Cost-benefit analysis of the implementation of landfill disposal bans in Queensland

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Synergies Economic Consulting Pty Ltd
www.synergies.com.au

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Executive Summary

The Draft Queensland Waste Avoidance and Resource Productivity Strategy (2014-2024) (draft waste strategy) sets out many challenges and opportunities for Queensland, one of which is increased recycling targets. However, increased recycling targets alone will not address the disposal of recyclable material to landfill. Through stakeholder consultation, it was noted landfill disposal bans could be used to complement the draft waste strategy.

The Department of Environment and Heritage Protection (DEHP) has engaged Synergies Economic Consulting (Synergies) and MRA Consulting Group (MRA) to assess the feasibility of introducing landfill disposal bans in Queensland.

Landfill disposal bans have been typically used to reduce the environmental impact of landfill disposal and to increase the tonnage of material recovered from waste. The most common categories of waste that are subject to landfill disposal bans include unsorted or untreated waste, biodegradable and organic waste, hazardous wastes and tyres. While it is difficult to isolate the impact of landfill disposal bans from other waste management policies (in particular landfill taxes and levies), there is evidence to suggest landfill disposal bans have facilitated significant reductions in the proportion of waste disposed of via landfill and a significant increase in the tonnages of waste material recovered. Landfill disposal bans are typically introduced a number of years after the introduction of a landfill tax or levy.

Due to the objectives of this project (i.e. to explore the feasibility of banning one or more materials from disposal via landfills), it was considered important to ensure the materials subject to this initial assessment would have the largest contribution to the targets set out in the draft waste strategy. This criteria was applied while acknowledging that there would be an opportunity to consider the inclusion of additional materials at a later date, if DEHP decided to assess the implementation of a landfill disposal ban in accordance with the *Regulatory Impact Statement System Guidelines*[1].

To identify the most appropriate materials for inclusion in this preliminary cost-benefit analysis the following issues were considered:

- the economic trade-off between the cost per tonne and the diversion rate from landfill;

[11] Queensland Treasury - http://www.treasury.qld.gov.au/office/knowledge/docs/ris-system-guidelines/ris-system-guidelines.pdf (sourced 9 October 2014).

- the existence of product stewardship schemes, either mandatory or voluntary, aimed at recycling or developing end-use markets (and the maturity of these schemes);
- the market for reuse materials and recovery rates; and
- the number of processors operating throughout Queensland.

Based on the above assessment, the following materials were identified:

- concrete (sorted) – South-East and North-East regions;
- concrete (mixed) – South-East and North-East regions;
- tyres (passenger and small heavy vehicles) – South-East, North-East and Inland regions;
- timber (mixed) – South-East and North-East regions;
- metals – South-East and North-East regions;
- MSW Green (kerbside and drop-off) – South-East and North-East regions; and
- MSW Green (all) – South-East and North-East regions.

The following impacts of the implementation of a landfill disposal ban were quantified for each of the above waste materials:

- reduction in the economic cost of disposal of waste via landfill;
- reduction in the cost of greenhouse gas emissions from landfill;
- increase in the economic value from recovered material;
- increase in the cost of recovery and reprocessing;
- increase in the cost of illegal dumping;
- increased compliance costs;
- cost of administration, monitoring and enforcement; and
- cost of policy development and implementation.

The following table summarises the Present Value (PV) estimates of the net economic impact of the implementation of a landfill disposal ban for each of these waste materials by region.

Net impacts of implementation of a landfill disposal ban by waste material and by region

Waste material	Net impact of ban for South-East ($)	Net impact of ban for North-East ($)	Net impact of ban for Inland ($)
Concrete (sorted)	69,201,636	25,627,825	NA
Concrete (mixed)	(441,665,379)	(212,467,178)	NA
Tyres	55,112	22,871	2,287
Timber	(89,242,740)	(26,142,527)	NA
Metals	(7,624,829)	(1,636,865)	NA
MSW Green (kerbside)	106,997	23,798	NA
MSW Green (mixed – all)	19,402,206	5,878,565	NA

Source: Synergies modelling.

The key drivers of the results by waste stream are as follows:

- for sorted concrete waste, the significant reduction in the cost of disposal of waste via landfill;
- for mixed concrete waste, the significant increase in the cost of recovering additional tonnages as a result of the ban;
- for tyre waste, the very low tonnages currently being disposed of via landfill;
- for metallic waste, the lack of value of metallic waste currently being disposed of via landfill;
- for MSW Green (kerbside), the very low tonnages currently being disposed of via landfill; and
- for MSW Green (mixed – all), the significant reduction in the cost of disposal of waste via landfill.

Based on the analysis conducted, the implementation of a landfill disposal ban on sorted concrete, tyres and all MSW Green material (in both the South-East and North-East regions) would result in a net economic benefit of $119.2 million in PV terms over the 10 year evaluation period. This result includes the cost of policy development and implementation. The implementation of a ban was found to result in a negative Net Present Value (NPV) for all other waste materials across all regions.

Sensitivity analysis was conducted on key parameters to assess the impact on the results of the analysis for each waste stream. The key conclusion to be drawn from this analysis is that the estimate that is applied for the cost of recovering and reprocessing additional material as a result of a landfill disposal ban has a significant impact on the net economic impact of the ban.

Based on MRA's analysis, there is sufficient capacity within the sorted concrete and tyre recycling markets to accept and process the additional tonnes likely to enter the market should a landfill disposal ban be implemented. However, additional capacity would be required to process the additional tonnes of MSW green material. Green waste can be recycled either through composting, mulch or as a feedstock in a waste-to-energy process. While the infrastructure requirements vary in accordance with the form of processing that is undertaken, a period of over 12 months is generally required to complete the planning, approval and construction stages for any type of new facility.

Prior to the implementation of a landfill disposal ban, careful consideration should be given to the timing of implementation and the need for complementary policies and standards. As shown through the desktop review, the introduction of a levy, in the early stages of the policy (i.e. to transition to a landfill disposal ban), has proved to be integral to providing the necessary economic signals to encourage additional investment in processing and recycling capacity. In the absence of a levy, it is important the complementary policy settings (e.g. phase-in implementation periods, and producer responsibility measures) are appropriate, so as to ensure any adverse unintended consequences are minimised and industry is provided with sufficient time to invest and to develop a good understanding of the future policy settings, including anticipated feedstock levels.

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1 Introduction

The Draft Queensland Waste Avoidance and Resource Productivity Strategy (2014-2024) (draft waste strategy) sets out many challenges and opportunities for Queensland, one of which is increased recycling targets. However, increased recycling targets alone will not address the disposal of recyclable material to landfills. Through stakeholder consultation it was noted that landfill disposal bans could be used to complement the draft strategy. Based on overseas experience, landfill disposal bans can be effective at increasing the quantity of material recycled and recovered from waste typically landfilled.

The Department of Environment and Heritage Protection (DEHP) has engaged Synergies Economic Consulting (Synergies) and MRA Consulting Group (MRA) to assess the feasibility of introducing landfill disposal bans in Queensland. The purpose of this assessment is to:

- understand how landfill disposal bans could help support the implementation of the draft waste strategy based on a desktop review of Australian and international jurisdictions;
- identify a short list of materials that would practically and feasibly benefit from a landfill disposal ban;
- conduct a market analysis of the price and recovery trends for the targeted wastes, existing industry capacity, and the market for the recovered materials;
- undertake a high-level cost-benefit analysis on the impacts of introducing landfill disposal bans for the short listed materials; and
- provide recommendations for implementation, including design attributes, implementation lead times, investment requirements, scope and suitability of complementary measures and market development opportunities.

The report is structured as follows:

- section 2 sets out the results of the desktop review of landfill disposal bans in other jurisdictions;
- section 3 discusses the process applied to identify a short list of materials that could feasibility benefit from a landfill disposal ban;
- section 4 describes the cost-benefit analysis conducted on the introduction of a landfill disposal ban;
- section 5 sets out the results of the cost-benefit analysis;

- section 6 provides some recommendations for implementation; and
- section 7 provides a summary of our findings.

2 Desktop review of landfill disposal bans

Internationally, landfill disposal bans have been implemented in a large number of countries, mostly across Europe and North America. Europe has the highest number of countries to implement a landfill ban and over the longest period of time. In contrast, there has been limited use of landfill disposal bans in Australia.

Based on our desktop review, the following common attributes and learnings have been identified:

- landfill disposal bans are typically used to reduce the environmental impact of landfill disposal and to increase the tonnage of material recovered from waste;
- the common categories of waste included in landfill disposal bans are:
  - unsorted or untreated waste;
  - biodegradable and organic waste;
  - hazardous wastes; and
  - tyres;
- Europe has used landfill disposal bans for the longest period of time, with many European countries implementing bans in response to the 1999 EU Landfill Directive (and some prior to this Directive);
- landfill disposal bans typically have lengthy implementation periods, the longest being 12 years;
- there is anecdotal evidence to suggest landfill disposal bans result in increased levels of illegally dumped waste. This includes the shipment of waste overseas to be illegally disposed of (as observed in some European countries);
- the most common complementary policy used to support landfill disposal bans are landfill taxes or levies, which have been applied in the majority of jurisdictions. Other complementary policies include waste sorting requirements, producer responsibility measures and mandatory arrangements for separate collection;
- in many cases, landfill disposal bans are implemented for a small number of waste materials with additional waste materials progressively added over time; and
- while it is difficult to isolate the impact of landfill disposal bans from other waste management policies, for those jurisdictions where a landfill disposal ban has been in place for several years, there has been a significant reduction in the proportion of waste disposed of via landfill and a significant increase in the tonnages of waste material recovered.

Attachment A provides an overview of the landfill disposal bans implemented in Europe, North America and Australia.

3 Potential materials for a landfill disposal ban

3.1 Background

Based on a preliminary analysis of the current waste management and disposal sector in Queensland, DEHP identified the following waste materials for consideration in the initial scoping of a potential landfill disposal ban:

- Concrete;
- tyres (car and light passenger vehicle);
- televisions and computers;
- batteries (used lead acid batteries);
- agricultural and veterinary chemical containers;
- oil, oil filters and containers;
- metals;
- timber; and
- MSW green (household kerbside and drop-off).

The trend in market prices and recovery rates for each of the materials identified above were analysed by MRA. For the purpose of this analysis, Queensland was separated into three zones – South East region, North East region and Inland (see Figure 1). This allowed distance and market availability factors to be included in the analysis.

Figure 1 Geographical breakdown of regions

Data source: MRA. 2014. Landfill disposal ban feasibility study: review of existing infrastructure and markets in Queensland. Report prepared for Synergies Economic Consulting. October. 6**.**

MRA's initial analysis was presented to industry representatives – waste generators and the waste management industry – at workshops held in early September 2014. The purpose of the workshops was to clarify and update MRA's preliminary results, to receive feedback on the initial list of potential materials for a landfill disposal ban, and to address potential barriers to entry.

As a result of the industry workshops, the following additional materials were identified as potential materials to be considered for a landfill disposal ban, either in the initial analysis or at a later date:

- gyprock;
- expanded polystyrene (EPS);
- commercial and industrial (C&I) mixed loads;
- construction and demolition (C&D) mixed loads;
- all agricultural plastics;
- commercial e-waste;
- mattresses; and
- paint.

DEHP also sought feedback from the Local Government Association of Queensland (LGAQ) on the use of landfill bans and other related materials[2].

3.2 Market assessment of potential materials

Due to the objectives of this project (i.e. to explore the feasibility of banning one or more materials from disposal via landfill), it was considered important to ensure the materials subject to this initial assessment were broadly consistent with the wider policy objective of contributing to the achievement of the recycling targets identified in the draft waste strategy. This assessment was undertaken acknowledging that there would be an opportunity to consider the inclusion of additional materials at a later date, if DEHP decided to assess the implementation of a landfill disposal ban in accordance with the *Regulatory Impact Statement System Guidelines*[3].

To identify the most appropriate materials the following criteria was applied.

Cost trade-off

It is important to ensure the materials identified for assessment are appropriate given the economic trade-off between the cost per tonne and the diversion rate from landfill, as shown in Figure 2. That is, the costs of recovery are low and a significant level (tonnes) are currently going to landfill.

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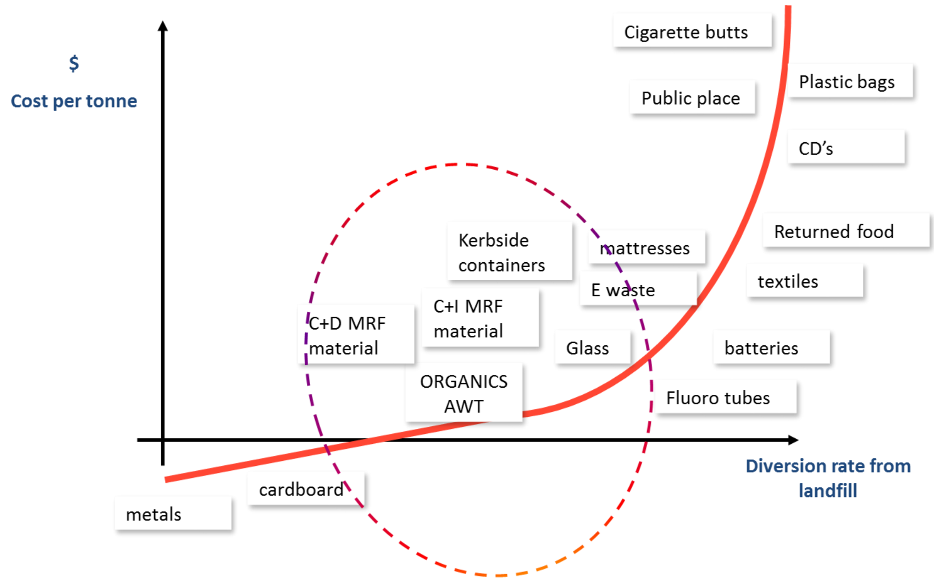
2 LGAQ provided a formal submission to DEHP on 3 October 2014 on the impact of a potential landfill ban.

33 Queensland Treasury - http://www.treasury.qld.gov.au/office/knowledge/docs/ris-system-guidelines/ris-system-guidelines.pdf (sourced 9 October 2014).

Figure 2 Economic trade-off



Data source: MRA analysis.

Based on this assessment, mattresses, expanded polystyrene and commercial e-waste were identified as materials to be considered at a later stage of the policy process (i.e. not part of this preliminary assessment).

National Product Stewardship Schemes

Policy makers have increasingly turned to approaches such as product stewardship schemes to target producers, or distributors, of products that are deemed to be problematic.[4] There are currently a number of schemes in place, either mandatory or voluntary, that are aimed at recycling or developing end-use markets. The table below summarises the schemes applicable to the materials identified above.

Table 1 Product Stewardship Schemes

	Scheme Objectives
Government Initiated Product Stewardship Arrangements	
National Television and Computer Recycling Scheme [a]	• A co-regulatory product stewardship scheme funded by the television and computer industry and regulated by the Australian Federal Government • Manufactures are required to join a 'co-regulatory arrangement', which manages collection and recycling of televisions and computers • The Scheme is intended to progressively increase recycling rates of televisions and computers to 80% by 2021-22 (from 30% in 2012-13)

[4] Productivity Commission. 2006, *Waste Management, Report no. 38*, Canberra. p XXXVI.

	Scheme Objectives
Australian Packaging Covenant [b]	• A sustainable packaging initiative which aims to change the culture of business to design more sustainable packaging, increase recycling rates and reduce packaging litter • A co-regulatory scheme that represents a collaboration between 900 government and industry organisations. • The APC has overseen a 20% reduction in volume of packaging waste generated since 2005, and an increase in packaging recycling from 39% in 2003 to 64.2% in 2013.
Used Oil Recycling	• Australian Government introduced a mandatory product stewardship program for used oil in 2001 to encourage increased recycling and more sustainable oil waste management • The scheme is funded by a 5.449cpl levy on targeted oils • The scheme has resulted in an increase in the volume of used oil being recycled from 0ML in 2000 to approximately 80ML in 2011-12
Voluntary Product Stewardship Arrangements	
drumMUSTER and ChemClear [c]	• Funded and operated by AgStewardship Australia • drumMUSTER is the national program for the collection and recycling of eligible non-returnable crop production and animal health product chemical containers. – As of May 2013, the program has reported the collection of more than 21 million agricultural and veterinary chemical drums for recycling purposes • ChemClear is a chemical collection and disposal service for unwanted and unknown agricultural and veterinary chemicals. – The ChemClear program has collected over 341 tonnes of obsolete agricultural and veterinary chemicals since 2003.
Future Product Stewardship Arrangements	
Waste architectural and decorative paint [d]	• A product stewardship pilot program involving industry groups is currently underway to gauge the effectiveness of implementing a national scheme • The scheme will seek to increase the recovery of resources and to reduce impacts on the environment through the increased collection and recycling of waste paint

a http://www.environment.gov.au/protection/national-waste-policy/television-and-computer-recycling-scheme. http://www.environment.gov.au/protection/national-waste-policy/publications/national-television-and-computer-recycling-scheme-outcomes-2012-13.

b http://www.packagingcovenant.org.au/data/Publications/APC_About_APC_FA.pdf.

c http://www.environment.gov.au/system/files/resources/0a517ed7-74cb-418b-9319-7624491e4921/files/factsheet-other-arrangement.pdf **d** http://www.environment.gov.au/protection/national-waste-policy/product-stewardship/legislation/product-list-2013-14

Waste materials subject to product stewardship programs were not included in the preliminary economic analysis for one of the following reasons:

- the objectives of the stewardship program are the same as the landfill disposal ban (i.e. to increase recovery rates and reduce the tonnages of waste being disposed of via landfill).
  - The existence of a stewardship program indicates there is already an established case for diverting the material from landfill; or
- the stewardship program has been recently implemented or still in the implementation phase.

It is acknowledged that some of the waste materials currently covered by mature stewardship programs (i.e. agricultural and veterinary containers, oil, oil filters and containers) could be included in a landfill disposal ban. For example, it is estimated the drumMUSTER scheme is currently resulting in approximately 50% of agricultural and veterinary container waste being recovered, with the remaining 50% being either disposed of on agricultural properties or via landfill.[5] Including agricultural and veterinary containers in a landfill disposal ban would result in a further reduction in the tonnages of this waste material that is disposed of via landfill. In the event that DEHP decides to assess the implementation of a landfill disposal ban in accordance with the *Regulatory Impact Statement System Guidelines* one or more of these waste materials could be included in the analysis.

For those waste materials that are subject to stewardship programs that have either recently been implemented (i.e. televisions and computers) or are currently in the implementation stage (i.e. paint), introducing a landfill disposal ban would result in additional costs being imposed on industry and government with minimal or no additional economic or environmental benefits. For example, anecdotal evidence indicates that current facilities are already struggling to meet demand for the recovery and recycling of computers and televisions under the National Television and Computer Recycling Scheme.[6] There is therefore currently no potential for a landfill disposal ban to increase recovery rates and divert further tonnages of computers and televisions from landfill.[7] An assessment of whether these materials should form part of a landfill disposal ban could be undertaken once the applicable stewardship program has been fully implemented.

Market for reuse materials and recovery rates

Through the desktop review, two key success factors were identified for the implementation of a landfill disposal ban – access to increased recovery rates i.e. feedstock (post implementation of the ban) and an established market for the recovered materials.

There are currently high rates of recovery for both lead acid batteries and tyres, particularly in the South East and North East regions.[8] Through the industry workshops,

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5 Based on advice provided at the industry consultation workshop.

6 Department of Sustainability, Environment, Water, Population and Communities (2013). National Waste Policy: Less Waste, More Resources. Discussion Paper on Proposed Amendments to the National Television and Computer Recycling Scheme. Australian Government.

7 A similar argument applies for the exclusion of paint from the analysis, as the Australian Government is currently implementing a pilot program as a preliminary step in implementing a national program.

8 MRA analysis.

it was noted that whilst there is a reasonable value attributed to the recycled materials from lead acid batteries, the cost of recovery in the Inland region would be prohibitive. This was less of an issue for tyre waste.

Due to the prohibitive transportation costs associated with lead acid batteries (in the Inland region) and the high proportion of batteries that are already recovered for recycling, lead acid batteries were not included in the preliminary assessment.

Major facilities processing targeted materials

As shown in the table below, there are a number of processors operating in the South East and North East regions. However, there are a limited number or no processors operating in the Inland region.

Table 2 Number of recyclers for each material by region

Material	South East	North East	Inland
Concrete	6	3	0
Tyres	4	1	0
Timber	16	7	1
Metals (Ferrous)	40	21	1
Metals (Non-ferrous)	40	21	1
MSW Green Wast	7	7	2

Source: MRA Consulting.

Due to the limited number of processors operating in the Inland region, the initial assessment focused on the feasibility of a ban applying to the coastal regions of Queensland (i.e. the North and South East regions) for all materials, with the exception of tyres.[9]

Summary

Based on the above assessment, the following materials were identified as suitable materials for the preliminary assessment:

- concrete (sorted) – South East and North East regions;
- concrete (mixed) - South East and North East regions;
- tyres (passenger and small heavy vehicles) – all regions; and
- timber (mixed) - South East and North East regions

[9] Tyre waste was assessed across all regions on the basis that it was the most likely to be viable for inclusion in a landfill disposal ban for the Inland region.

- metals - South East and North East regions;
- MSW green (kerbside and drop-off) - South East and North East regions; and
- MSW green (all) - South East and North East regions.

Collectively these waste streams represent approximately 38% of total waste currently going to landfill in Queensland.

MRA's analysis of the current market arrangements, for each of the above materials, is provided in Attachment A.[10]

10 MRA. 2014. *Landfill disposal ban feasibility study: review of existing infrastructure and markets in Queensland*. Report prepared for Synergies Economic Consulting. October.

4 Cost-benefit analysis of landfill disposal bans

The objective of a social cost-benefit analysis is to systematically identify and value the impacts that a proposal will have on the community. This includes all benefits and costs, whether they are private or social. These benefits and costs are all valued on the basis of the standard principles of welfare economics (i.e. individuals' willingness to pay and accept change).[11]

This section sets out the approach used in the cost-benefit analysis on the implementation of a landfill disposal ban for the shortlisted materials identified in section 3.2, the base case for the analysis, and the benefits and costs of banning the disposal of these waste materials in landfills.

4.1 Approach

The step-by-step approach that has been followed in undertaking this cost-benefit analysis is as follows:

- a review of current waste management and disposal arrangements in Queensland was undertaken and a stakeholder workshop was held to develop a shortlist of waste materials that could be included in a landfill disposal ban;
- based on this shortlist, the waste materials considered appropriate for inclusion in this high-level cost-benefit analysis were identified (see section 3.2);
- the impacts of the implementation of a landfill disposal ban covering the identified materials were identified (costs and benefits), in addition to the parameter estimates required to quantify these impacts;
- research was undertaken to determine estimates to be applied to the identified parameters;
- the costs and benefits of the implementation of a landfill disposal ban were modelled individually by waste material and by region (i.e. South-East, North-East and Inland);
- sensitivity analysis was conducted on key parameters and assumptions; and
- based on the results, potential options for the implementation of a landfill disposal ban were identified (i.e. by waste material and by region).

[11] Willingness to pay is the monetary value that an individual would be willing to pay for a non-monetary benefit associated with a project. Willingness to accept is the monetary value that an individual would require in order to be willing to accept an impact.

4.2 Review of targeted materials

This section presents an overview of the existing infrastructure and markets in Queensland for each of the shortlisted waste materials. The overview has been restricted to the regions in which a ban on each material has been assessed (South-East and North-East for all materials with the exception of tyres, which has been assessed for all three regions).

4.2.1 Concrete (sorted)

Table 3 presents an overview of the collection and diversion volumes for sorted concrete waste in the South-East and North-East regions.

Table 3 Collection and diversion data for concrete (sorted) (2012/13)

Region	Tonnes recovered	Tonnes landfilled	Interstate/ overseas market
South-East	211,961	187,969	No
North-East	94,908	84,165	No

Source: Estimates provided by MRA Consulting Group.

The recovery and recycling of sorted concrete waste is very competitive in South-East Queensland. There are six firms processing concrete and some processors currently have plans to expand the capacity of their facilities. The lead time for expansion is 6 months. There are fewer processors in the North-East region, however the market is considered competitive.

There are no significant barriers to entry to the concrete processing market. This means that to the extent that a landfill disposal ban results in a significant increase in the tonnages of sorted concrete waste that are supplied to the market, new participants will be able to enter the market and process these tonnages.

4.2.2 Concrete (mixed)

Table 4 presents an overview of the collection and diversion volumes for mixed concrete waste in the South-East and North-East regions.

Table 4 Collection and diversion data for concrete (mixed) (2012/13)

Region	Tonnes recovered	Tonnes landfilled	Interstate/ overseas market
South-East	963,460	854,403	No
North-East	431,400	382,569	No

Source: Estimates provided by MRA Consulting Group.

The characteristics of the markets for the recovery and recycling of mixed concrete waste in the South-East and North-East regions are similar to those described above for sorted concrete waste.

4.2.3 Tyres

Table 5 presents an overview of the collection and diversion volumes for tyre waste in the South-East and North-East regions.

Table 5 Collection and diversion data for tyres (2012/13)

Region	Tonnes recovered	Tonnes landfilled	Interstate/ overseas market
South-East	22,838	192	Yes – significant interstate and overseas markets
North-East	10,226	92	Yes – significant interstate and overseas markets
Inland	1,023	9.2	Yes – significant interstate and overseas markets

Source: Estimates provided by MRA Consulting Group.

Tyre waste that is recovered is typically shredded and granulated for processing. The market for the processing of tyre waste in Queensland is as follows:

- in the South-East, there is one large processor and a small number of lower scale processors;
- in the North-East, there is one processor; and
- there are no market participants in the Inland region.

The majority of the recovered material that is produced by tyre waste processors is supplied into overseas markets (e.g. Asia for Tyre Derived Fuels).

4.2.4 Timber

Table 6 presents an overview of the collection and diversion volumes for timber waste in the South-East and North-East regions.

Table 6 Collection and diversion data for timber waste (2012/13)

Region	Tonnes recovered	Tonnes landfilled	Interstate/ overseas market
South-East	73,691	245,636	No
North-East	17,950	59,833	No

Source: Estimates provided by MRA Consulting Group.

Most timber waste is generated from building demolitions. While significant tonnages of timber waste are generated, demand for recovered timber is more limited than other components of the Construction and Demolition (C&D) waste stream. There is therefore little excess demand for recovered timber products. The markets for the recovery and recycling of timber waste in the South-East and North-East regions are competitive.

4.2.5 Metals

Table 7 presents an overview of the collection and diversion volumes for metal waste in the South-East and North-East regions.

Table 7 Collection and diversion data for metals (2012/13)

Region	Tonnes recovered	Tonnes landfilled	Interstate/ overseas market
South-East	580,000	25,200	Yes – significant interstate and overseas markets
North-East	110,910	4,800	Yes – significant interstate and overseas markets

Source: Estimates provided by MRA Consulting Group.

The value of recovered metals means there are strong economic incentives for the recovery and reprocessing of metal waste (ferrous and non-ferrous). This is demonstrated by the fact that the vast majority of metallic waste is currently being recovered and the large number of market participants in the South-East and North-East regions. It is not anticipated that the market in these regions would experience any difficulties absorbing the additional tonnages that would be created in the event of a landfill ban on metallic waste.

The value of the material that is recovered from metallic waste is largely subject to international market forces, with the majority of recovered material being exported overseas. The international price of the recovered metal is highly variable (ranging from $250/tonne to $800/tonne).

4.2.6 MSW green (kerbside)

Table 8 presents an overview of the collection and diversion volumes for MSW Green material (kerbside) in the South-East and North-East regions.

Table 8 Collection and diversion data for MSW Green (kerbside) (2012/13)

Region	Tonnes recovered	Tonnes landfilled	Interstate/ overseas market
South-East	25,000	170	No
North-East	5,000	30	No

Source: Estimates provided by MRA Consulting Group.

There are currently seven local councils in South-East Queensland that offer an optional green waste collection service to approximately 113,000 households. The market for the processing of MSW Green material in the South-East and North-East regions is competitive. Almost 50% of recovered MSW Green material is sent to waste-to-energy facilities while the other half is sent to organic processors.

4.2.7 MSW green (mixed – all)

Table 9 presents an overview of the collection and diversion volumes for MSW green waste (mixed – all) in the South-East and North-East regions.

Table 9 Collection and diversion data for MSW green (mixed – all) (2012/13)

Region	Tonnes recovered	Tonnes landfilled	Interstate/ overseas market
South-East	401,381	171,165	No
North-East	201,162	78,472	No

Source: Estimates provided by MRA Consulting Group.

As stated above, the market for the recovery and recycling of MSW Green material in the South-East and North-East regions is competitive.

4.3 Key inputs

A cost-benefit analysis employs a number of key parameters to derive its results. These parameters and the estimates that have been applied are set out in the following sections.

4.3.1 Cost of landfill disposal

There is an economic cost associated with the disposal of waste in landfills. As the implementation of a landfill disposal ban will result in a reduction in the volume of waste that is disposed of in landfills, the policy will result in a benefit through avoided landfill costs. Quantifying this benefit requires an estimate to be applied for the cost of landfilling waste.

The following estimates for the cost of landfill disposal have been applied for the analysis of the impact of a landfill disposal ban across all waste materials:

- $68.40 per tonne for all waste landfilled in the South-East region; and
- $62.90 per tonne for all waste landfilled in the North-East and Inland regions.

These estimates are based on cost estimates developed by BDA Group in its 2009 assessment of the full cost of landfill disposal in Australia which was prepared for the Department of the Environment, Water, Heritage and the Arts.[12]

[12] BDA Group (2009). The full cost of landfill disposal in Australia. Prepared for the Department of the Environment, Water, Heritage and the Arts.

4.3.2 Cost of recovery and reprocessing

The diversion of waste from landfill to recycling facilities results in an economic cost being incurred. This cost includes:

- additional waste collection and sorting costs;
- increased costs associated with transporting waste to recycling facilities; and
- cost of reprocessing waste material.

In order to quantify the extent to which a landfill disposal ban will result in an economic cost through additional recovery and reprocessing costs, it is necessary to apply estimates for the cost of recovering and reprocessing different types of waste.

The per tonnage cost that will be incurred in the recovery and reprocessing of waste will vary under the base case and under a landfill disposal ban. The extent to which a landfill disposal ban will result in an increase in the cost of recovery and reprocessing for a waste material will depend on several factors including:

- the equipment and infrastructure that is required for recovery and reprocessing;
- the current capacity of the market for recovery and reprocessing relative to the additional tonnages that would need to be recovered under a landfill disposal ban;
- the number and location of recovery and reprocessing facilities; and
- the cost of sorting and transporting the banned waste material.

Table 10 presents the estimates used for the costs of recovering and reprocessing the different waste materials included in the cost-benefit analysis. The same cost estimates have been applied in across all regions.

Table 10 Cost of recovery and reprocessing under the base case and with a landfill ban

Waste material	Cost under the base case ($/tonne)	Cost with a landfill ban ($/tonne)
Concrete (sorted)	19	19
Concrete (mixed)	39	139 (additional cost of $100/tonne to account for sorting either at the site or by the waste generator)
Tyres	140	140
Timber	60	180 (additional cost of $120/tonne to account for sorting either at site or by the waste generator)
Metals	29	129 (additional cost of $100/tonne to account for sorting either at site or by the waste generator)
MSW Green (kerbside)	40	40
MSW Green (mixed – all)	40	76 (based on a lift rate of $1.10 per additional service plus bin hire fee of $0.40 per household and $40 processing fee, with a saving of $16/tonne for residual not to landfill)

Note: The additional cost of sorting waste is contingent upon the assumption that the ban structure would be a 100% 'black and white' ban. This structure treats all banned materials as 'contaminants'. This means that any load containing any banned material must be either rejected at a landfill site and sorted at an additional rate of a minimum of $100/tonne being passed on to the waste generator.

Source: Estimates provided by MRA Consulting Group.

4.3.3 Economic value of recovered material

Diverting waste from landfill to reprocessing activities results in an economic benefit equal to the value consumers place on the recycled materials. This is a key benefit of any waste management policy that aims to increase waste recovery rates. In order to estimate this impact, it is necessary to determine the opportunity cost of disposing of waste via landfill.

The impact of a landfill disposal ban depends on the impact of a ban on demand and supply of recycled materials. Where there is a wide range of uses and strong demand for a recovered material (e.g. tyres or metallic waste), additional recovered tonnages are likely to result in a greater economic value than when uses are relatively narrow and demand is not as strong (e.g. recovered timber). In the latter scenario, the tonnages of material that would be recovered as a result of the implementation of a landfill disposal ban would be of lesser economic value than the tonnages of that material that are recovered under the base case.

The economic benefit from the increased recovery of waste material is determined by:

- the price of recovered material – the market price of recovered material has been used as a proxy for the economic benefit; and

- the tonnage of waste that is landfilled under the base case – the greater the tonnage of waste that is landfilled, the greater the tonnage that will be recovered as a result of the implementation of a landfill disposal ban.

Table 11 sets out the estimates for the market prices of recovered material under the base case and with a landfill ban. The estimates do not vary by region.

Table 11 Market price of recovered material under the base case and with a landfill ban

Waste material	Price under the base case ($/tonne)	Price with a landfill ban ($/tonne)
Concrete (sorted)	16	16
Concrete (mixed)	16	8 (significant increase in recovered material and weak demand for recovered concrete will result in a 50% reduction to economic value)
Tyres	100	100
Timber	108	54 (significant increase in recovered material and weak demand for recovered timber will result in a 50% reduction to economic value)
Metals	525	29 (only applies to metallic waste that is landfilled under the base case on the basis that this material has little economic value)
MSW Green (kerbside)	44	44
MSW Green (mixed – all)	44	22 (significant increase in recovered material and weak demand for MSW Green will result in a 50% reduction to economic value)

Source: Estimates provided by MRA Consulting Group.

4.3.4 Cost of illegal dumping

It is anticipated that there will be an increase in illegal dumping as a result of the implementation of a landfill disposal ban.

Estimating this impact requires an estimate to be applied for the cost per tonne of illegally dumped waste. A cost estimate of $800/tonne has been adopted across all materials and regions, based on the median cost to councils of managing illegal dumping estimated for the 'State of Waste and Recycling in Queensland' report.[13]

The costs of collecting and disposing of illegally dumped waste will be largely incurred by local councils. Any additional costs, incurred due to an increase in illegal dumping as a result of the landfill disposal ban, will represent an increased cost to local councils.

13 Department of Environment and Heritage Protection (2013). State of Waste and Recycling in Queensland.

4.3.5 Greenhouse gas emissions from landfilled waste

The landfilling of waste results in the emission of greenhouse gases. Australian National Greenhouse Accounts emission factors were used to calculate the tonnes of greenhouse gas emissions as a result of the estimated reductions in landfilled waste resulting from the implementation of a landfill disposal ban. The factors used in the analysis are as follows:

- concrete – 0 tCO_2-e per tonne of landfilled waste;
- tyres – 2.5 tCO_2-e[14] per tonne of landfilled waste;
- timber – 1.2 tCO_2-e[15] per tonne of landfilled waste;
- metals – 0 tCO_2-e per tonne of landfilled waste; and
- MSW Green – 1.4 tCO_2-e[16] per tonne of landfilled waste.[17]

4.3.6 Economic cost of greenhouse gas emissions

An estimate of $10 per tonne of CO_2-e has been applied to estimate the cost of greenhouse gas emissions from the landfilling of waste. This is consistent with the cost estimate applied in the recently released expert report on the Renewable Energy Target Scheme.[18]

4.3.7 Effectiveness of the landfill ban

While it is intended that the landfill ban will prevent the landfilling of all banned materials, experience in other jurisdictions demonstrates that there is still likely to be a proportion of banned waste materials that will be deposited in landfills, either due to non-compliance or lack of awareness. The following assumptions have been adopted for the proportion of banned waste materials that will be recovered as a result of the implementation of a landfill disposal ban:

- 90% of landfilled waste to be recovered as a result of the ban in years 1 and 2; and
- 95% of landfilled waste to be recovered as a result of the ban from year 3 onwards.

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14 Based on emissions factor for 'rubber and leather'.

15 Based on emissions factor for 'wood'.

16 Based on the average of the emissions factors for 'food' and 'garden and green'.

17 Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (2013). Australian National Greenhouse Accounts – National Greenhouse Accounts Factors.

18 Commonwealth of Australia (2014). Renewable Energy Target Scheme – Report of the Expert Panel.

4.3.8 Growth rates

An annual growth rate of 1% has been applied to the tonnages of waste material to be landfilled and recovered under the base case for all waste materials across all regions. This assumption is based on advice provided by the MRA Consulting Group, based on current trends in waste generation and landfill disposal.

4.4 Base case

In order to assess the impact of a policy it is necessary to define the base case (i.e. the status quo). In this case, the base case is the continuation of current waste management and disposal arrangements for the targeted waste materials without the implementation of a landfill disposal ban.

The table below summarises the results of the base case in terms of the Present Values (PV) of forward-looking costs and economic values associated with the landfilling and recovery of waste material. The PVs have been calculated based on a 10-year evaluation period (consistent with the draft waste strategy) and a real social discount rate of 7%, consistent with the research paper[19] released by the Productivity Commission.[20]

Table 12 PV estimates of economic costs and benefits from landfilling and material recovery under the base case by waste material and region

Base case estimate	PV South-East ($)	PV North-East ($)	PV Inland ($)
Concrete (sorted)			
Cost of landfill	95,845,091	39,464,783	NA
Cost of emissions from landfilled waste	-	-	NA
Cost of tonnes recovered	30,021,826	13,442,621	NA
Value of tonnes recovered	25,281,538	11,320,102	NA
Concrete (mixed)			
Cost of landfill	435,658,718	179,385,760	NA
Cost of emissions from landfilled waste	-	-	NA
Cost of tonnes recovered	280,108,210	125,421,587	NA
Value of tonnes recovered	114,916,189	51,455,010	NA
Tyres			
Cost of landfill	97,900	43,139	4,314
Cost of emissions from landfilled waste	35,782	17,146	1,715

19 Harrison, M. (2010). Valuing the Future: the social discount rate in cost-benefit analysis. Visiting Researcher Paper. Productivity Commission.

20 Whilst a real discount rate of 7% has been applied, Synergies is of the view that the true social discount rate is likely to be significantly lower. However, a conservative approach has been adopted by aligning with the views of the Productivity Commission.

Base case estimate	PV South-East ($)	PV North-East ($)	PV Inland ($)
Cost of tonnes recovered	23,834,917	10,672,382	1,067,656
Value of tonnes recovered	17,024,941	7,623,130	762,611
Timber			
Cost of landfill	125,249,402	28,055,562	NA
Cost of emissions from landfilled waste	21,973,579	5,352,412	NA
Cost of tonnes recovered	32,960,458	8,028,663	NA
Value of tonnes recovered	59,328,825	14,451,594	NA
Metals			
Cost of landfill	12,849,440	2,250,709	NA
Cost of emissions from landfilled waste	-	-	NA
Cost of tonnes recovered	125,387,295	23,977,077	NA
Value of tonnes recovered	2,269,942,415	434,067,781	NA
MSW Green (kerbside)			
Cost of landfill	106,059	23,445	NA
Cost of emissions from landfilled waste	21,708	5,218	NA
Cost of tonnes recovered	119,686,273	59,983,732	NA
Value of tonnes recovered	131,654,901	65,982,105	NA
MSW Green (mixed – all)			
Cost of landfill	87,276,759	36,795,348	NA
Cost of emissions from landfilled waste	17,863,664	8,189,744	NA
Cost of tonnes recovered	119,686,273	59,983,732	NA
Value of tonnes recovered	131,654,901	65,982,105	NA

Source: Estimates provided by MRA Consulting Group.

4.5 Benefits

There are three benefits associated with the reduction in waste disposed of via landfill:

- a reduction in the cost of landfilling;
- a reduction in the cost of greenhouse gas emissions as a result of landfilling; and
- an increase in the economic value of recovered material.

4.5.1 Reduced cost of landfilling

There is an economic cost that is incurred as a result of sending waste to landfill. This cost includes the operational costs of operating a landfill (i.e. labour, fuel and materials, rehabilitation), the cost of the land on which the landfill site is situated, and other costs associated with maintaining the landfill site (i.e. gas recovery and flaring, fencing, capping and landscaping). There are also environmental costs associated with disposing of waste in landfills (other than the cost of greenhouse gas emissions), including leachate leakage and damage to amenity.

As a result of the implementation of a landfill disposal ban, less waste will be disposed of in landfills. This will result in a reduction in the environmental cost that is incurred as a result of the landfilling of waste, hence resulting in an economic benefit. The cost estimates that have been applied for the landfilling of waste have been set out in section 4.3.1.

The magnitude of this benefit is primarily dictated by the tonnages of waste material that are landfilled under the base case. For waste materials where a significant proportion of current waste is disposed of via landfill, the implementation of a landfill disposal ban will result in significant tonnages being diverted from landfill, subsequently resulting in a significant economic benefit. For example, it is estimated that 871,577 tonnes of mixed concrete will be landfilled in the South-East region in 2014/15 under the base case. As a result of the implementation of a landfill disposal ban, it is anticipated that this total will fall by 90% to 87,158 tonnes. Applying the estimate for the cost of landfilling waste in the South-East region ($68.40/tonne) to the reduced tonnes of landfilled waste results in an economic benefit in 2014/15 of $53,654,249.

The table below sets out the estimates for the PVs of the economic benefit resulting from the reduced cost of landfilling by waste material and region.

Table 13 Economic benefit of reduced cost of landfilling by waste material

Waste material	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)	89,861,455	37,000,985	NA
Concrete (mixed)	408,460,421	168,186,656	NA
Tyres	91,789	40,445	4,045
Timber	117,430,047	26,304,045	NA
Metals	12,047,245	2,110,197	NA
MSW Green (kerbside)	99,438	21,981	NA
MSW Green (mixed – all)	81,828,046	34,498,204	NA

Source: Estimates provided by MRA Consulting Group.

4.5.2 Reduced cost of greenhouse gas emissions

There is an economic cost associated with the greenhouse gas emissions that result from the landfilling of waste. Sections 4.3.5 and 4.3.6 set out the parameter estimates that have been applied to estimate the greenhouse gas emissions resulting from the landfilling of different waste materials and the cost of greenhouse gas emissions respectively. The table below summarises the PV estimates of the economic benefit that will be derived from the reduction in greenhouse gas emissions due to the reduction in landfill tonnages under a landfill disposal ban, based on these parameter estimates.

Table 14 Economic benefit of reduction in greenhouse gas emissions by waste material

Waste material	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)	-	-	NA
Concrete (mixed)	-	-	NA
Tyres	33,548	16,075	1,608
Timber	20,601,763	5,018,260	NA
Metals	-	-	NA
MSW Green (kerbside)	20,353	4,892	NA
MSW Green (mixed – all)	16,748,430	7,678,456	NA

Source: Estimates provided by MRA Consulting Group.

There is no benefit derived from the reduction in greenhouse gas emissions from the diversion of concrete and metallic waste from landfills as these materials are inert waste, and subsequently do not result in any greenhouse gas emissions.

4.5.3 Increased value of recovered material

When a waste material is sent to landfill there is an economic cost associated with the forgone value of recycling the materials. A landfill disposal ban results in a benefit equal to the value of the tonnage of waste that is recovered. The magnitude of this benefit is determined by applying an estimate for the value of recovered material (i.e. the lost commodity value of landfilled waste) to the additional tonnages of recovered waste as a result of the landfill disposal ban.

The following approach has been applied to estimate the increase in the economic value that is derived from recovered waste material under a landfill disposal ban:

- the value of the material that is currently recovered under the base case is estimated based on the current price of each recovered material (i.e. the current price of recovered material is used as a proxy for the economic value that is derived);
- an estimate has been derived for the price that would apply to recovered material as a result of a landfill disposal ban. This price has been applied to the additional tonnages of material that are to be recovered as a result of the ban to estimate the economic value that will be derived from this material (i.e. the price of recovered material that will apply under the ban has been used as a proxy for the value of additional material that will be recovered as a result of the landfill disposal ban);[21]

[21] The market price of recovered material under a landfill disposal ban has not been applied to estimate the economic value of material that is recovered under the base case, as the introduction of a landfill disposal ban will not result in

- the economic value of the additional tonnages that will be recovered as a result of the ban has been added to the estimate for the economic value of material currently being recovered under the base case (which is calculated based on the current market value of recovered material); and
- the estimate for the economic value of material that is currently recovered under the base case is subtracted from the total economic value of recovered material under a landfill disposal ban (including tonnages recovered under the base case and as a result of the ban) to produce an estimate for the increase in the economic value of recovered material as a result of the implementation of a landfill disposal ban.

It is noted that this approach represents a lower bound estimate of the economic value that is derived as a result of the additional tonnages recovered as a result of the landfill disposal ban, as there is likely to be consumer surplus derived by users of the material which represents additional value beyond the market price of the recovered material.[22] However, it is not possible to estimate the value of this consumer surplus as this would require detailed information on the profile of demand for each of the recovered materials, which is not available. Sensitivity analysis has been performed on this parameter for key waste materials.

The estimates for market value that have been applied to the waste materials under the base case and landfill disposal ban scenarios are set out in Table 11.

The following table presents the PVs of the economic benefit estimated for the increase in the tonnages of recovered material by waste material and region.

a reduction in the economic value that is derived from this material. Rather, the key issue is the economic value that will be derived from material that is recovered as a direct result of the introduction of a landfill disposal ban. The market price that will apply under a landfill disposal ban is considered an appropriate proxy for the economic value of this material.

22 Consumer surplus exists where the willingness of consumers to pay for a good or service exceeds the market price. For example, if a consumer is willing to pay $150 for a tonne of recovered material but the market price is $100 per tonne, the consumer is gaining consumer surplus in relation to that tonne valued at $50.

Table 15 Economic benefit of increase in recovered material by waste material

Waste material	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)	20,796,024	7,189,109	NA
Concrete (mixed)	47,263,606	21,162,836	NA
Tyres	132,762	63,615	6,362
Timber	92,411,287	22,341,310	NA
Metals	5,053,272	962,528	NA
MSW Green (kerbside)	63,283	15,212	NA
MSW Green (mixed – all)	26,038,247	11,937,448	NA

Source: Estimates provided by MRA Consulting Group.

4.5.4 Other benefits

The implementation of a landfill disposal ban also has the potential to result in other benefits that have not been quantified in this analysis. The two most significant of these benefits are:

- a reduction in waste generation – a landfill disposal ban increases the cost associated with the disposal of waste material. This provides an economic incentive to reduce the generation of waste material through up-stream process innovation in the manufacturing and construction sectors. To the extent that these innovations reduce the tonnages of waste material that is generated, this constitutes a resource saving and economic benefit attributable to the landfill disposal ban; and
- a reduction in the cost of greenhouse gas emissions attributable to production using 'virgin' materials – as previously noted, the implementation of a landfill disposal ban will result in a significant increase in the tonnages of material that are recovered and reprocessed. This will result in a reduction in total 'virgin' production (i.e. production and manufacture of good using 'virgin' materials). As 'virgin' production is more emissions intensive than production using recovered materials, this will translate to a reduction in the economic cost associated with greenhouse gas emissions resulting from production and manufacturing.

4.6 Costs

There are four main costs that will be incurred in implementing a landfill disposal ban on selected waste materials. These are:

- increased resource recovery costs;
- the cost of increases in illegal dumping;
- compliance costs incurred by landfill operators and waste generators; and

- monitoring and compliance costs to be incurred by government.

4.6.1 Increased resource recovery costs

The benefit that is derived from the diversion of waste from landfills (i.e. reduced cost of landfilling and reduction in the cost of greenhouse gas emissions), also creates a cost associated with the increase in recovery and reprocessing activities. The cost of these activities under both the base case and a landfill ban are set out for each waste material in section 4.3.2. The economic cost associated with the increase in recovery and reprocessing activities under a landfill ban for each waste material will be determined by:

- the additional tonnage of waste that will be recovered and reprocessed as a result of the implementation of a landfill ban (i.e. the tonnages that are being landfilled under the base case) – the higher the tonnages to be recovered, the higher the additional cost that will be incurred from recovering and reprocessing activities; and

- the cost of recovery and reprocessing under a landfill ban – for some waste materials, the implementation of a landfill disposal ban will result in a significant increase in the cost of recovery and reprocessing, due to the additional sorting and treatment requirements associated with reprocessing waste material that is currently disposed of via landfill. It is important to note that this additional cost will only apply to the material that is recovered as a result of the landfill disposal ban (i.e. waste that is disposed of via landfill under the base case). Based on the advice providing by MRA, this is likely to be the case for mixed concrete waste, timber waste, metallic waste and mixed MSW Green material.

Table 16 presents the PV estimates for the increase in the cost of the recovery and reprocessing of waste material under a landfill disposal ban by waste stream.

Table 16 Economic cost of increase in recovery and reprocessing of waste material by waste stream

Waste material	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)	24,695,279	11,057,558	NA
Concrete (mixed)	821,205,160	367,704,276	NA
Tyres	185,867	89,061	8,906
Timber	308,037,625	74,471,035	NA
Metals	22,478,346	4,281,590	NA
MSW Green (kerbside)	57,530	13,829	NA
MSW Green (mixed – all)	89,950,309	41,238,458	NA

Source: Estimates provided by MRA Consulting Group.

The cost associated with increased recovery and reprocessing activities will be most significant for mixed concrete, timber and mixed MSW Green materials.[23] This is driven by both the significant tonnages of these materials that will be recovered as a result of a landfill disposal ban and the higher cost that will be incurred in reprocessing these materials.

4.6.2 Increased cost of illegal dumping

Any policy measure that increases the cost associated with the disposal of waste material has the potential to increase illegal dumping. The impact of the implementation of a landfill disposal ban on illegal dumping and the associated cost is discussed in section 4.3.4. In order to account for this impact, the following parameter estimates have been adopted:

- a cost estimate of $800/tonne of illegally dumped waste (see section 4.3.4); and
- an assumption that the implementation of a landfill disposal ban will result in a 1% increase in the tonnage of illegally dumped waste across all waste materials (based on advice provide by MRA).

Table 17 presents the PV estimates for the costs that will be incurred under a landfill disposal ban as a result of the estimated increase in illegal dumping.

Table 17 Economic cost of increase in illegal dumping by waste stream

Waste material	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)	11,209,952	5,019,368	NA
Concrete (mixed)	50,954,236	22,815,359	NA
Tyres	11,450	5,487	549
Timber	4,394,728	3,568,275	NA
Metals	1,502,858	286,259	NA
MSW Green (kerbside)	12,405	2,982	NA
MSW Green (mixed – all)	10,207,808	4,679,853	NA

Source: Estimates provided by MRA Consulting Group.

[23] For MSW Green material, it is noted the increased cost associated with the recovery and reprocessing of additional material under a landfill disposal ban (due largely to the cost of providing an additional bin and collection service to households) will be incurred by local Councils and, to the extent that Councils pass on this additional cost, subsequently by ratepayers. This impact has been accounted for in the analysis of the costs and benefits of the landfill disposal ban.

4.6.3 Compliance costs

The implementation of a landfill disposal ban will impose an additional compliance burden and subsequently additional costs on landfill operators and waste generators. Based on advice provided by MRA, the cost of business compliance due to the implementation of a landfill disposal ban is estimated at $2 per tonne across all waste materials and regions. This estimate has been applied to the tonnage of waste that is to be landfilled under the base case. Table 18 presents the PV estimates for this cost by waste material and by region.

Table 18 Economic cost of increased business compliance costs by waste stream

Waste material	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)	2,802,488	1,254,842	NA
Concrete (mixed)	12,738,559	5,703,840	NA
Tyres	2,863	1,372	137
Timber	3,662,263	892,069	NA
Metals	375,715	71,565	NA
MSW Green (kerbside)	3,101	745	NA
MSW Green (mixed – all)	2,551,952	1,169,963	NA

Source: Estimates provided by MRA Consulting Group.

4.6.4 Administration, monitoring and enforcement costs

The implementation of a landfill disposal ban will require government to allocate additional resources to ongoing administration, monitoring and enforcement activities. It is anticipated that these costs will be higher in the earlier years of the ban as waste generators and landfill site operators experience difficulties adjusting to the new requirements. The following cost estimates have been applied to account for the administration, monitoring and enforcement costs that will be incurred by government as a result of the introduction of a landfill ban:

- $2.66 per tonne in years 1 and 2 of the evaluation period (across all waste streams and regions); and
- $1.73 per tonne in years 3 onwards (across all waste streams and regions).[24]

As with the compliance cost estimates, these costs have only been applied to waste material that is disposed of via landfill under the base case. Table 19 presents the PV estimates for this cost by waste material and by region.

[24] These cost estimates were derived by estimating the relationship between business compliance and administration, monitoring and enforcement costs from the previous cost-benefit analysis of the implementation of an industry waste levy and applying this proportion to the compliance cost estimate of $2/tonne to be applied for this analysis.

Table 19 Economic cost of increased administration, monitoring and enforcement costs by waste stream and by region

Waste material	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)	2,748,124	1,230,500	NA
Concrete (mixed)	12,491,452	5,593,195	NA
Tyres	2,807	1,345	135
Timber	3,591,221	874,764	NA
Metals	368,426	70,176	NA
MSW Green (kerbside)	3,041	731	NA
MSW Green (mixed – all)	2,502,448	1,147,268	NA

Source: Estimates provided by MRA Consulting Group.

4.6.5 Policy development and implementation

The development and implementation of a landfill disposal ban policy will impose an additional up-front cost on government. The cost for year 1 of the study period (2015) has been estimated at $1,056,500. This represents 25% of the estimate for up-front policy development and implementation costs applied in the cost-benefit analysis of the industry waste levy. This is based on advice provided by the Department that the cost for the implementation of a landfill disposal ban would be significantly lower than for a waste levy. This cost was not distributed across the waste materials, as it is not expected to vary based on the materials included within the scope of the landfill disposal ban.

5 Results

This section presents the results of the modelling of the economic benefits and costs of the implementation of a landfill disposal ban for the identified waste materials, across the applicable regions for each material. It also presents the results of the sensitivity analysis performed on a number of key parameters and assumptions.

5.1 Net economic impact

Table 20 summarises the total PV estimates for the benefits and costs, and the overall NPV result, of the implementation of a landfill disposal ban by waste material and by region (where applicable).

Table 20 PV estimates for the benefits and costs of the implementation of a landfill disposal ban by waste material and by region

Estimate	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)			
Total benefits	110,657,480	44,190,094	NA
Total costs	41,455,844	18,562,269	NA
Net impact of a landfill disposal ban	**69,201,636**	**25,627,825**	**NA**
Concrete (mixed)			
Total benefits	455,724,028	189,349,492	NA
Total costs	897,389,407	401,816,670	NA
Net impact of a landfill disposal ban	**(441,665,379)**	**(212,467,178)**	**NA**
Tyres			
Total benefits	258,099	120,136	12,014
Total costs	202,987	97,265	9,726
Net impact of a landfill disposal ban	**55,112**	**22,871**	**2,287**
Timber			
Total benefits	230,443,096	53,663,615	NA
Total costs	319,685,837	79,806,143	NA
Net impact of a landfill disposal ban	**(89,242,740)**	**(26,142,527)**	**NA**
Metals			
Total benefits	17,100,517	3,072,725	NA
Total costs	24,725,346	4,709,590	NA
Net impact of a landfill disposal ban	**(7,624,829)**	**(1,636,865)**	**NA**
MSW Green (kerbside)			
Total benefits	183,074	42,086	NA
Total costs	76,077	18,288	NA
Net impact of a landfill disposal ban	**106,997**	**23,798**	**NA**
MSW Green (mixed – all)			
Total benefits	124,614,724	54,114,108	NA

Estimate	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Total costs	105,212,518	48,235,543	NA
Net impact of a landfill disposal ban	**19,402,206**	**5,878,565**	**NA**

Source: Synergies modelling.

A detailed breakdown of the PV estimates for the individual benefits and costs by waste material and by region is set out in Attachment B.

The following discussion provides a summary of the key drivers of the results for each of the waste materials included in the analysis.

5.1.1 Concrete (sorted)

The estimated net impact of the implementation of a landfill disposal ban for sorted concrete waste is:

- a net economic benefit of $69.1 million in PV terms for the South-East region; and
- a net economic benefit of $25.6 million in PV terms for the North-East region.

These results are largely driven by the significant benefit associated with the reduced cost of landfill (PVs of $89.9 million and $37.0 million respectively). This is attributable to the significant tonnages of sorted concrete waste currently being disposed of via landfill (i.e. the base case). In addition, given the mature market for the recovery and reprocessing of sorted concrete waste, the cost of recovery was not assumed to increase as a result of the implementation of a landfill disposal ban. Furthermore, it was considered that the market would be capable of absorbing the additional tonnage of recovered material without any reduction in market value.

5.1.2 Concrete (mixed)

The estimated net impact of the implementation of a landfill disposal ban for mixed concrete waste is:

- a net economic cost of $441.7 million in PV terms for the South-East region; and
- a net economic cost of $212.5 million in PV terms for the North-East region.

These results are primarily driven by the significant increase in the cost of recovering and reprocessing mixed concrete waste under a landfill disposal ban compared to the base case. Due to additional costs associated with sorting, separation and storage, the cost of recovering and reprocessing the additional tonnages is estimated at $139 per tonne, compared to the current cost of $39 per tonne. The total costs incurred, largely as a result of the increase in the cost of material recovery, are estimated at $821.2 million and $367.7 million in PV terms for the South-East and North-East regions, respectively.

A reduced market value for the material recovered as a result of the landfill disposal ban has also been applied, based on advice provided by MRA. The economic value of the additional recovered material has been estimated at $8 per tonne, compared to the $16 per tonne estimate applied to tonnages recovered under the base case.

5.1.3 Tyres

The estimated net impact of the implementation of a landfill disposal ban for tyres is:

- a net economic benefit of $55,100 in PV terms for the South-East region;
- a net economic benefit of $22,900 in PV terms for the North-East region; and
- a net economic benefit of $2,300 in PV terms for the Inland region.

The small net economic benefit of the implementation of a landfill disposal ban on tyres is due to the small tonnages of tyres currently being disposed of via landfill in Queensland. It is noted that this analysis was limited to tyres from passenger and small heavy vehicles.

5.1.4 Timber

The estimated net impact of the implementation of a landfill disposal ban for timber waste is:

- a net economic cost of $89.2 million in PV terms for the South-East region; and
- a net economic cost of $26.1 million in PV terms for the North-East region.

These results are primarily driven by the significant increase in the cost of recovering and reprocessing timber waste for tonnages recovered as a result of the landfill disposal ban. Due to the additional costs associated with sorting, separation and storage, the cost of recovering and reprocessing these additional tonnages of timber waste under a landfill disposal ban is estimated at $180 per tonne, compared to $60 per tonne for material recovered under the base case. The costs incurred as a result of the increase in material recovery were estimated at $308.0 million and $74.5 million in PV terms in the South-East and North-East regions, respectively.

A reduced market value for the material recovered as a result of the landfill disposal ban has also been applied, based on advice provided by MRA. The value of the additional recovered timber has been estimated at $108 per tonne, compared to $54 per tonne for material that is recovered under the base case.

5.1.5 Metals

The estimated net impact of the implementation of a landfill disposal ban for metallic waste is:

- a net economic cost of $7.6 million in PV terms for the South-East region; and
- a net economic cost of $1.6 million in PV terms for the North-East region.

These results are primarily driven by the lack of value attributed to the metallic waste that is currently being disposed of via landfill. Under the base case, the material that is recovered from metallic waste is valued at $525 per tonne. Alternatively, for metallic waste that is to be recovered as a result of a landfill disposal ban an estimate of $29/tonne has been applied, based on advice provided by MRA. These estimates indicate that waste generators are currently recovering metallic waste where it is economic to do so. Thus, the metallic waste currently being disposed of via landfill is of little economic value. Furthermore, the cost of recovery (i.e. sorting, separation and storage) is significantly higher for the waste that is currently being disposed of via landfill ($129 per tonne) than under the base case ($29 per tonne).

5.1.6 MSW Green (kerbside)

The estimated net impact of the implementation of a landfill disposal ban for MSW green (kerbside) is:

- a net economic benefit of $107,000 in PV terms for the South-East region; and
- a net economic benefit of $23,800 in PV terms for the North-East region.

Similar to the results of the analysis for tyre waste, these small net benefit estimates are attributable to the small tonnages of MSW green (kerbside) material currently being disposed of via landfill.

5.1.7 MSW Green (mixed – all)

The estimated net impact of the implementation of a landfill disposal ban for MSW green (mixed – all) is:

- a net economic benefit of $19.4 million in PV terms for the South-East region; and
- a net economic benefit of $5.9 million in PV terms for the North-East region.

The two main impacts of the implementation of a landfill disposal ban on all MSW green material are the reduction in the cost of landfilling and the increase in material recovery costs. The first of these impacts (valued at $81.8 million and $34.5 million in PV terms for the South-East and North-East regions respectively) is attributable to the significant tonnages of mixed MSW green material that are currently being disposed of via landfill. The implementation of a ban results in the costs associated with the material being disposed of via landfill being avoided.

In relation to the second impact, the cost of recovering mixed MSW green material that is currently being disposed of via landfill is estimated at $76 per tonne, compared to the current cost estimate of $40 per tonne. This results in total costs attributable to the increase in material recovery as a result of the ban of $90.0 million and $41.2 million in PV terms for the South-East and North-East regions respectively.[25] This increased cost offsets a significant proportion of the total benefits of the implementation of a landfill disposal ban on mixed MSW green material (including the reduced cost of landfill, greenhouse gas emissions and the increased economic value from recovered material).

5.1.8 Overall net impact

Based on the analysis conducted, the implementation of a landfill disposal ban on sorted concrete, tyres and all MSW green material (in both the South-East and North-East regions) would result in a net economic benefit of $119.2 million in PV terms over the 10 year evaluation period. The implementation of a ban was found to result in a negative NPV for all other waste materials across all regions.

5.2 Employment impact

Whilst this study has not directly assessed the impact of the implementation of a landfill disposal ban on employment, it is anticipated that the implementation of a ban would result in a net increase in employment in the waste treatment sector. This is attributable to resource recovery and reprocessing activities being more labour intensive than the operation of landfill sites.[26] Subsequently, any policy that results in the diversion of waste from landfill to reprocessing facilities will have a positive net impact on employment.

The 2010 National Waste Report estimated that for every 10,000 tonnes of waste material that is reprocessed, approximately 9.2 jobs (direct) are created, compared to 2.8 jobs

[25] As previously noted, this represents an additional cost to local government and subsequently (assuming these costs are to be passed on) to ratepayers.

[26] Department of the Environment, Water, Heritage and the Arts (2010). National Waste Report 2010.

(direct) for landfill disposal.[27] For example, based on these estimates, the implementation of a landfill disposal ban on sorted concrete waste would result in a net increase in employment of 128 positions in the South-East region (based on the estimate for the annual average of sorted concrete waste to be landfilled under the base case over the evaluation period of 200,000 tonnes).

An increase in the tonnage of reprocessed waste material is also likely to result in an increase in skilled labour positions, with reprocessing facilities providing employment from entry-level unskilled labour (e.g. sorting activities) through to skilled engineering positions (e.g. renewable energy production).[28]

5.3 Sensitivity analysis

Sensitivity analysis shows how the results of the analysis are affected by changes to key parameters and assumptions. This provides policy makers with an indication of the level of certainty associated with the modelled results in addition to identifying the critical parameters and assumptions in terms of the impact on the net economic impact of the policy or program.

The sensitivity analysis has been conducted in two parts:

- the sensitivity of the overall net impact of a landfill disposal ban including sorted concrete, tyres and all MSW green material has been assessed based on changes to:
  – the discount rate (4% and 10%);
  – the cost of disposing of waste via landfill (+/- 50%);
  – the cost per tonne of greenhouse gas emissions (+/- 50%); and
- the sensitivity of the net impacts of the implementation of a landfill disposal ban on sorted concrete and all MSW green material has been assessed (on an individual basis) against changes to:
  – the cost of recovering additional material under a landfill disposal ban (+/- 50%); and
  – the value of material recovered as a result of a landfill disposal ban (+/- 50%).[29]

Table 21 presents the results on the first component of the sensitivity analysis.

27 Department of the Environment, Water, Heritage and the Arts (2010).

28 Department of the Environment, Water, Heritage and the Arts (2010).

29 Tyre waste was excluded from this part of the sensitivity analysis due to the very low economic benefit estimated for this waste material as a result of the implementation of a landfill disposal ban.

Table 21 Sensitivity analysis for the implementation of a landfill disposal levy on sorted concrete, tyre waste and all MSW Green material

Parameter	Net Present Value ($)	% change in NPV relative to base
Base result	119,205,927	NA
	Discount rate	
Low (4%)	138,461,763	+16.2%
High (10%)	103,687,420	-13.0%
	Cost of disposing of waste via landfill	
Low (-50%)	(2,399,687)	-102.0%
High (+50%)	240,925,282	+102.0%
	Cost of greenhouse gas emissions (tCO2-e)	
Low (-50%)	106,966,868	-10.3%
High (+50%)	131,444,985	+10.3%

Source: Synergies modelling.

The results presented in the above table demonstrate that the only parameter that has a significant effect on the net impact of the implementation of a landfill disposal ban on sorted concrete, tyre and all MSW green material is the cost estimate that is applied per tonne of waste that is disposed of via landfill. A significant reduction of 50% to this parameter estimate (resulting in cost estimates of $34.20 per tonne and $31.50 per tonne for the South-East and North-East/Inland regions respectively) results in an estimated net economic cost of $2.4 million. However, it is important to note that it is highly unlikely that these alternative cost estimates are accurate estimates for the economic cost of disposing of waste via landfill.

The second component of the sensitivity analysis demonstrated the importance of the estimate that is adopted for the cost of recovering and reprocessing additional material as a result of a landfill disposal ban in terms of the economic impact on individual waste streams for which it is anticipated that this cost will be significantly higher than the current recovery and reprocessing cost (i.e. mixed concrete, timber, metals and all MSW green). For example:

- for mixed concrete waste, while the NPV estimates remained negative under all scenarios, there was a significant reduction in the negative NPVs estimated when the cost of recovering additional material due to the ban was reduced from $139 per tonne to $69.50 per tonne (noting that the estimated cost of recovery and reprocessing of mixed concrete under the base case is $39 per tonne). This alternative estimate resulted in a reduction in the negative NPV for the South-East region from ($441.7 million) to ($31.1 million) (a 93.0% reduction) and an equivalent reduction from ($212.5 million) to ($28.6 million) (a 86.5% reduction) in the North-East region;

- for timber waste, a reduction in the cost of recovering additional material due to the ban from $180 per tonne to $90 per tonne (noting that the estimated cost of recovery and reprocessing of timber waste under the base case is $60 per tonne) results in the NPV estimates for this waste material increasing from ($89.24 million) to $64.78 million (a 172.6% increase) in the South-East region and from ($26.14 million) to $11.1 million (a 142.5% increase) in the North-East region; and
- for metallic waste, a reduction in the cost of recovering additional material due to the ban from $129 per tonne to $64.50 per tonne (noting that the estimated cost of recovering and reprocessing of metallic waste under the base case is $29 per tonne) results in NPV estimates for this waste material increasing from ($7.6 million) to $3.6 million (a 147.4% increase) in the South-East region and from ($1.6 million) to $0.5 million (a 131.3% increase) in the North-East region.

6 Recommendations for implementation

Based on the above analysis, where a landfill disposal ban on sorted concrete, tyres and all MSW green material (in both the South-East and North-East regions) would result in a net economic benefit, consideration has been given to the additional infrastructure that would be required to process the additional materials and the complementary policy requirements. Each of these issues is discussed below.

6.1 Required infrastructure for recycling

Based on MRA's analysis (see Table 22) the sorted concrete and tyre recycling markets are capable of accepting and processing the additional tonnages likely to enter the market, should a landfill disposal ban be implemented. However, additional capacity would be required to process the additional tonnages of MSW green material.

Table 22 Current capacity and potential future need for investment (t/a)

Material	Current capacity (t)	Planned investment (t)	Future needs (t)	Need for investment (t)
Concrete (sorted)	>2,000,000	600,000	>250,000	None
Tyres	>60,000	>60,000	300	None
Green waste (total)	>800,000	Unknown	>200,000	>200,000

Source: MRA. 2014. Landfill disposal ban feasibility study: review of existing infrastructure and markets in Queensland. Report prepared for Synergies Economic Consulting. October. 20

As noted by MRA, green waste can be recycled either through composting, mulch or as a feedstock in a waste-to-energy process. The infrastructure requirements vary in accordance with the form of processing that is undertaken. MRA's report (Attachment A) identifies the most common applicable technologies currently used in Queensland, which could be reasonably expected to be expanded should all green waste be banned from landfill.

The likely infrastructure cost, for a range of facilities capable of processing green waste should all green waste be banned from landfill, are detailed in Table 23 (a more detailed summary is provided in Table 7 of the MRA report).

Table 23 Infrastructure costs required for various green waste processing facilities

Technology	Infrastructure required	Facility examples	Capital costs	Operating costs
Mobile Aerated Floor	Mobile floor Air delivery pipes Air blowers Temp and oxygen sensors Enclosed building	Peats Soil & Garden Supplies (SA)	$1m/10,000 tpa (this can be used as a scaling factor to accommodate different tonnages)	$80-$120/t
Windrow Composting	Operational plant Enclosed building	Dulverton (TAS)	$1m/20,000 tpa	$60-$80/t
		Groundswell (NSW	$200,000/5,000 tpa	$50-$70/t
Tunnel Composting	Enclosed concrete tunnels Air delivery	SAWT Penrith Line (NSW)	$60m/120,000 tpa	$160-$220/t
Mulching	Mobile or static mulching machine	Timber Waste Recycling, Melbourne	$18,000 - $24,000	$80/t

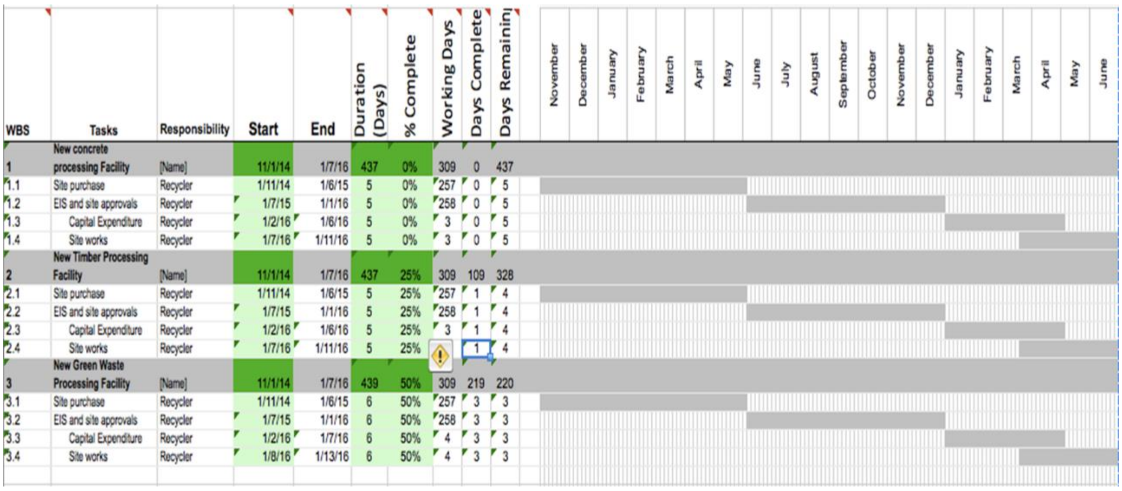
Source: MRA. 2014. Landfill disposal ban feasibility study: review of existing infrastructure and markets in Queensland. Report prepared for Synergies Economic Consulting. October. p 22.

6.2 Implementation issues

6.2.1 Planning and construction of new facilities

Any new development will require a lead-time for all approvals and processes to be put in place. Figure 3 estimates the average time requirements needed for the planning, approval and construction stages of a new facility type.

Figure 3 Implementation GANTT Chart for new facilities



WBS	Tasks	Responsibility	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remainin
1	New concrete processing Facility	[Name]	11/1/14	1/7/16	437	0%	309	0	437
1.1	Site purchase	Recycler	1/11/14	1/6/15	5	0%	257	0	5
1.2	EIS and site approvals	Recycler	1/7/15	1/1/16	5	0%	258	0	5
1.3	Capital Expenditure	Recycler	1/2/16	1/6/16	5	0%	3	0	5
1.4	Site works	Recycler	1/7/16	1/11/16	5	0%	3	0	5
2	New Timber Processing Facility	[Name]	11/1/14	1/7/16	437	25%	309	109	328
2.1	Site purchase	Recycler	1/11/14	1/6/15	5	25%	257	1	4
2.2	EIS and site approvals	Recycler	1/7/15	1/1/16	5	25%	258	1	4
2.3	Capital Expenditure	Recycler	1/2/16	1/6/16	5	25%	3	1	4
2.4	Site works	Recycler	1/7/16	1/11/16	5	25%		1	4
3	New Green Waste Processing Facility	[Name]	11/1/14	1/7/16	439	50%	309	219	220
3.1	Site purchase	Recycler	1/11/14	1/6/15	6	50%	257	3	3
3.2	EIS and site approvals	Recycler	1/7/15	1/1/16	6	50%	258	3	3
3.3	Capital Expenditure	Recycler	1/2/16	1/7/16	6	50%	4	3	3
3.4	Site works	Recycler	1/8/16	1/13/16	6	50%	4	3	3

Data source: MRA. 2014. Landfill disposal ban feasibility study: review of existing infrastructure and markets in Queensland. Report prepared for Synergies Economic Consulting. October. p 24.

It is estimated that it may take up to six months to find a suitable site for each facility, but this time could be reduced should a recycler already own a suitable plot of land. Under Queensland planning law, if a 'coordinated project' has the potential to cause environmental, social or economic impacts the project proponent must prepare an Environmental Impact Statement (EIS). This would be the case for a green waste facility. The process of consultation and approval may take up to six months, but may take longer should any significant submissions be received, which require additional information. Capital expenditure and site works are likely to take an additional six months.

6.2.2 Distance

Generally, the distance travelled by processors was considered one of the inhibiting factors to the implementation of all bans, especially for denser materials such as concrete and timber, which are not economically viable to transport to suitable processors. Such materials are easily recycled in the South East region where recyclers are situated close to generators and markets.

6.2.3 Regulatory and policy framework

There are a number of relevant Queensland State Controls and Council specific controls, which apply to the construction and functioning of sites to recycle organic waste and other inert waste which may prove to be barriers to the implementation of a landfill disposal ban; when there is not enough current market capacity.

6.3 Complementary policies

At the industry workshops, it was noted that further assistance was required in the area of complementary policies and standards as these can have a material impact on the size of the market for the recovered materials and the associated price/value of recovered material.

For example, the State Government guidelines, requiring a minimum percentage of recycled concrete in State construction projects, has been removed. This has caused a reduction in the market's capacity to absorb recycled concrete. Therefore, a landfill disposal ban would be best implemented with a reinstatement of State Government guidelines to utilise recovered concrete and aggregate materials.

7 Conclusions

There are a wide range of policy instruments that can be applied to contribute to meeting the increased recycling targets set out in the draft waste strategy for Queensland. One of these instruments is a ban on the disposal of specified waste materials in landfills. The outcomes of stakeholder consultation and overseas experience indicates that landfill disposal bans can be effective at increasing the quantity of material recovered from waste that is typically landfilled.

A cost-benefit analysis was conducted on the implementation of a landfill disposal ban to apply to the following waste materials:

- sorted concrete;
- mixed concrete;
- tyres;
- timber;
- metals;
- MSW green (kerbside); and
- MSW green (mixed – all).

The following impacts of the implementation of a landfill disposal ban were quantified for each of the above waste materials in the South-East and North-East regions (and Inland region for tyres):

- reduction in the economic cost of disposal of waste via landfill;
- reduction in the cost of greenhouse gas emissions from landfill;
- increase in the economic value from recovered material;
- increase in the cost of recovery and reprocessing;
- increase in the cost of illegal dumping;
- increased compliance costs;
- cost of administration, monitoring and enforcement; and
- cost of policy development and implementation.

Table 24 summarises the PV estimates of the net economic impact of the implementation of a landfill disposal ban for each of these waste materials by region.

Table 24 NPV impacts of implementation of a landfill disposal ban by waste material and by region

Waste material	NPV of ban for South-East ($)	NPV of ban for North-East ($)	NPV of ban for Inland
Concrete (sorted)	69,201,636	25,627,825	NA
Concrete (mixed)	(441,665,379)	(212,467,178)	NA
Tyres	55,112	22,871	2,287
Timber	(89,242,740)	(26,142,527)	NA
Metals	(7,624,829)	(1,636,865)	NA
MSW Green (kerbside)	106,997	23,798	NA
MSW Green (mixed – all)	19,402,206	5,878,565	NA

Source: Synergies modelling.

The key drivers of the results in the above table by waste stream are as follows:

- for sorted concrete waste, the significant reduction in the cost of disposal of waste via landfill;
- for mixed concrete waste, the significant increase in the cost of recovering additional tonnages as a result of the ban;
- for tyre waste, the very low tonnages currently being disposed of via landfill;
- for metallic waste, the lack of value of metallic waste currently being disposed of via landfill;
- for MSW green (kerbside), the very low tonnages currently being disposed of via landfill; and
- for MSW green (mixed – all), the significant reduction in the cost of disposal of waste via landfill.

Based on the analysis conducted, the implementation of a landfill disposal ban on sorted concrete, tyres and all MSW green material (in both the South-East and North-East regions) would result in a net economic benefit of $119.2 million in PV terms over the 10 year evaluation period. This result includes the cost of policy development and implementation. The implementation of a ban was found to result in a negative NPV for all other waste materials across all regions.

Sensitivity analysis was conducted on key parameters to assess the impact on the results of the analysis for each waste stream. The key conclusion to be drawn from this analysis is that the estimate that is applied for the cost of recovering and reprocessing additional material as a result of a landfill disposal ban has a significant impact on the net economic impact of the ban.

Based on MRA's analysis, there is sufficient capacity within the sorted concrete and tyre recycling markets to accept and process the additional tonnages likely to enter the market should a landfill disposal ban be implemented. However, additional capacity would be required to process the additional tonnages of MSW green material. Green waste can be recycled either through composting, mulch or as a feedstock in a waste-to-energy process. Whilst the infrastructure requirements vary in accordance with the form of processing that is undertaken, it generally takes over 12 months to complete the planning, approval and construction stages for any type of new facility.

Prior to the implementation of a landfill disposal ban, careful consideration should be given to the timing of implementation and the need for complementary policies and standards. As shown through the desktop review, the introduction of a levy, in the early stages of the policy (i.e. to transition to a landfill disposal ban), has proved to be integral to providing the necessary economic signals to encourage additional investment in capacity. In the absence of a levy, it is important that the complementary policy settings (e.g. phase-in implementation periods, and producer responsibility measures) are appropriate, so to ensure any adverse unintended consequences are minimised and industry is provided sufficient time to invest and to develop a good understanding of the future policy settings, including anticipated feedstock levels.

A Overview of landfill disposal bans

The purpose of this section is to provide an overview of the landfill disposal bans that have been implemented in other jurisdictions, both in Australia and internationally. Of the jurisdictions considered, Europe has had the most experience with this type of policy instrument.

A.1 Objectives

Landfill disposal bans are typically implemented to:

- increase material recovery – by imposing a ban on the landfilling of certain types of waste, authorities can increase the proportion of waste that is diverted to recycling facilities;
- alleviate pressure on landfill capacity – if the volume of waste being landfilled is placing pressure on the availability of landfill capacity, a ban on the landfilling of certain types of waste can alleviate some of this demand pressure; and
- reduce the adverse impact of landfills on the environment and human health – there are negative environmental and health consequences associated with the disposal of waste via landfill. These negative consequences are reduced when a landfill disposal ban is implemented.

Landfill disposal bans can be implemented to address one or more of these objectives. There are also secondary objectives underpinning some landfill disposal ban policies, such as increasing the level of energy generated from waste material, providing incentives for reducing the generation of waste material, and reducing the community's dependency on landfill as a waste treatment option.

The objectives of landfill disposal ban policies are primarily dictated by the circumstances and context in which the ban is implemented. For example, in European countries where land is scarce, bans are often implemented to reduce capacity issues (in addition to other objectives) whilst in North America, there is a greater focus on material recovery and the environmental and human health impact of landfills.

A.2 Categories of waste covered

Landfill disposal bans can be implemented on:

- specific waste streams, such as Municipal Solid Waste (MSW), Commercial and Industrial (C&I), Construction and Demolition (C&D), and hazardous or regulated waste;

- specific waste materials, such as tyres, timber, metals, etc;
- specific properties of waste, such as Total Organic Carbon (TOC) value or waste that is recoverable; or
- any combination of the above.

The waste types or categories included within the scope of landfill disposal bans varies significantly across jurisdictions. Based on the desktop review conducted, the four most common types or categories included in a landfill disposal ban are:

- untreated waste;
- biodegradable/organic waste;
- recoverable waste; and
- hazardous waste (e.g. explosive).

An overview of the waste types and categories applied in the jurisdictions reviewed, is provided in the tables below.

Table A.1 Banned materials – Australian jurisdictions

Jurisdiction	Waste categories banned from landfill
Queensland	• N/A
New South Wales	• Tyres • Medical waste
Victoria	• Certain hazardous wastes
South Australia	• Hazardous waste • Lead acid batteries • Liquid waste • Medical waste • Oil • Whole tyres • Aggregated cardboard and paper • Aggregated glass and packaging • Aggregated metals • Aggregated PET or HDPE plastic packaging • Vegetative matter collected by councils • Vehicles • PP or LDPE plastic packaging • Whitegoods • PVC or PS plastic packaging • Fluorescent lighting • Computer monitors and televisions • Whole earth mover tyres • Other electrical or electronic equipment
Western Australia [a]	• Tyres

Tasmania	• Untreated contaminated soil
Australian Capital Territory	• Electronic waste • Tires • Mattresses

Note: a The ban is only for the Perth Metro Area.

Source: South Australia - http://www.epa.sa.gov.au/environmental_info/waste/legislation/waste_to_resources_policy/landfill_bans; http://www.environment.gov.au/protection/national-waste-policy/publications/landfill-ban-investigation-final-report; Western Australia http://www.wasteauthority.wa.gov.au/media/files/documents/impacts_tyre_policies.pdf.

Table A.2 Waste categories included in landfill disposal bans in European countries

Jurisdictions	***Waste categories included in landfill disposal ban***
Austria	• Sludges and similar wastes • Liquid waste (except leachate) • Inflammable and explosive waste • Gasses under pressure • Infectious wastes and wastes for which the hazardous content exceeds specified limits
Belgium (Flanders)	• Unsorted household waste • Waste collected for the purpose of recovery or that is fit for recycling • Old and expired medication
Belgium (Wallonie)	• Separated household waste • Non-hazardous industrial and packaging waste • Waste from pre-treatment and sorting facilities • Non pre-treated fine residual household waste • Bulky waste
Denmark	• Untreated waste, including mixed municipal waste
Estonia	• Unsorted waste
Finland	• Household waste where the biodegradable component has not been separately collected • Expanded in 2011 to cover all biodegradable waste
France	• All waste types other than residual waste
Germany	• Waste with an organic component that has not been stabilised and made inert
Hungary	• All materials included in the EU Landfill Directive • Tyres and rubber scrap
Ireland	• All biodegradable waste that has not been subject to pre-treatment
Italy	• Waste materials prescribed under the EU Landfill Directive • Waste containing or contaminated by certain materials (e.g. PCBs, PCTs, PCDD, PCDF) • Waste containing ozone depleting substances • Waste with unknown effects on the environment and human health
Netherlands	• Batteries • Oil filters • Hazardous wastes • Paper and cardboard • Organic waste • Electrical and electronic equipment • Plastic waste • Tyres • Building and demolition waste

	• Wood waste • Contaminated soil • Household waste
Norway	• Biodegradable waste
Sweden	• Combustible waste • Organic waste

Source: Hyder Consulting. 2010. Landfill Ban Investigation – Final Report. Prepared for the Department of Sustainability, Environment, Water, Population and Communities. Various sources

Table A.3 Materials banned from landfills – USA (items banned as of 2008)

State	Yard Trimmings	Containers, paper	Whole Tires	Used Oil	Lead-Acid batteries	White goods	Electronics	C&D	Other
Alabama				X	X				
Alaska				X	X				
Arizona				X	X				
Arkansas	X		X		X				
California			X	X	X	X	X		
Colorado			X	X	X		X		
Connecticut	X		X		X				
Delaware	X		X						
Florida	X		X	X	X				
Georgia	X		X	X	X				
Hawaii			X						
Idaho			X						
Illinois	X		X	X	X	X			X
Indiana	X		X						
Iowa	X		X	X	X	X			X
Kansas			X						
Kentucky			X		X				
Louisiana			X	X	X	X			
Maine			X	X	X	X	X		X
Maryland	X		X	X	X				
Massachusetts	X	X	X		X	X	X	X	
Michigan	X	X	X	X	X				
Minnesota	X		X	X	X	X	X	X	
Mississippi			X		X				
Missouri	X		X	X	X	X			
Nebraska	X		X	X	X	X			
New Hampshire	X		X	X	X		X		
New Jersey	X	X	X	X	X	X	X		
New Mexico				X	X				X
New York			X						
North Carolina	X	X	X	X	X	X			X

North Dakota				X	X	X		
Ohio	X		X					
Oregon			X				X	
Pennsylvania	X		X		X			
Rhode island	X	X	X	X	X	X	X	
South Carolina	X		X	X	X	X		X
South Dakota	X		X	X	X	X		
Tennessee			X	X	X			
Texas			X	X	X	X		
Utah			X	X	X			
Vermont	X	X	X	X	X	X		
Virginia			X		X		X	
West Virginia	X		X	X	X			
Wisconsin	X	X	X	X	X	X		
Wyoming				X	X			

Source: *http://www.biocycle.net/images/art/1010/bc101016_s.pdf*

A.3 Duration

Landfill disposal bans have been a key feature of waste management policies in several European countries for over a decade. The 1999 EU Landfill Directive (the Directive) established an overarching objective to prevent or reduce as far as possible the negative impact of landfilling on the environment. The Directive included targets for reductions in landfill volumes across the EU (see box below).

Box A.1 EU Landfill Directive

In 1999, The European Union (EU) introduced 'Council Directive 99/31/EC' (the EU Landfill Directive). The objective of the Directive was to prevent or reduce as far as possible the negative impact of landfilling on the environment. This was to be achieved by introducing stringent technical requirements for the landfilling of waste. The deadline for the implementation of the Directive by EU member states was 16 July 2001.

The Directive specifies that the following wastes may not be accepted in a landfill facility:

- liquid waste
- flammable waste
- explosive or oxidising waste
- hospital and other clinical waste which is infectious
- any other type of waste that fails to meet the acceptance of criteria in Annex II.

The Directive also set out a system of operating permits for landfill sites, standard waste acceptance procedures, and arrangements for reporting on progress to the European Commission. The Directive was later expanded to include a ban on whole tyres (from 2003) and shredded tyres (from 2006).

The Directive also included targeted reductions in the proportion of total waste being landfilled (relative to 1995 levels):

- 75% by 2006

- 50% by 2009
- 35% by 2016.

Data source: Waste – Landfill of Waste. European Commission; http://ec.europa.eu/environment/waste/landfill_index.htm; DOA: 27 August 2014.

Landfill disposal bans, once implemented, are maintained indefinitely. In most cases, bans are initially introduced for a small number of waste streams or materials with additional materials added over time. For example, in Belgium (Flanders), a landfill disposal ban was initially implemented on unsorted wastes in 1998 before being expanded to cover combustible residual waste in the year 2000. A similar approach was used in Nova Scotia, as shown in the table below.

Table A.4 Materials banned from disposal in Nova Scotia

Date of ban	Materials and products
Between 1996 and 1999	Beverage containers Corrugated cardboard Newsprint Lead-acid batteries Used tires Yard waste Paint products Compostable organic material Steel/tin food containers Glass food containers Polyethylene bags and packaging
Since 2008	Televisions Desktop, laptop, and notebook computers Computer accessories Computer monitors Printers
Since 2009	Computer scanners Audio-video recording systems Telephones and fax machines Cell phones and other wireless devices

Source: http://www.novascotia.ca/nse/waste/docs/SolidWasteStrategyFinalReport1995.pdf

A.4 Effectiveness of landfill disposal bans

Based on the jurisdictions considered in the desktop review, landfill disposal bans have facilitated large reductions in the proportion of waste being disposed of via landfill. However, it is important to note that it is difficult to isolate the outcomes attributable to a single waste management policy on waste disposal and diversion rates.

In most jurisdictions, landfill disposal bans are accompanied by a range of complementary policies, most commonly landfill disposal levies or taxes, which often precede the implementation of landfill disposal bans. The table below provides an overview of the reductions to landfill disposal rates and increases in waste material recovery rates achieved in the European jurisdictions included in the review.

Table A.5 Results of landfill disposal ban policies in various European

Jurisdiction	Reduction in landfill disposal	Increase in material recovery
Austria	Reduction in proportion of waste being disposed of via landfill from 29% in 1999 to 4% in 2006	3% increase in waste material recovery
Belgium	Reduction in proportion of waste being disposed of via landfill from 25% in 1997 to 3% in 2007	66% increase in waste material recovery
Estonia	Reduction in tonnage MSW being disposed of via landfill – 267,000 tonnes in 2010 compared to 403,000 tonnes in 2001	Increase to recycling rate from 5% of MSW generated in 2001 to 20% in 2010
Finland	Landfill ban has been found to be ineffective and unenforceable – government is currently in the process of redesigning a stricter ban to be implemented in the foreseeable future	
Germany	Reduction in proportion of waste being landfilled from 27% of total waste in 2000 to 1% in 2006	25% increase in waste material recovery
Netherlands	Reduction in proportion of waste being disposed of via landfill from 35% in 1995 to 10% in 2006	27% increase in waste material recovery
Sweden	Reduction in proportion of waste being disposed of via landfill from 23% in 2001 to 4% in 2007	32% increase in waste material recovery

Source: Hyder Consulting (2010). Landfill Ban Investigation – Final Report. Prepared for the Department of Sustainability, Environment, Water, Population and Communities. various sources.

A.5 Unintended consequences

The potential unintended consequences that can arise as a result of the implementation of a landfill disposal ban include:

- an increase in the tonnages of illegally dumped waste;
- significant increases in the cost of waste management for businesses due to the lack of capacity in the recovery and processing market for waste categories or materials included in the landfill disposal ban; and
- adverse impacts in the markets for recovered waste materials due to the significant increase in volumes as a result of the landfill disposal ban and the lack of uses for recovered material.

There is anecdotal evidence that the implementation of policies that increase the cost of waste disposal (including landfill taxes or levies and landfill disposal bans) result in an increased rate of illegal dumping. For instance, a study conducted in the United Kingdom estimated that the proportion of tyres being illegally disposed of increased from 4% to 10% between 2003 and 2010 following the introduction of the EU Landfill

Directive.[30] Studies have also indicated that since the implementation of landfill disposal bans there has been an increase in the proportion of waste that is generated in European countries being shipped internationally to be illegally disposed of.[31]

While little can be done to prevent the illegal dumping of waste materials, aside from increasing expenditure on compliance monitoring and enforcement activities, the other two unintended consequences identified above can be addressed through complementary measures. For example, the implementation of a landfill levy or tax prior to the implementation of a landfill disposal ban can provide economic incentives to increase the capacity of the recovery and processing sector, so that the sector has the capacity to accommodate the increased quantity of materials that will be made available once the landfill disposal ban is implemented. Similarly, policies and regulations can be implemented or adjusted, to expand the potential uses for recovered waste materials.

A.6 Complementary waste management policies

In almost all jurisdictions included in the desktop review, landfill disposal bans have been implemented as part of a suite of waste management policies. The most common complementary policy is a waste disposal levy or tax, which is typically implemented several years in advance of a landfill disposal ban. The purpose of this policy is to provide an economic incentive to increase the capacity of the waste recovery and processing market. It also enables the market to accommodate the increased volumes that will result from the implementation of a landfill disposal ban without significant costs being imposed on businesses and industry. The table below provides a summary of the complementary waste management policies that apply in the European countries reviewed.

30 Baird, J., Curry, R. & Cruz, P. (2014). An overview of waste crime, its characteristics, and the vulnerability of the EU waste sector. *Waste Manag Res* 32:97.

31 'A Comprehensive Assessment of Illegal Waste Dumping' – Elizabeth Hanfman. http://www.waterhealtheducator.com/upload/Illegal%20Waste%20Dumping%20Article.pdf; DOA: 20 September 2014.

Table A.6 Overview of complementary waste management policies in European countries

Jurisdiction	Landfill tax/levy	Incineration tax/levy	Producer responsibility measures	Mandatory separate collection	Variable landfill charging	Documentation and reporting obligations
Austria	✓		✓	✓	✓	✓
Belgium	✓	✓	✓	✓	✓	
Denmark	✓					
Estonia	✓					
Finland	✓					✓
France	✓					
Germany			✓	✓	✓	✓
Hungary	✓					
Ireland	✓			✓		
Italy	✓					
Netherlands	✓		✓	✓	✓	
Norway	✓	✓				
Sweden	✓	✓				
Austria	✓		✓	✓	✓	✓
Belgium	✓	✓	✓	✓	✓	
Denmark	✓					

Source: Hyder Consulting (2010). Landfill Ban Investigation – Final Report. Prepared for the Department of Sustainability, Environment, Water, Population and Communities. Various sources.

B PV estimates of benefits and costs by waste material and by region

Table B.1 NPV of the implementation of a landfill disposal ban by waste material and by region

Impact	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Concrete (sorted)			
Reduced cost of landfilling	89,861,455	37,000,985	NA
Reduced cost of GHG emissions from landfilling	-	-	NA
Increased value of recovered material	20,796,024	7,189,109	NA
Total benefits	**110,657,480**	**44,190,094**	**NA**
Increased resource recovery costs	24,695,279	11,057,558	NA
Increased cost of illegal dumping	11,209,952	5,019,368	NA
Increased compliance costs	2,802,488	1,254,842	NA
Ongoing monitoring and enforcement costs	2,748,124	1,230,500	NA
Total costs	**41,455,844**	**18,562,269**	**NA**
Net impact of a landfill disposal ban	**69,201,636**	**25,627,825**	**NA**
Concrete (mixed)			
Reduced cost of landfilling	408,460,421	168,186,656	NA
Reduced cost of GHG emissions from landfilling	-	-	NA
Increased value of recovered material	47,263,606	21,162,836	NA
Total benefits	**455,724,028**	**189,349,492**	**NA**
Increased resource recovery costs	821,205,160	367,704,276	NA
Increased cost of illegal dumping	50,954,236	22,815,359	NA
Increased compliance costs	12,738,559	5,703,840	NA
Ongoing monitoring and enforcement costs	12,491,452	5,593,195	NA
Total costs	**897,389,407**	**401,816,670**	**NA**
Net impact of a landfill disposal ban	**(441,665,379)**	**(212,467,178)**	**NA**
Tyres			
Reduced cost of landfilling	91,789	40,445	4,045
Reduced cost of GHG emissions from landfilling	33,548	16,075	1,608
Increased value of recovered material	132,762	63,615	6,362
Total benefits	**258,099**	**120,136**	**12,014**
Increased resource recovery costs	185,867	89,061	8,906
Increased cost of illegal dumping	11,450	5,487	549
Increased compliance costs	2,863	1,372	137
Ongoing monitoring and enforcement costs	2,807	1,345	135
Total costs	**202,987**	**97,265**	**9,726**
Net impact of a landfill disposal ban	**55,112**	**22,871**	**2,287**
Timber			

Impact	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Reduced cost of landfilling	117,430,047	26,304,045	NA
Reduced cost of GHG emissions from landfilling	20,601,763	5,018,260	NA
Increased value of recovered material	92,411,287	22,341,310	NA
Total benefits	**230,443,096**	**53,663,615**	**NA**
Increased resource recovery costs	308,037,625	74,471,035	NA
Increased cost of illegal dumping	4,394,728	3,568,275	NA
Increased compliance costs	3,662,263	892,069	NA
Ongoing monitoring and enforcement costs	3,591,221	874,764	NA
Total costs	**319,685,837**	**79,806,143**	**NA**
Net impact of a landfill disposal ban	**(89,242,740)**	**(26,142,527)**	**NA**
Metals			
Reduced cost of landfilling	12,047,245	2,110,197	NA
Reduced cost of GHG emissions from landfilling	-	-	NA
Increased value of recovered material	5,053,272	962,528	NA
Total benefits	**17,100,517**	**3,072,725**	**NA**
Increased resource recovery costs	22,478,346	4,281,590	NA
Increased cost of illegal dumping	1,502,858	286,259	NA
Increased compliance costs	375,715	71,565	NA
Ongoing monitoring and enforcement costs	368,426	70,176	NA
Total costs	**24,725,346**	**4,709,590**	**NA**
Net impact of a landfill disposal ban	**(7,624,829)**	**(1,636,865)**	**NA**
MSW Green (kerbside)			
Reduced cost of landfilling	99,438	21,981	NA
Reduced cost of GHG emissions from landfilling	20,353	4,892	NA
Increased value of recovered material	63,283	15,212	NA
Total benefits	**183,074**	**42,086**	**NA**
Increased resource recovery costs	57,530	13,829	NA
Increased cost of illegal dumping	12,405	2,982	NA
Increased compliance costs	3,101	745	NA
Ongoing monitoring and enforcement costs	3,041	731	NA
Total costs	**76,077**	**18,288**	**NA**
Net impact of a landfill disposal ban	**106,997**	**23,798**	**NA**
MSW Green (mixed – all)			
Reduced cost of landfilling	81,828,046	34,498,204	NA
Reduced cost of GHG emissions from landfilling	16,748,430	7,678,456	NA
Increased value of recovered material	26,038,247	11,937,448	NA
Total benefits	**124,614,724**	**54,114,108**	**NA**
Increased resource recovery costs	89,950,309	41,238.458	NA
Increased cost of illegal dumping	10,207,808	4,679,853	NA
Increased compliance costs	2,551,952	1,169,963	NA

Impact	PV for South-East ($)	PV for North-East ($)	PV for Inland ($)
Ongoing monitoring and enforcement costs	2,502,448	1,147,268	NA
Total costs	**105,212,518**	**48,235,543**	**NA**
Net impact of a landfill disposal ban	**19,402,206**	**5,878,565**	**NA**

Source: Synergies modelling.