waste made up approximately 20-30% of the composition. It is important that GRC consider the merits of providing enhanced kerbside waste collection services that allow for optimised source separation and increased recovery of food waste and/or green waste. It is however noted that the business case for introducing a third bin for food waste, garden organics or FOGO may not necessarily be favourable for Council. Even though the overall waste quantities captured will increase and landfill diversion rates will increase, input costs for green waste processing will also increase, as will contaminations levels in organics captured for processing (at least in early stages). This will necessitate some level of decontamination and pre-processing (at a cost) and a percentage of residuals from organics processing requiring landfill disposal.

It may be appropriate to implement an interim processing solution following the roll out of a third bin, where organics are supplied to a private/merchant operator for compositing, whilst Council more fully considers their position in terms of provision of organics processing infrastructure.

The potential for collaboration with a suitable experienced private sector participants to support development of energy from waste or alternative fuel production is also included in this priority.

Avoidance and waste reduction	Reuse waste	Recycle or compost waste	Recover fuel or energy from waste	Dispose of Waste
✓	✓	✓	✓	

Objectives

The objective of Strategic Priority 3 is to:

- Increase recycling recovery rates from all waste streams to support activity towards GRC's goal of a 20% increase in recycling compared with 2017/18 baseline.

Actions for development

The key actions and associated time frames when the actions will be delivered for this Strategic Priority are outlined below.

Action	Timeframe
Consider broadening commercial recycling options provided by Council, including collection services together with attracting additional customers to waste facilities for recycling	1 – 2 years

Reduce contamination rates in yellow bin lid through development and implementation of education program	1 – 2 years
Explore introduction of a three bin kerbside collection system to recover food waste and/or green waste. Including consideration delivery model, service provision and regional collaboration	3 – 5 years
Develop an implementation plan for source separated organics i.e food waste, garden organics, or both (FOGO)	3 – 5 years
Implementation of the proposed “Precinct Upgrade” particularly recycling facilities at Benaraby Regional Landfill	1 – 2 years
Consider market led opportunities for provision of dry residual waste as feedstock for refuse derived fuel projects, by identifying suitably experienced private sector participants seeking to develop infrastructure or feedstock in the region	1-2 years

8.4 Priority 4 – Optimise existing infrastructure

The existing waste collection services and Council operated waste infrastructure, requires ongoing review to ensure they continue to meet Council's own corporate and operational objectives and are sufficiently flexible to adjust to changes in state or national policy positions.

Avoidance and waste reduction	Reuse waste	Recycle or compost waste	Recover fuel or energy from waste	Dispose of Waste
		✓		✓

Objectives

The objective of Strategic Priority 4 is to:

- Optimise GRC waste services and infrastructure to support efficient waste management.

Actions for development

The key actions and associated time frames when the actions will be delivered for this Strategic Priority are outlined below.

Action	Timeframe
Operational efficiency review of current transfer station network including locations, operating hours, materials handled and staffing arrangements	1 – 2 years
Review of current waste collection services contracts (and commercial arrangements)	1 – 2 years
Ongoing monitoring to review the success of "Precinct Upgrade" at Benaraby Landfill after implementation, in terms of improved recycling and resource recovery performance	3 – 5 years and then ongoing

8.5 Priority 5 – Organics processing infrastructure

As discussed in Section 6, a series of biological and thermal waste processing technology options were reviewed and assessed via MCA to assess potentially suitable options for GRC. This priority focuses on considerations surrounding the potential for implementation of waste technology options in the region.

From the MCA, in-vessel composting was ranked the most applicable technology for waste management in the region. In-vessel composting aligns with “Recycle or compost waste” in the waste hierarchy, supports the GRC Corporate Plan goals to target zero waste to landfills and also supports action towards recycling targets. Composting however targets the organic fraction of the waste stream only and will not on its own fully achieve recycling and zero waste goals.

There are numerous factors affecting the potential for commercially viable implementation of a waste processing technology solution for GRC. While there is believed to be a reliable supply of feedstock, further analysis is required to provide a more accurate description of the volumes and composition of feedstock available, as data quality is currently a significant barrier to further consideration of the viability of this option.

It is also possible that opportunity may exist for collaboration with the private sector and further discussions with other local government authorities is required. It is noted that any infrastructure decision should not be made until such time as the Queensland Government release the *Waste and Resource Recovery Infrastructure Plan*. Based on discussions with DES, the plan is due for release (in draft) by end of 2019 calendar year and will set out the State’s preference for infrastructure based on an assessment of state wide waste and resource recovery data, population growth estimates and waste generation forecasts. Alignment with the plan should facilitate a more straightforward approvals process with the State.

Avoidance and waste reduction	Reuse waste	Recycle or compost waste	Recover fuel or energy from waste	Dispose of Waste
		✓	✓	✓

Objectives

The objective of Strategic Priority 5 is:

- Develop a plan to drive the reduction in organics disposed to landfill, aligned to GRC and State government targets.

Actions for development

The key actions and associated timeframes when the actions will be delivered for this Strategic Priority are outlined below.

Action	Timeframe
Review waste generation and composition data	1 – 2 years
Conduct a detailed economic feasibility study for the proposed infrastructure, including market review for end products	3 – 5 years
Determine Council’s role in infrastructure delivery and operation	1 – 2 years
Develop a business case and approach to market	3 – 5 years

Action	Timeframe
Identify potential for collaboration with suitably experienced private sector participants to support development of organics processing infrastructure in the region	3 – 5 years
Implementation of stakeholder engagement and an education plan for proposed infrastructure	3 – 5 years (and ongoing)
Organics infrastructure development (if deemed viable)	5 – 10 years

8.6 Priority 6 – Regional collaboration

The purpose of this priority is to explore the potential for collaboration with surrounding councils in the Fitzroy region and local industry for future waste management and potential waste infrastructure. Although waste collection and aggregation is challenging as a result of the large area of the GRC and distances involved, consideration should be given to identifying potential for regional synergies. Quantities of waste generated in population centres outside of Gladstone are relatively low however there may be potential for realising transport efficiencies for certain wastes, and back loading of product (such as compost), in the event that development of new regional waste management infrastructure facilitates this.

It is also possible that scope may exist for aggregation of suitable feed stocks for solid fuel production from selected waste streams, including agricultural wastes, possibly through collaboration with private sector alternate fuel producers. These additional volumes may supplement quantities of high calorific value material potentially recoverable from the MSW, C&I and C&D waste streams in the region, improving overall project economics. This aligns with "Recover fuel from waste" in the waste hierarchy.

Avoidance and waste reduction	Reuse waste	Recycle or compost waste	Recover fuel or energy from waste	Dispose of Waste
✓		✓	✓	✓

Objectives

The objective of Strategic Priority 4 are as follows:

- Further explore waste management opportunities at a regional level.

Actions for development

The key actions and associated time frames when the actions will be delivered for this Strategic Priority are outlined below.

Action	Timeframe
Review appropriateness of kerbside recycling materials collected with respect to markets/reprocessing options for recovered commodities during contract review and retendering	1 – 2 years
Continue participating in co-mingled recycling processing services with RRC MRF	Ongoing
Assess collaborative opportunities with surrounding LGAs, including regional funding	Ongoing

8.7 Priority 7 – Data collection and management

Reliable and transparent data is crucial for regional collaboration and waste infrastructure planning. Furthermore, consistent and accurate data allows for meaningful review of waste reduction targets, performance evaluations and meaningful comparison with the state and other local councils. The purpose of this priority is to improve waste data collection and reporting in the region. This was a barrier to further analysis and insight in the development of this Strategy.

It is acknowledged that the State Government through the Department of Environment and Science are currently working on a number of avenues to improve waste data collection across Queensland. This includes potential changes the Queensland Waste Data System framework as well as the development of materials flows analysis for key material streams in the economy. These underpin monitoring of progress towards achieving the goals and targets of the *Queensland Waste and Resource Recovery Strategy*, *Resource Recovery Industry Roadmap* and the development of a Circular Economy Policy for Queensland. Therefore the actions identified in this priority may or may not be in the direct control of Gladstone Regional Council.

Avoidance and waste reduction	Reuse waste	Recycle or compost waste	Recover fuel or energy from waste	Dispose of Waste
✓	✓	✓		

Objectives

The objective of Strategic Priority 7 is to:

- Improve and standardise waste data collection.

Actions for development

The key actions and associated time frames when the actions will be delivered for this Strategic Priority are outlined below.

Action	Timeframe
Development of standard data collection systems and reporting template	1 – 2 years
Improve data collection of GRC waste generation and reuse (i.e. green waste and construction and demolition waste) to better inform decision making on changes in service and infrastructure planning	1 – 10 years
Include the provision of data in electronic format in contracts with waste service providers	1 – 10 years
Map regional waste data as a means to inform better waste management and infrastructure planning	1 – 10 years

9. Implementation plan

The proposed 10 year implementation plan for the Gladstone Regional Council's Waste Management and Resource Recovery Strategy actions is outlined below.

Strategic actions	Delivery timeframe									
	Years									
	1	2	3	4	5	6	7	8	9	10
Priority 1 – Waste education										
Appoint waste and recycling education officer										
Develop Gladstone region waste and recycling education plan										
Update and action existing *GRC Litter and Illegal Dumping Prevention Strategy 2014*										
Develop community engagement and education program	*Ahead of proposed changes*									
Priority 2 – Reuse of recovered material in local projects										
Review contract conditions and procurement policies										
Review Council engineering specifications										
Develop recovered resources database or repository										
Review and update GRC procurement processes										
Implement contract and policy changes										
Update Council engineering specifications										
Maintain active presence in Gladstone region industrial and business communities										
Collaborate with local industry for market development										
Maintain active relationships with State Government and Local Government Association of Queensland										

Strategic actions	Delivery timeframe									
	Years									
	1	2	3	4	5	6	7	8	9	10
Priority 3 – Landfill diversion through recycling										
Assess options to increase commercial recycling										
Implement an education program, to reduce contamination rates										
Construct “Precinct Upgrade” at Benaraby Regional Landfill										
Consider supply of feedstock for refuse derived fuel projects										
Review options for a three bin kerbside collection system										
Develop plan for source separated organics										
Priority 4 – Optimise existing infrastructure										
Review operation of current transfer station network										
Review of current waste collection services contracts										
Ongoing review of the “Precinct Upgrade” at Benaraby Regional Landfill										
Priority 5 – Organics processing infrastructure										
Review waste generation and composition data										
Determine Council role in infrastructure delivery and operation										
Identify suitably experienced private sector participants										
Develop detailed economic feasibility study										
Develop a business case										
Develop and implement stakeholder engagement and education plan										
Undertake organics infrastructure development (if deemed viable)										

Strategic actions	Delivery timeframe									
	Years									
	1	2	3	4	5	6	7	8	9	10
Priority 6 – Regional collaboration										
Audit kerbside recycling materials collected										
Participate in RRC MRF co-mingled recycling processing services										
Identify collaboration opportunities with surrounding LGAs										
Priority 7 – Data collection and management										
Develop standard data collection systems and reporting template										
Improve data collection of GRC waste generation and reuse										
Provision of data in electronic format in waste service contracts										
Develop regional waste data mapping										

10. References

10.1 Legislation and regulation

Environmental Protection Act 1994

Environmental Protection Regulation 2008

Environmental Protection (Waste Management) Regulation 2000

Local Government Act 2009

National Environmental Protection Council Act

National greenhouse Gas and Reporting Act (NGER Act 2007)

Product Stewardship for Oil Act (2007)

Product Stewardship for Products Act (2011

Waste Reduction and Recycling Act 2011

Waste Reduction and Recycling Regulation 2011

10.2 References

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Blue Environment Pty Ltd and Randell Environmental Consulting (2018) *National Waste Report 2018*, prepared for the Department of the Environment and Energy

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GHD (2019) *Gladstone Regional Council Waste Strategy Phase 1 and 2 Interim Report June 2019*

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Gladstone Regional Council (2018) *Gladstone Regional Council 2018 – 2023 Corporate Plan*

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Queensland Government (2018) *Recycling and waste in Queensland 2018,*

Queensland Government (2019) *Queensland Waste Data System*

Queensland Government (2019) *Queensland Waste Management and Resource Recovery Strategy*

Queensland Government (2019) *Transforming Queensland's Recycling and Waste Industry – Directions Paper*

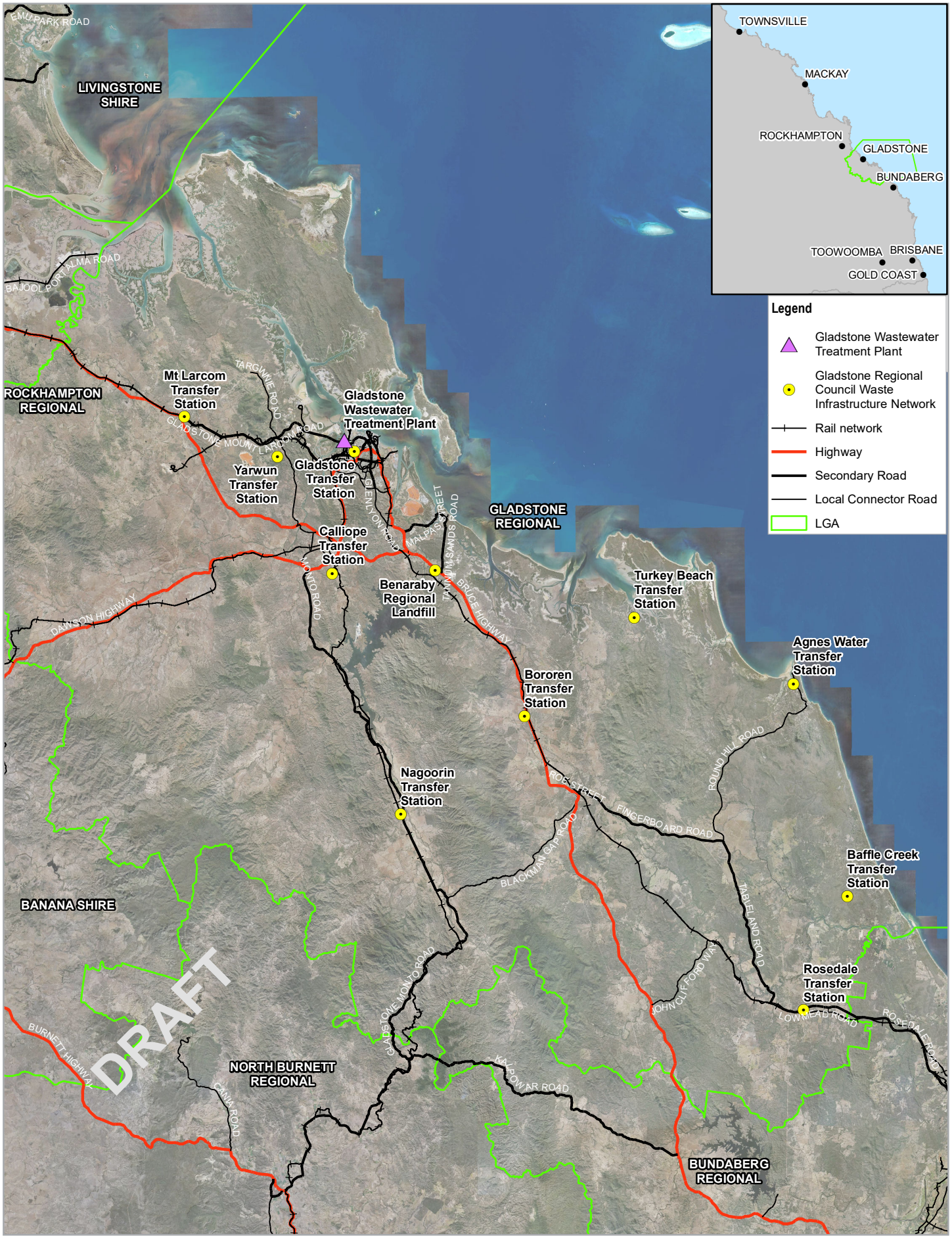
Queensland Government Statistician's Office (2015), *Local government areas snapshot*

Sustainability Victoria (2018) *Guide to Biological Recovery of Organics*

Sustainability Victoria (2018) *Resource Recovery Technology Guide*

Appendices

Appendix A – Gladstone Region Waste Infrastructure Map



Paper Size ISO A4

0 5 10 15 20

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Gladstone Regional Council
Gladstone Regional Council Waste Strategy

Project No. 41-32593
Revision No. B
Date 26/08/2019

Gladstone Regional Council Waste Infrastructure Network

FIGURE 1

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Print date: 26 Aug 2019 - 14:07

Data source: DNRME - LGA, Road (2019), Rail (2017). GA - Place Names, Mainlands (2007) GHD - Waste infrastructure network, Gladstone Wastewater Treatment Plant (2019) . Created by: knoble

Appendix B – Gladstone Regional Council Waste Data

Appendix B

Gladstone Regional Council waste Data 2015-2018

Waste Stream	Received (tonnes)			Recovered (tonnes)			Disposed (tonnes)		
	2015/2016	2016/2017	2017/2018	2015/2016	2016/2017	2017/2018	2015/2016	2016/2017	2017/2018
Asbestos	339.57	339.57	249.27	0	0	0	339.57	339.57	249.27
Acid sulfate	0	34.5	185.93	0	0	0	0	34.5	185.93
Aluminium Cans				47	46.1	44.42			
Biosolids	530	858.4	1044.6	232	858.4	1044.6	0	0	0
Cardboard				187	241.41	425.07			
Chemicals(1)				0	0	1.66			
Clean Earthern	42847.61	3544.87	579.98	42847.6	38	579.98	0	0	0
Contaminated soil	237	195.5	36.72	0	0	243.5	237	195.5	243.5
Concrete				3778.43	1501.06	1183			
E-waste				79.5	60.2	63.12			
Ferrous Metals				300	1619.68	1064.44			
General Kerbside	16900	15541.36	15121.9						
General waste (street/public place)	175	5342.1	5436.8						
Glass				1307	1290.9	1243.66			
Litter/illegal	100	62.23	26.09						
Lead Batteries				44.66	76.17	42.3			
Mineral Oil					20.91	281.95			
Non-Ferrous Metal				50	59.09	599.16			
Paper and packaging (street/public place)	55	55	34.26						
Paper and packaging from commercial sources	200								
Paper				2194	2166.41	2087.58			
Plastics				280	276.62	266.5			
Self haul	5000	2015	11417						
Steel Cans				93	92.21	88.83			
Timber				1666.68	738.87	63.01			
Tyres				84	0	26.7			
Commercial Green waste	2000	1186.7	987.52	16650	3800	3263.64	348	0	0
Residential Green waste	15000	424.89	1631.82						
Other regulated	726	0	0				726	0	0
Comercial and Industrial	29200	19932.48	13046.8				22882	16556.77	12059.28
Construction and demolition	10292	3500	5854.86				5680	1128.73	1075.53
Municipal solid waste	42230	28050.92	38158.38				13169	15541.36	15666

Data not provided

Appendix C – EfW Technology Information

Appendix C
Biological and Thermal Technologies

Technology type	Technology definition	Technology options	Accepted feedstock	Scale	Footprint	Indicative capital cost	Indicative operating costs	Products / By-products	Opportunities	Constraints	Case studies
Direct combustion	The feedstock (waste or a fuel derived from waste) is burnt in excess oxygen (from air) to produce heat or release the energy contained in the feedstock.	Moving grate Fixed grate Fluidised bed	MSW, C&I, RDF, Wood, Hazardous waste, clinical waste	50,000 - 400,000 tpa (large plants are 1 million+ tpa)[3]	0.15-0.2m2/t [1]	$60M - $100M[1]	$110-$170/tonne [3]	Heat Incinerator bottom ash Air pollution control residues	- Diversion of materials from landfill - Heat and electricity generation - Potential use for incinerator bottom as an aggregate substitute - Mature and proven technology - Tolerates a wide range of wastes	- Requires gas cleaning and monitoring systems - By products may need to be handled as hazardous waste - Power generation via raising steam for a turbine - low energy efficiency and possible risk of corrosion due to nature of feed stock	Macadamia Nut Power Plant - AGL Energy Services
Gasification	The feedstock (organics or fossilised organic materials (e.g. coal)) is converted at elevated temperatures, with controlled amounts of oxygen, into a synthesis gas (syngas).	Fluidised bed Plasma	C&I, MSW, woodchip, clean biomass and hazardous wastes, RDF	>10,000-250,000 tpa [3]	0.12-0.2m2/t [1]	$80M - $130M[1]	$120-$180/tonne [3]	Syngas Heat char/aggregate product (such as slag)	- Syngas has potential to be used as a versatile fuel	- Feedstock properties are narrower than conventional combustion - Process required to make waste suitable for gasification will require some energy input, additional space and operating cost - High capital costs for infrastructure/construction - Few operating examples on complex feed stocks with >2 yrs continuous operating history - Limited experience operating gasifiers with MSW feedstock - Few gasifiers producing syngas for export as product (globally)	
Pyrolysis	The feedstock is heated in the absence of oxygen causing the organic solids to breakdown through physical and chemical processes into char, oil and gas.	Fixed bed/retort Combined pyrolysis and gasification	RDF, MSW, industrial waste, medical waste, oil and sewage sludge, tyres, waste plastics	10,000-100,000 tpa [1]	0.12-0.4m2/t	$30M - $50M[1]	$100-$170/tonne [5]	Pyrolysis oil Syngas Char Bottom ash [5]	- Pyrolysis oil has potential to be refined into a versatile "drop in" liquid fuel	- Limited experience of waste pyrolysis - Disposal of byproducts - Cost of refining pyrolysis oil into market ready fuel - Limited commercial operating experience using MSW	Northern Oil Advanced Biofuels Refinery - Southern Oil & J.J. Richards
Composting	An aerobic process where organic waste is converted into compost product which can be used as a soil conditioner.	Open windrow Enclosed/covered In-vessel	Garden organics (GO), food organics and garden organics (FOGO) - separated or commingled, Commercial food wastes, manures	In vessel: 10,000 - 100,000 tpa Open: 2,00-0 - 50,0000 tpa	Open: 0.7-0.8 m2/t* [2] In vessel: 0.4 - 0.7 m2/t* [2]	Open : $3M - $5M[2] In-vessel: $9M - $15M[2]	Open: $20-$35/tonne[2] In-vessel: >$50-$80/tonne	Compost, mulch	- Applied at small scale to commercial scale - Low capital investment - Tolerant to fluctuations in feedstock capacity - Relatively easy to expand capacity	- Increased risk of odour release (i.e. not suitable for highly urban environments) - Large footprint or land required - Market demand for products can be limited	Open windrow composting facility Dingley Village - Enviromix Bulla Organics Recycling Facility (IVC) - Veolia
Anaerobic digestion	The feedstock (biodegradable material) is broken down by micro organisms through a series of anaerobic (absence of oxygen) processes into biogas and digestate.	Low solids Multi-stage Dry or high solids	FOGO, Additional organics (commercial food and food manufacturing, agricultural, energy crops, WWTP sludge, and biowaste) Combined digestion of food waste and other biowaste (biosolids)	Dry: 20,000-80,000 tpa Wet: 10,000 - 50,000 tpa	Dry: 0.4-0.7 m2/t* [2] Wet: 0.2-0.4 m2/t* [2]	Dry: $15M - $25M[2] Wet: $12M - $20M[2]	Dry: >$50-$80/tonne[2] Wet: $35-$50/tonne [2]	Biogas, biomethane, CNG, electricity, heat, digestate	-Low or negligible emissions - Digestate can be spread on land - Potential for digestion of biosolids with organic waste	- Less tolerant to fluctuations in feedstock quantity - Can only be scaled with the addition of extra digestion tanks - Energy recovery through gas engine gives low efficiency - Digestate may require further processing (e.g. pasteurisation or composting) before land application - Digestate can be highly odorous - Regulatory policy settings around digestate uses currently unclear	Aurora food to waste energy plant - Yarra Valley Water, Vic Richgro/Biogas Renewables AD facility - Jandakot WA
Mechanical biological treatment (MBT)	The combination of several processes, such as a MRF and composting or anaerobic digestion.	Combination of mechanical processing technologies and biological processing	MSW, C&I and Additional single stream organics	50,000-250,000 tpa [1]	0.2-0.5m2/t	$50M - $80M[1]		Recyclable materials, compost, RDF *Output is dependent on configuration*	- Can be designed to suit local requirements - Can treat a wide range of waste streams - Does not require source separation	- High cost - Difficult to secure viable market for outputs/products - Low revenue	Eastern Creek UR-3R Facility
Hydrothermal Liquefaction (HTL)	A thermal process where the feedstock is subject to high pressures and temperatures of around 250C to 350C, breaking down the solids into liquid components. This process results in the conversion of carbon into bio-crude, a liquid that can be further refined into bio fuels	Thermochemical process	Biosolids, food processing slurries, manures, high lignin wastes and woody biomass	*No data available	*No data available	*No data available	*No data available	Bio-crude Contaminated water Contaminants	- Feedstock does not need to be dried before treatment - Tolerant to some fluctuation in feedstock quality	- Bio-crude requires processing to remove oxygen prior to distillation - Very low commercial maturity in Australia	

Notes

1. Sustainability Victoria (2018) Resource Recovery Technology Guide
2. Sustainability Victoria (2018) Guide to Biological Recovery of Organics
3. Ricardo-AEA (2013) *Waste to Energy Background paper,* prepared for Zero Waste SA
3. JRC Science (2016) *Towards a better exploitation of the technical potential of waste-to-energy* , prepared for European Commission
4. WALGA (2013) *Waste to Energy Discussion Paper*
5. WALGA (2009) *Alternative Waste Treatment (AWT) Technology Discussion paper*

Appendix D – Multi Criteria Analysis

Appendix D
Multi Criteria Analysis

Category		Criteria	Weighting		Question	Score: In-vessel composting	Anaerobic Digestion (dry)	Anaerobic Digestion (wet) (1)	Direct Combustion	Gasification
Financial	1	Operational cost	12.5%	40%	What are the operational costs of the technology?	1	0	0	-1	-2
	2	Capital cost (relative to competing options)	10.0%		What is the capital investment required for the technology?	-1	-1	0	-2	-2
	3	Ability to generate revenue	10.0%		Can the technology generate revenue to offset energy consumption costs?	0	-1	-1	1	1
	4	Market availability for end products	3.75%		Is there a viable market demand/availability for end products over life of facility?	1	2	2	2	1
	5	Market availability for by-products	3.75%		Is there a viable market demand/availability for by-products over life of facility?	2	0	0	-1	-1
					SUB TOTAL	0.14	-0.13	-0.03	-0.19	-0.35
Technical Performance	6	Proven technology	10.0%	25%	Is the technology proven and reliable for the waste stream/material under consideration?	2	0	0	2	-1
	7	Operational complexity	7.5%		Does the technology have operational simplicity in its process that capitalises on existing regional skill base?	2	0	0	-1	-2
	8	Treatable components of MSW and C&I stream	2.5%		Does the technology readily treat multiple components of the waste stream?	-1	-1	-2	1	2
	9	Feedstock pre-treatment requirements	2.5%		What level of pre-treatment of feedstock is required for the technology	0	-1	-1	2	-2
	10	Feedstock quantity flexibility	2.5%		Is the technology able to handle variation in waste input quantity with little additional expenditure?	0	-1	-1	-1	-1
					SUB TOTAL	0.33	-0.08	-0.10	0.18	-0.28
Social and Environmental	11	Scale of community behaviour change	3.0%	20%	What level of behaviour change is required of residents as part of the implementation of the infrastructure option?	-1	-1	-1	1	1
	12	Employment opportunities	3.0%		Does the technology create new job opportunities within GRC?	0	1	0	2	2
	13	Greenhouse gas reduction	3.0%		Does the technology reduce greenhouse gas emissions compared to landfill disposal?	1	2	2	1	1
	14	Alignment with GRC Corporate Plan	2.0%		Does the technology contribute with the GRC Corporate plan goal to decrease reliance on landfill, target zero waste to landfill and reduce fossil fuel reliant energy consumption?	-1	0	0	1	1
	15	Community acceptance	2.0%		What is the likely level of community support for the proposed technology?	1	0	0	-1	0
	16	Approvals pathway - statutory and environmental	2.0%		How long will it take and level of complexity in process required to get to get approvals	1	0	0	-2	-2
	17	Ongoing environmental compliance requirements	2.0%		What is the level of complexity and cost of ongoing environmental compliance for the technology?	0	-1	-1	-2	-2
	18	Potential air quality impacts	2.0%		What controls are required to manage potential impacts on air quality, including odour?	1	0	0	-1	-1
	19	Landfill reduction potential	1.0%		To what extent does the technology divert waste from landfill?	2	1	0	-1	-1
					SUB TOTAL	0.06	0.05	0.01	0.01	0.03
Risk/Uncertainty	20	Supply chain	5.0%	15%	How reliable is the feedstock supply?	2	2	2	0	-1
	21	Volatility of market for end products	5.0%		Is there a secure market/take off for products and by-products?	0	0	-1	1	1
	22	Susceptibility to competition	3.0%		What is the potential for the technology to be disrupted by other competitors (feedstock, products)?	-1	-1	-1	0	1
	23	Policy/governance changes	2.0%		How resilient is the technology to policy changes?	1	-1	-1	-1	-1
					SUB TOTAL	0.09	0.05	0.00	0.03	0.01

Notes

(1) Introduction of wet AD system with capacity for digestion of food waste and wastewater treatment sludge (biosolids) at Gladstone WWTP.

TOTAL SCORE	0.61	-0.10	-0.12	0.03	-0.59
Adjusted score (multiplied x100)	61.25	-10.00	-12	3	-59
Re-baselined (plus 100)	161.25	90.00	89	103	42
RANKING	**1**	**3**	**4**	**2**	**5**

Appendix D
Multi-criteria Analysis Scoring Definitions

Criteria	Question	Weighting		-2	-1	0	1	2
Financial Performance								
Operational cost	What are the operational costs of the technology?	12.50%	40%	High operational costs	Moderate to high operational costs	Moderate operational costs	Low to moderate operational costs	Low operational costs
Capital cost (relative to competing options)	What is the capital investment required for the technology?	10.00%		High capital investment required to establish	Moderate to high capital cost	Moderate cost of capital investment	Low to moderate capital cost	Low capital investment required to establish
Ability to generate revenue	Can the technology generate revenue to offset energy consumption costs?	10.00%		Risk of increasing negative revenue (cost) for disposing by-products	No net revenue generated and some costs for managing by-products	No net energy revenue generated	Stable net energy revenue generation	Increasing net energy revenue generation
Market availability for end products	Is there a viable market demand/availability for end products over life of facility?	3.75%		No viable market in the region (over 20 years) for products	Developing regional market demand for products (over 20 years)	Likely viable market in the region for products (over 20 years)	Moderately stable end market for products (over 20 years)	Very stable, viable market for products (over 20 years)
Market availability for by-products	Is there a viable market demand/availability for by-products over life of facility?	3.75%		No viable market in the region (over 20 years) for by-products	Developing regional market demand for by-products (over 20 years)	Likely viable market in the region for by-products (over 20 years)	Moderately stable end market for by-products (over 20 years)	Very stable, viable market for by-products (over 20 years)
Technical Performance								
Proven technology	Is the technology proven and reliable for the waste stream/material under consideration?	10%	25%	Concept or discontinuous operation of experimental/pilot plant in Australia or internationally	Continuous operation of a pilot or proof of concept plant (substantial reliability demonstrated at process level); not yet continuously operating commercially	Operated successfully at commercial scale in Australia or internationally for 1-2 years (acceptable reliability demonstrated)	Operated successfully at commercial scale in Australia or internationally for >5 years (good reliability demonstrated); some process optimisation expected over time.	Operated successfully at commercial scale in Australia for many years (5+ years) and stable, well proven technology with reliable operating performance and minimal requirement for scheduled downtime.
Operational complexity	Does the technology have operational simplicity in its process that capitalises on existing regional skill base?	7.5%		Highly complex, specialised/skilled staff required. Skills not currently available in the region.	Moderately complex, specialised/skilled staff required. Skills not currently available in the region.	Moderately complex operation. Upskilling of regional staff required.	Simple to moderately complex operation. Some basic training required.	Simple operation, basic level of training required. Skills readily available in region.
Treatable components of MSW and C&I stream	Does the technology readily treat multiple components of the waste stream?	2.5%		Can only process single (homogenous) waste streams	Can accept some variance in waste streams but only suitable for MSW or C&I	Can accept some variance in waste streams	Can accept a wide variety of waste streams (MSW or C&I)	Can accept a wide variety of waste streams (including MSW and C&I)
Feedstock pre-treatment requirements	What level of pre-treatment of feedstock is required for the technology	2.5%		Requires extensive pre-treatment involving extensive mechanical processes (shredding, grinding, sorting and/or drying)	Requires moderate pre-treatment (grinding/shredding only)	Requires pre-treatment involving simple manual processes (i.e. removal of bulky items, contaminants and recoverable material).	Requires minimal pre-treatment (selective visual screening on receipt)	No pre-treatment of feedstock required
Feedstock quantity flexibility	Is the technology able to handle variation in waste input quantity with little additional expenditure?	2.5%		Inflexible waste input quantity without significant additional expenditure	Can handle small variation in input quantity	Able to handle moderate variation in waste input quantity with little additional expenditure	Able to handle moderate to large variations in waste input quantity with little additional expenditure	Able to handle large variations in waste input quantity with no additional expenditure
Social and Environmental								
Scale of community behaviour change	What level of behaviour change is required of residents as part of the implementation of the infrastructure option?	3.0%	20%	Unrealistic level of behaviour change required of residents	Moderate level of behaviour change required of residents	Acceptable level of behaviour change required of residents	Minimal behaviour change required of residents	No behaviour change required of residents
Employment opportunities	Does the technology create new job opportunities within GRC?	3.0%		No net increase in jobs created and displacement (loss) of existing employment in the region	No net increase in local jobs created but current levels maintained	<5 new jobs created; net increase in long term regional employment (direct and indirect)	<10 new jobs created; net increase in long term regional employment (direct and indirect)	10+ new jobs created; net increase in long term regional employment (direct and indirect)
Greenhouse gas reduction	Does the technology reduce greenhouse gas emissions compared to landfill disposal?	3.0%		Significant increase in net greenhouse gas emissions compared to landfill disposal	Moderate increase in net greenhouse gas emissions compared to landfill disposal	No reduction in greenhouse gas emissions compared to landfill disposal	Moderate net reduction in greenhouse gas emissions compared to landfill disposal	Significant net reduction in greenhouse gas emissions compared to landfill disposal
Alignment with GRC Corporate Plan	Does the technology contribute with the GRC Corporate plan goal to decrease reliance on landfill, target zero waste to landfill and reduce fossil fuel reliant energy consumption?	2.0%		Lowest contribution to corporate plan targets	Low relative contribution to corporate plan targets	Modest contribution to corporate plan targets	Moderate contribution to corporate plan targets	Highest contribution to corporate plan targets
Community acceptance	What is the likely level of community support for the proposed technology?	2.0%		High level of community objection/opposition	Moderate level of community objection/opposition	Community acceptance (neutral)	Moderate level of community support	High level of community support
Approvals pathway - statutory and environmental	How long will it take and level of complexity in process required to get to get approvals	2.0%		Extensive approval process with duration expected >3 yrs	Approval process with duration expected 2 to 3 years	Approval process with duration expected 1 to 2 years	Approval process with duration expected around 1 year	Straightforward approval process and less than 1 year
Ongoing environmental compliance requirements	What is the level of complexity and cost of ongoing environmental compliance for the technology?	2.0%		Extensive and costly ongoing environmental compliance; high maintenance	Moderate and somewhat expensive ongoing environmental compliance	Modest ongoing environmental compliance requirements and costs (compared to other options)	Relatively low ongoing environmental compliance requirements and costs (compared to other options)	Straightforward and lowest cost environmental compliance
Potential air quality impacts	What controls are required to manage potential impacts on air quality, including odour?	2.0%		High level of offensive odour production and risk of regular impacts on surrounding sensitive receptors	Moderate level of odour production and risk of regular impacts on surrounding sensitive receptors	Some risk of odour nuisance events <5% of yr (<440 hrs)	Some risk of odour nuisance events <1% of yr (<88 hrs)	No odour produced
Landfill reduction potent	To what extent does the technology divert waste from landfill?	1.0%		Minimal diversion of waste from landfill	Low diversion of waste from landfill	Modest diversion of waste from landfill	Significant diversion of waste from landfill	Highest diversion of waste to landfill
Risk/Uncertainty								
Supply chain	How reliable is the feedstock supply?	5%	15%	Unreliable and/or inadequate feedstock supply	Some fluctuation in feedstock availability	Reliable feedstock supply	Short term increase only in feedstock supply	Long term increasing feedstock supply
Volatility of market for end products	Is there a secure market/take off for products and by-products?	5%		Risk of high volatility in market for products and by-products	Risk of moderate volatility in market for products and by-products	Developing market for products and by-products	Stable market for products and by-products	Increasing demand and/or value for end products
Susceptibility to competition	What is the potential for the technology to be disrupted by other competitors (feedstock, products)?	3%		Highly susceptible to competition	Moderately susceptible to competition	Somewhat susceptible to competition	Slightly susceptible to competition	Not susceptible to competition
Policy/governance changes	How resilient is the technology to policy changes?	2%		Highly sensitive to policy/governance and regulatory changes	Moderately sensitive to policy/governance and regulatory changes	Somewhat sensitive to policy/governance and regulatory changes	Low sensitivity to policy/governance and regulatory changes	Resilient to policy/governance and regulatory changes

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Revision	Author	Reviewer		Approved for Issue		
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