1. General Information

1.1 Introduction

This document details the proposal by Recovered Energy Australia (REA) for the development of a Municipal Solid Waste to Energy (WtE) Project in Laverton North, 18km west of Melbourne’s CBD (Figure 1-1).

Making a significant contribution to Melbourne’s resource recovery objectives, the WtE facility is planned to enable more than 97% of waste it processes to be diverted from landfill, add flexibility to Victoria’s waste management system and extend the life of existing landfills.

The proposed plant will recover energy through gasification technology that will then be converted to electricity using steam turbines. Initially this energy will be distributed through the existing electricity grid. As the surrounding industrial estate develops, the plant will provide steam and/or heat to nearby industry, as required.

The plant will predominantly use waste from the separated general waste stream generated by households across Melbourne’s local municipal areas (typically the red bin in Plate 1-1). This will be supplemented by residual waste now sent to landfill after sorting is completed at Materials Recovery Facilities (MRF). Given the focus on residual source separated household and post MRF wastes, the proposed facility and the selected gasification technology will supplement and not undermine existing recycling programs. It is not the intention to import and process any other waste streams. Hazardous wastes or prescribed wastes will not be processed in this WtE facility.

Plate 1-1: Source Separated Household Municipal Waste

This Works Approval Application (WAA) has been developed to fulfil the statutory requirement of the Environmental Protection Authority, Victoria (EPA) and follows the EPA Works Approval Application Guidelines, Publication 1658.

The project will allow REA to develop a sustainable alternative solution to landfilling a portion of Melbourne’s residual waste through releasing the energy incorporated in the waste and generating
a long-term, stable base load energy source which can provide steam and heat to local industry and
electricity into the national grid.

The project will involve the development of a thermal WtE plant within the designated Laverton
Industrial 2 Zone. The WtE plant will use state of the art Advanced Thermal Treatment (ATT)
Technology to recover energy through the gasification of a nominal 200,000 tonnes (+/- 20%) of
residual Municipal Solid Waste (MSW) per annum, sourced from the Melbourne metropolitan area.

The structure of this application document is outlined below:

- Section 1: This section provides an introduction to the proposed project, providing details of
  the proponent, the scope, purpose and rationale for the project, the project benefits, the
  choice of technology and an overview of the project;
- Section 2: This section provides an overview of the planning context and other approvals
  required, together with the rationale for choosing the Laverton North site for the project
  and the projected project implementation time frame;
- Section 3: This section outlines the track records of the engineering, procurement and
  construction (EPC) contractors, summarising their experience and capabilities regarding
  supplying the technology and designing and constructing the facility.
- Section 4: This section provides an overview of community and stakeholder consultation
  undertaken to date, the issues raised by the various stakeholders and outlines future
  consultation activities that are planned as the project moves forward.
- Section 5: This section provides details on the risk analysis completed to inform both the
  facility design and the best practice assessment;
- Section 6: This section provides a more detailed description of the project including input
  and output streams, details of the technology and the process proposed for the project, site
  layout and separation distances;
- Section 7: This section provides details on how the technology and practices proposed
  represent best practice;
- Section 8: This section describes energy use, greenhouse gas implications of the project and a
  consideration of the potential impacts of climate change;
- Section 9: This section describes water resource use within the project;
- Section 10: This section describes the air emissions impacts expected from the project;
- Section 11: This section describes the noise emissions impacts expected from the project;
- Section 12: This section discusses surface water considerations associated with the
  development of the project;
- Section 13: This section discusses land and groundwater considerations associated with the
  project;
- Section 14: This section describes the characteristics of solid waste generated by the project
  and details the characteristics and destination of industrial and prescribed waste;
- Section 15: This section includes a risk assessment of non-routine operations and outlines
  the framework for ongoing environmental management during the construction and
  operation of the project;
- Section 16: This section describes the health risk assessment undertaken for the proposed
  WtE facility.
Figure 1-1: Map Showing the General Location of the Proposed REA Municipal Waste to Energy Facility
1.2 Primary Information

1.2.1 Company Legal Entity
Company Name: Recovered Energy Australia Pty Ltd
ABN: 80524914064
ACN: 619571489
Corporate Office: Suite 13, 150 Chestnut Street, Cremorne, Richmond, Victoria. 3121

A current ASIC company extract is attached in Appendix 1.

1.2.2 Contact Details
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1.3 Introduction to the Project

1.3.1 Scope and Purpose of Works Approval
This WAA seeks statutory approval to develop a WtE plant based on the processing of residual household waste to initially generate electricity for distribution to the national grid and then later supply steam and/or heat to surrounding businesses.

Works approvals are issued by EPA Victoria under the Environment Protection Act 1970 (EP Act) for the development of, or upgrades to, industrial sites scheduled under the Environment Protection (Scheduled Premises) Regulations 2017 (the regulations).

The Works Approval, when issued, will allow for project construction to take place. Once constructed and in accordance with EPA regulatory requirements and the guidance and conditions set out in the Works Approval, REA will apply for an EPA licence to commission and operate the facility. This licence will include specific conditions around operation, monitoring and the environmental performance for the project.

1.3.2 Rationale for the Project
Waste generation in Victoria continues to grow with currently more than four million tonnes disposed annually to landfills\(^1\). Landfills generate nuisance odours and complaints from nearby residents and even best practice landfills generate fugitive methane emissions in considerable quantities, which is a significant contributor to environmental greenhouse gas production (being approximately 25 times more potent than CO\(_2\) in terms of emissions accounting). Over the last 10 years many of the metropolitan and regional landfills in Victoria have closed, forcing councils to rely on fewer, larger landfill facilities typically located further from council collection areas. This has imposed a greater transport burden on these councils. It has resulted in additional greenhouse gas production through increased transit and contributes to growing congestion across Melbourne’s major transport corridors.

Councils are currently attempting to reduce their reliance on landfill through increased recycling initiatives. These initiatives include the provision of a variety of collection bins at the household and broad education programs to encourage source separation of recyclables and food and garden waste from residual waste.

China recently imposed import restrictions on 24 streams of ‘recyclable material’ which has excluded 99% of the recyclables that Australia previously sold to that country. This represents 29% (920,000 tonnes) of all paper and 36% (125,000 tonnes) of all plastics collected from household kerb-side recycling. In response to the Chinese import bans on waste, Malaysia and Vietnam have now introduced similar bans on the importation of waste into their countries. This has had a significant impact on much larger waste-generating countries than Australia causing wide ramifications on the value of recyclables in global markets and placing considerable strain on councils and waste industry recycling activities in Australia. It has generated a significant increase in demand for alternative markets and international destinations for the recycled product and resulted in greater stockpiling of unmarketable waste and increased reliance on landfills. None of these are sustainable long-term solutions for Victoria’s increasing population and its resultant waste loads.

The waste hierarchy dictates that avoiding, reducing and reusing waste should be priority objectives of any mature waste system. Even with cohesive strategies, education and commitment to changing product and consumer habits (which will evolve over generations), households and industry will continue to generate residual waste requiring ‘end of life’ treatment. While the waste per household is likely to fall over time, the sustained population growth across Victoria indicates that absolute waste volumes destined for disposal will continue to grow.

The Statewide Waste and Resource Recovery Infrastructure Plan (SWRRIP) was prepared by Sustainability Victoria on behalf of the Victorian Government under the legislative framework provided by the Environment Protection Act 1970. The SWRRIP provides a long-term vision and roadmap to guide future planning for waste and resource recovery investment in the state. SWRRIP states that “WtE is lower in the wastes hierarchy than recovery. As such, the benefits from WtE are best realised when the feedstock is a material stream or waste that cannot viably be recovered for higher order recovery, that is, for reuse or recycling” and “is preferred to landfill as it captures the energy value of waste and reduces the use of landfill.” The “environmental and economic benefits from WtE are best realised when the materials cannot be viably recovered for reuse or recycling.”

The REA WtE project is based on recovering energy primarily from residual waste which has been sorted by the householder. Whilst it is recognised that recoverable/recyclable materials do occur in residual waste, the SWRRIP study highlighted that “improved source separation and a reduction in the contamination at the point of generation” were key to improving recovery of recyclable materials from the residual bin collection system. The REA proposal foresees and allows for a reduction of up to 50% in food waste entering the MSW stream. Furthermore, it facilitates the recovery and recycling of metals and inert material, such as glass, for reuse in products like road construction materials.

The potential for further sorting of the residual waste to increase reuse or recycling of materials in this mixed waste stream has been evaluated in Section 6.2.4 of this works approval application. This evaluation shows that while quantities of recyclable materials remain, (particularly food and garden organics, timber, paper and cardboard, glass and hard and flexible plastics), the cost of treatment, the quantities available, the limitations of the market (particularly with paper, cardboard, glass and

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2 A Crisis too Big to Waste - China’s recycling ban calls for a long-term rethink in Australia. The Conversation, May 8, 2018 6.14am AEST
3 Sustainability Victoria (2018) Statewide Waste and Resource Recovery Infrastructure Plan
some plastic), the market price of the commodities, combined with the contamination associated with wet food waste (even assuming a 50% uptake of FOGO), it is not economic to further sort the residual waste prior to gasification. This analysis is further supported by the situation in Victoria where no materials recovery facilities (MRF’s) currently operate on mixed residual waste, presumably because operation on this waste stream is not economically viable and landfills are not required to sort residual waste entering the facilities. REA has in principle agreements with third parties who will repurpose the slag and separate metals within it for resale. The slag includes glass as well as other inert materials which can be used as road base or other construction materials. It is REA’s view that recovering energy from this residual waste stream is a better outcome for the community, environment and public health than the alternative, disposal to landfill. In this context, REA believes the proposal is consistent with the objectives of SWRRIP.

REA has been encouraged by rising support in the community which was highlighted in the Waste to Energy Consultation Report which indicated “the community is supportive of waste to energy as an alternative to landfill, but the risks must be recognised and managed4”.

REA’s Laverton North proposed gasification facility will be the first in Australia to provide a localised solution for managing locally generated waste. The site was specifically selected for its proximity to a heavily industrialised area that demonstrates a continuously growing demand for energy. The energy produced by the REA project offers a ready supplement to local energy demand through direct grid connection and/or direct supply of steam or hot water to adjacent industry.

REA is not currently a recipient of State or Federal Government support and is funding the project development entirely through local investment. Engineering, Procurement and Construction (EPC) contractors have been chosen and design works are progressing with early designs completed. This WAA continues the project development process to enable REA to offer metropolitan councils an alternative waste treatment option when their existing contracts for disposal to Melbourne landfills expire in 2021.

1.3.3 Project Benefits
Strategic benefits provided by the proposal include:

- Providing an additional 40 full time equivalent jobs during operation and approximately 400 jobs during construction;
- Localised state of the art renewable energy generation (that can support local industry and community) that diverts around 195,000 tonnes of MSW from landfill;
- Improved environmental waste management outcomes;
- A localised operation that will reduce waste haulage distances and is expected to be cost comparable with landfill gate fees;
- A receiveal system that requires no change to current council bin collection, waste aggregation or transport practices;
- Meeting best practice standards;
- Sufficiently flexible technology to accommodate changes in the composition of waste and recycling systems as they develop over time;
- Delivering a significant reduction in net greenhouse gas (GHG) emissions;
- Increased energy security by delivering around 15.1 MW of base load electricity into Western Suburbs grid.

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4 Report to the Minister for Energy, Environment and Climate Change Waste to energy consultation and case study for Melbourne’s West, 13 December 2017Energy, Environment and Climate Change.
1.3.4 **Choice of Technology**

REA has spent considerable time and resources investigating alternative processes and suppliers for managing the disposal of MSW. REA’s directors have evaluated a range of pathways including conventional incineration, gasification, pyrolysis, mechanical biological treatment (waste sorting with anaerobic digestion) and combinations of these processes to identify options capable of meeting the specific financial and environmental conditions necessary to secure the support of Melbourne’s communities, financiers and regulators. The positive and negative aspects of each technology were assessed against the criteria set out in Figure 1-2 and the criteria listed below:

- The technology needed to be the best available for the treatment of household mixed residual waste. Its working specification had to be capable of accommodating the compositional variations in waste expected over time as household recycling habits change and consumer expectations evolve (i.e. the introduction of Food organics and garden organics combined collection (FOGO) or reduction in packaging);
- Specifically, the technology needed to be able to effectively process the entire residual waste stream with relatively low energy values (as low as 6.6MJ/kg);
- The technology needed to demonstrate best practice environmental performance and clearly offer a significant improvement on the environmental performance of Victoria’s best practice landfills. In this context, operation of the system at temperatures exceeding 1100°C was important as this would minimise the potential for precursor hydrocarbon generation and restrict the potential for the formation of complex organic molecules such as dioxin and furan;
- Be scalable to accommodate small groups of councils, providing an opportunity for councils to take responsibility for their own residual waste and reduce their transport and handling requirements;
- Be financially viable within the context of the existing and projected landfill gate fees and wholesale energy prices in Victoria;
- The technology needed to demonstrate a history of technical and operational reliability processing MSW to energy at full scale production to requisite specifications with sufficient reference sites operating over at least five years to demonstrate reliability and credibility;
- The technology provider needed to show an association/partnership with a credible third-party EPC contractor capable and willing to validate and underwrite the integrated facility performance necessary to facilitate cohesive design and construction.

The evaluation process technology selection score card is summarised in Figure 1.3 and further information on the technology selection is provided in Section 7.7.

This evaluation identified gasification, an Advanced Thermal Treatment (ATT) technology, as the most suitable for the treatment of mixed residual wastes comparable to that of Melbourne’s household residual bin waste. Importantly, the technology was scalable to accommodate small groups of Councils and it offered the best opportunity to generate energy from waste with a viable financial return at gate fees consistent with those expected in Melbourne. This technology generated only minimal residual waste thereby optimising diversion from landfill and significantly mitigating the associated current and legacy environmental impacts associated with MSW disposal to landfills. Additional advantages of this ATT are:

- That the gasifier slag produced is inert, is not odorous, produces no greenhouse gas and tests from reference sites suggest it will be suitable to be recycled into clean fill, road base, cement or repurposed for other manufacturing uses;
- The proposed location of the WtE facility within greater Melbourne is typically closer to the source of waste than existing landfills and other proposed WtE projects and as such will result...
in relatively lower transport costs for Councils and the consequent greenhouse gas emissions of their logistics.

Figure 1-2: Waste to Energy Project Evaluation Flow Sheet
Gasification technology has been in use for over 200 years\(^5\) in processing of oil, coke and petroleum products. Refinement of this technology for the processing of MSW and similar wastes derived from MRF’s commenced in the early 1970’s with commercial scale processing plants built specifically for this purpose being more prevalent since the beginning of this decade.

While the UK and Europe are perceived by some to be leaders in waste to energy processing there is significantly more experience and successfully implemented examples of modern gasification facilities specifically designed to process waste across Asia and more specifically in Japan\(^6\) and China.

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5 ClimateTechWiki – A Clean Technology Platform Gasification of Municipal Solid Waste for Large-Scale Electricity/Heat
http://www.climatetechwiki.org/technology/msw
Gasification plants which have or are operating successfully on, residual waste derived from MRF’s, industrial waste and MSW include:

- The Lahti Energia facility in Finland, a fluidised bed gasifier which is processing solid waste from multiple streams and generating 50MW of electricity and 90MW of steam for district heating;
- Chinook Sciences installation of 11 waste to energy gasification pyrolysis facilities worldwide since 2005. Their largest facility, which will process 300,000 t/a of MSW is now in construction at Sharjah in the UAE;
- Averoy waste to energy facility (commissioned 2000), Forus District Heating Plant (commissioned 2001) and Sarpsborg (commissioned 2002) in Norway process solid waste and MSW using gasification to generate steam and/or heat;
- Levenseat Waste to Energy facility in the UK which will process up to 400,000 t/a of post MRF residual waste into electricity is now commissioning;
- Ebara Corporation in Japan has more than 25 years experience delivering waste management and energy recovery using a two stage gasification process to produce electricity from high pressure superheated steam at 400°C;
- Nippon Steel & Sumikin Energy in Japan have built 37 gasification plants varying in size from 10,000 – 250,000 tonnes/annum7. These include the, Kita-Nagoya Plant processing 224,000 t/a of MSW in 2 trains, Narumi Plant processing 176,000 t/a in 2 trains, Shin-Moji Plant processing 240,000 t/a in 3 trains and Saitama Plant processing 126,000 t/a in 2 trains.
- Kobelco Eco-Solutions in Japan have built 17 gasification plants over 18 years. They are the select technology provider to the Hooten Bio Power plant to be constructed in the UK which will process 224,000 tonnes p.a. of refuse derived fuel into 26.5MW of electricity.

EcoWaste, REA’s selected technology provider, based in China, has installed over 20 gasification facilities across Asia and the Middle East since 2004. These gasification facilities have been specifically designed with the capability to process medical, hazardous, industrial and mixed municipal waste to the operational standards expected by regulators. EcoWaste currently have another 8 gasification facilities in construction.

In China, EcoWaste built its first gasifier to process medical waste in 2004. These gasifiers are vertical rotary type systems which are a modification of the conventional sloping rotary kiln used extensively around the world for the treatment of industrial and hazardous waste. The gasifiers are designed to discrete sizes and for modular deployment to facilitate the flexible and scalable processing requirements of different applications and regional populations.

The gasifier processing lines have been adapted to enable the receipt and processing of mixed MSW. The first MSW specific gasification facility was commissioned at Jinan in Shandong Province China in 2005. Since that time EcoWaste has built 6 gasifier facilities specifically intended to process MSW (Table 3-1). These facilities all utilize the same gasifiers but in different sizes and different configurations to process mixed MSW volumes of between 8 and 350 t/d.

Recognition of the practical and environmental merits of the EcoWaste gasification process and its process control has led to significant expansion in demand for these gasifiers. EcoWaste now has 8 MSW to energy gasification facilities under construction across Asia and the Middle East which are expected to be commissioned before the end of 2019. The facilities now under construction are typically being implemented with multiple lines to provide for larger processing capacities, with the

largest being constructed at Zhumadian in Henan Province, China. This facility will include 8 standard 150 tonne/day gasifiers in 4 lines providing a processing capacity in the order of 1200 t/d. Table 1-1 summarises these major developments.

<table>
<thead>
<tr>
<th>No.</th>
<th>Waste Type</th>
<th>Project Name</th>
<th>Rated Capacity (t/d)</th>
<th>Commissioned (MM/YY)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>MSW</td>
<td>Iran Norsha MSW Gasification Power Plant</td>
<td>200t/d</td>
<td>Dec-18</td>
<td>EP</td>
</tr>
<tr>
<td>24</td>
<td>MSW</td>
<td>Iran Sari MSW Gasification Power Plant</td>
<td>450t/d</td>
<td>Jun-19</td>
<td>EP</td>
</tr>
<tr>
<td>25</td>
<td>MSW</td>
<td>Zhejiang Longyou MSW Gasification Power Plant</td>
<td>450t/d</td>
<td>Jun-19</td>
<td>PPP</td>
</tr>
<tr>
<td>26</td>
<td>MSW</td>
<td>Ningbo Xiangshan MSW Gasification Power Plant</td>
<td>600t/d</td>
<td>Aug-19</td>
<td>BOT</td>
</tr>
<tr>
<td>27</td>
<td>MSW</td>
<td>Sichuan juzhaigou MSW Gasification Disposal Plant</td>
<td>150t/d</td>
<td>Aug-19</td>
<td>EP</td>
</tr>
<tr>
<td>28</td>
<td>MSW</td>
<td>Indonesia Surabaya MSW Gasification Power Plant</td>
<td>750t/d</td>
<td>Sep-19</td>
<td>EP</td>
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<tr>
<td>31</td>
<td>MSW</td>
<td>Iran Rasht MSW Gasification Power Plant</td>
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<td>Dec-19</td>
<td>EP</td>
</tr>
<tr>
<td>32</td>
<td>MSW</td>
<td>Henan Zhumadian MSW Gasification Power Plant</td>
<td>1200t/d</td>
<td>Dec-19</td>
<td>PPP</td>
</tr>
</tbody>
</table>

Table 1-1: EcoWaste Gasification Facilities under Construction

There is a clear history of gasifiers’ successfully processing MSW or MRF residual waste particularly in Finland, Norway, Northern Ireland, Japan, China and Asia since the early 2000’s. The technology is continuously being refined and is now well proven in its capability to process a wide range of wastes and is increasingly being deployed around the world as a preferred treatment solution to “end of life” residual wastes. In 2012, the SWIP study for the WA Government Department of Environment and Conservation found that gasification appears to be at the point of being able to compete with more established combustion processes; including at larger scales and that a substantial increase in the use of this technology is expected in the coming years.

1.3.5 General Description of the WtE Project

REA is proposing to install a gasifier waste treatment system with heat recovery and electricity generation which is capable of operating on relatively low energy value MSW (6.6MJ-13.2MJ/kg) originating from Metropolitan Melbourne’s source separated residual household waste bin collections. The treatment system proposed is modular with the current design incorporating six individual gasifiers which, based on the compositional analysis of the residual household waste predicted in 2021 (11.3MJ/kg), will provide for the treatment of a nominal 600 tonnes per day of residual MSW (200,000t/annum).

This proposed facility will generate approximately 17.2 MW of electricity which, after allowing for the load (2.1 MW) required to operate and manage the MSW processing operation, will result in approximately 15.1 MW of base load power being available for dispatch into the grid and/or nearby industrial energy users.

The modular multi-gasifier design and multiple processing lines characteristic of the proposed system have a number of advantages over single furnace thermal production facilities. These include:

- Each gasifier can be isolated from the production process should issues develop. This provides a risk mitigation measure for upset or emergency conditions and allows greater control of emissions during these conditions;
- Each processing train; which includes the thermal oxidation chamber, heat recovery boiler and flue gas treatment system can be isolated and shut down during upset conditions or

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during an emergency whilst keeping the remainder of the plant operating. This allows management of each emission stream and provides an adverse emissions risk mitigation measure not available to single thermal operation facilities;

• The highly modular design allows for discrete maintenance of equipment without necessitating any significant shutdowns facilitating greater process availability and continuous capacity;

• Every piece of major equipment in each processing train is individually monitored in real-time so that each process can be discretely optimised by its own control systems providing for the rapid rectification of any out-of-specification activity or, if required, shutoff and diverted to an alternate process line.

Figure 1-4 shows a simplified process flow diagram of a typical gasifier system for the treatment of MSW and Table 1-2 summarises each step in the WtE process.
### Summary of operational steps in the WtE process

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>More Details</th>
</tr>
</thead>
</table>
| Resident separation of household waste types | • Melbourne municipalities typically provide households with two or three waste bins so that residents can take responsibility for separating their recyclable materials and green waste from other rubbish which is currently only suited to landfiling (and is known as the ‘residual waste’).  
• This practice of separating waste where it is produced, known as ‘source separation’ is generally regarded as the most efficient method for identifying and separating recyclable materials.  
• In the case of householder separation, it also directly engages the community and confirms their contribution in realising the maximum potential for suitable wastes to be recycled.  
• Household waste left after residents separate their recyclable items and green waste (where a separate green organics bin is provided) is placed in the residual waste bin for collection, and currently directed to landfill for disposal. REA is proposing to redirect this residual bin waste to the proposed facility and to recover the energy embodied in that waste which is typically lost to landfill.  
• A proportion of household recyclable waste currently sent for sorting is classified as unsuitable for recycling at the materials recovery facility (MRF) and is also directed to landfill. REA also considers this residual waste suited to the recovery of energy and processing at the proposed facility. | Section 1.1  
Section 6.2  
Section 6.2.4 |
| Residual waste collected from curb side and delivered to the facility with no disruption to existing contracts and service procedures | • Municipal councils have contracts for the collection of household residual waste that are separate from their contracts for the disposal of that waste at landfill.  
• REA considers it imperative that the waste logistics task is not further complicated by any alternative disposal proposal and, ideally, is simplified to reduce the impact of trucks on our communities.  
• REA is proposing a relatively small facility. This provides for a more localised solution better suited to servicing local communities when compared to current large-scale landfills and facilities that rely on much more significant waste volumes to sustain their operations.  
• The scale of facility proposed and the Laverton North site were selected to provide simplified access and to accommodate existing compactor garbage trucks. This will minimise additional handling and costs commonly associated with changing practices.  
• The Laverton North site is closer to many of the communities it is intended to serve offering potential for reduced transport distances and associated costs, facilitating environmental, road congestion and potential economic benefits. | Section 6.2 |
| Compactor trucks deliver residual waste to WtE processing plant in Laverton North. | • Waste trucks carrying residual household garbage enter the WtE facility following designated pathways to a tipping hall.  
• Access to the tipping hall is controlled by rapid roller doors which immediately close once the truck enters.  
• The tipping hall is the first of two areas that are kept under negative air pressure (air is continually sucked in to be used in the process) effectively representing the first of TWO sequential airlocks specifically designed to limit any potential for odour to escape out of the facility.  
• The garbage trucks turn in the tipping hall and back up to one of several roller doors that enclose the waste holding bunker.  
• Backing vehicles activate another fast acting roller door, enabling the truck to eject its load of MSW into the waste feed bunker. Once the garbage truck is emptied it moves away from the waste bunker and the roller door closes.  
• Air is continually extracted from the fully enclosed bunker and directed into the gasification process effectively creating a second airlock. The bunker design ensures there is limited potential for odour to escape in the short time taken to unload waste from the trucks.  
•Exiting trucks follow marked exit pathways that facilitate vehicle movements and prevent accidents. |
| MSW in the waste bunker is continually mixed by grab cranes | • Grab cranes mix the residual MSW as it arrives to integrate and smooth any variations in the waste feed to the gasifiers.  
• The grab cranes also ensure that any naturally occurring decomposition of the biological waste does not cause waste in the bunker to overheat.  
• The facility is designed to receive a wide range of materials. The grab cranes will however remove any waste deposited in the bunker that the operator considers oversized or obviously unsuitable for processing (such as refrigerators or engines that should not be in the sorted waste).  
• The grab crane operator can lift and deposit oversized but suitable waste into a shredder to ensure no blockages occur in the gasifier feeder.  
• Normal operational capacity of the waste bunker provides for 2 days’ waste storage, although total capacity can accommodate up to 4 days’ waste to manage the requirements of public holidays and any unforeseeable or scheduled upset conditions in the operation of the plant. |
| Controlled MSW waste feed to the gasifiers | • The grab cranes deliver waste from the bunker to a step feeder that progressively feeds waste into the hopper located above each gasifier.  
• The hoppers above each gasifier act as a ‘vapour lock’ for the gasifier, constricting air flow into and out of the gasifier.  
• Each hopper has a twin roller system at its base (the top of the gasifier) which controls the feed rate of waste into each of the gasifiers. |
The process control systems regulate the flow of waste into the gasifier through the rollers according to computerised feedback systems that continuously monitor gasifier and emissions performance. This ensures that optimum retention and effective processing of the waste occurs.

The rollers that feed the gasifiers also act to size the waste as it passes through to the gasifier to ensure blockages cannot occur in the feed or slag and that all waste is exposed for sufficient time and optimal operating conditions in the gasification process.

Gasifiers heat the waste to generate synthesis gas (syngas)

- The gasifiers are started by introducing auxiliary heat which is produced by the initial oxidation of clean and sorted wood. Start-up heating takes less than eight hours and is only necessary following gasifier shutdowns that are expected to be required once a year as part of their routine maintenance program.
- Once the gasifiers reach their operating temperatures, waste is stated to be fed into the chamber. At operating temperature, the molecular bonds in the waste break and chemical reactions occur. These reactions produce the energy needed to maintain the gasifiers’ operating temperatures without the need to add any external heat sources.
- The gasifiers are enclosed vessels that operate at high temperatures with limited air. Restricting the air in the gasifier ensures there is not enough oxygen available for combustion of the waste to occur. Instead the highly controlled environment in the gasifier facilitates discrete chemical reactions that produce a gas similar to natural gas (syngas).
- The gasifier operates at temperatures of ≥850°C which is sufficient to destroy almost all organic materials.
- Primary air for the process is drawn from the waste bunker which also creates the negative pressure in the bunker and tipping hall necessary to prevent odours from escaping.
- The gasifiers are configured vertically. Adding small amounts of air from the base of the gasifier ensures the area at the bottom is always the hottest part of the chamber. Waste is dropped into the gasifier from the top. The waste gradually moves down through different temperature zones toward the hottest part of the gasifier where only inert materials such as earthen wastes, metal and glass will remain.
- Inert materials eventually pass through the bottom of the gasifier as a partially fused, granular, sterile slag.
- The gasifiers and their internal grates are designed to rotate on their axes to ensure the waste is appropriately mixed and sufficiently exposed to the operating environment of the gasifier, thus maximising its conversion to gas and minimising residual ash production.
By restricting air in the gasifier there is less nitrogen and oxygen available in the process, significantly reducing the opportunity for undesirable acid gases (NOx, SO2, HCl, HF) and carbon dioxide gas to form.

Dioxins and furans typically form in the temperature range of 200°C to 500°C in an oxygen rich environment. The low oxygen and high operating temperatures of these gasifiers ensure the circumstances for the formation of these toxins are unlikely to exist.

The gasification process is highly modular. The proposed facility will incorporate six discrete gasifiers paired in three processing lines. The layout provides for great flexibility and redundancy across the facility to help manage continuous operation under maintenance and adverse operating conditions of any part of the system.

<table>
<thead>
<tr>
<th>Syngas is combusted in oxidation chamber</th>
</tr>
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<tbody>
<tr>
<td>The syngas generated in the gasifier is drawn up through the gasifier into the close coupled oxidation chamber where additional air is introduced so that the syngas combusts to generate heat.</td>
</tr>
<tr>
<td>The syngas concentrates energy drawn from the waste and when combined with the oxygen from the addition of air, facilitates higher operating temperatures enabling the oxidation chamber to operate consistently at between 1100°C-1200°C.</td>
</tr>
<tr>
<td>At these operating temperatures almost all residual organic molecules including halogenated hydrocarbons passing into the oxidation chamber with the syngas will be destroyed.</td>
</tr>
</tbody>
</table>

Heat is recovered in the heat recovery system

<table>
<thead>
<tr>
<th>Heat is recovered in the heat recovery system</th>
</tr>
</thead>
<tbody>
<tr>
<td>The heat generated in the oxidation chamber is directed through a boiler system which superheats the water into 450°C steam.</td>
</tr>
<tr>
<td>The conversion of gas to steam rapidly absorbs the heat, dropping the process air passing through the system from +1100°C to less than 200°C in less than five seconds. Time in the critical temperature zone where dioxins and furans can reform (de novo synthesis requires 500°C – 200°C) occurs in the boiler for less than 2 seconds. This rapid reduction in temperature of the hot gases is an important process that minimises the possibility of unwanted organic molecules reforming in the process air and exiting the heat recovery system in the flue gas.</td>
</tr>
</tbody>
</table>

The steam is directed to two steam turbines to generate electricity

<table>
<thead>
<tr>
<th>The steam is directed to two steam turbines to generate electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>The superheated steam is sent to standard steam turbine generators which generate electricity to meet the plant requirements. The balance (15.1MW) is available for export to the grid and/or adjacent industrial energy users.</td>
</tr>
<tr>
<td>Steam is captured and condensed for reuse after it passes through the turbines.</td>
</tr>
<tr>
<td>The system used is combined heat and power which provide scope for heat to be extracted from the system for direct use.</td>
</tr>
</tbody>
</table>

Section 6.3.4

Section 6.3.5

Section 6.3.6
supply to localised industrial consumers as demand is identified.

| Flue gas exiting the heat recovery section | • Flue gas exiting the heat recovery section undergoes a series of cleaning steps to minimise contaminant levels of the final emissions.  
• These emission cleaning systems are best practice and include:  
  o Acid gas scrubbing with atomised lime sprays to remove any hydrochloric acid, hydrofluoric acid and sulphur dioxide.
  o Powdered activated carbon addition to remove any remaining organic molecules and volatile metals such as dioxins and mercury.
  o Air filtering system to remove almost all particulates, activated carbon and residual lime from the flue gas stream before being released to the atmosphere. | Section 3.3.7  
Section 3.3.8  
Section 7.4.2 |
| Monitoring of flue gas prior to exhausting through the stack | • Monitoring of a wide range of parameters occurs in real time and is used to manage the operation of the plant. Performance data will be available for review on the REA website or other media as technology allows.  
• Air emissions measured on a continuous basis include nitrogen oxides, carbon monoxide, sulphur dioxide, hydrochloric acid, hydrofluoric acid, dust, mercury and volatile organic compounds.  
• Other parameters which cannot be measured on a continuous basis will be measured through air sampling on a regular basis. These include base metals, formaldehyde, methane, dioxin and furan. | Section 6.3.9 |
| Flue gas released to atmosphere through a stack | • The cleaned flue gas is primarily steam. The cleaned flue gases released to the air are continuously monitored to ensure any potential contaminants do not exceed the threshold limits set by EPA Victoria and world best practice expectations detailed in the European Union Industrial Emissions Directive.  
• The expected emissions have been modelled using site specific criteria to confirm the environmental performance of the facility.  
• The gasification and ancillary systems provide for extensive operational and process control and, with the continuous monitoring they facilitate rapid resolution of adverse conditions to ensure environmental performance will not be compromised. | Section 6.3.9 |
| Solid waste production | • Inert material and ash pass through the gasifier as a partially fused slag and are cooled in a water bath. The slag presents as small rock like pieces. The slag is expected to meet the required standards for reuse as road base and will be further processed to recover any metals that also pass through the process. | Section 6.3  
Section 14.0  
Section 14.14.1.3 |
Due to the efficiency of the gasification and ancillary systems, the process produces an extremely small amount of residual fly ash when compared to other alternative WtE systems.

The facility is expected to produce fly ash at a rate of less than 2% of the input volume providing for an overall potential diversion of around 98% of the received waste from landfill.

The typical treatment for flyash is stabilisation and disposal at appropriately licensed landfills.

REA is familiar with alternative options that could provide reuse opportunities for the ash. These will be evaluated once the facility is operational.

- The system is designed with six discrete gasifiers, three separate syngas processing lines each with their own flue gas monitoring and treatment systems. The three lines supply steam to, two steam turbines.
- Each gasifier can be isolated from the syngas processing lines and any of the syngas processing lines can be isolated, should conditions require.
- Significant redundancy is built into the system to allow for consistent and continuous operation.
- Each component in the system is constantly monitored to ensure optimum operating conditions are maintained and to quickly identify unusual conditions and the unlikely occurrence of failure in any components.
- Should upset or emergency conditions occur, discrete gasifiers or process lines can be taken offline to provide for corrective action.

Table 1-2: Summary of Operational Steps in the WtE Process

### 1.3.6 Location of Proposed WtE Facility

The proposed project site is located in Laverton North, to the south of Dohertys Road and is accessed by the existing court in Alex Fraser Drive (Figure 1-5). The site is approximately 50,000m² and is currently vacant land located in an established area of industrial development.
Figure 1-5: Map Showing the Location of the Proposed WtE Facility in Laverton North