TBL Assessment of (Domestic) Food Organics Management

Department of Environment and Conservation NSW

This report has been prepared for NSW Department of Environment and Conservation in accordance with the terms and conditions of appointment for proposal NSMHI06/NS6077 dated 10 February, 2006. Hyder Consulting Pty Ltd (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

Published by:

Department of Environment and Conservation NSW
59–61 Goulburn Street
PO Box A290
Sydney South 1232

Ph: (02) 9995 5000 (switchboard)
Ph: 131 555 (environment information and publications requests)
Ph: 1300 361 967 (national parks information and publications requests)

Fax: (02) 9995 5999
TTY: (02) 9211 4723

Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

DEC 2007/153
ISBN 9781 74122 3682
March 2007
Printed on recycled paper

DEC Forward

About the TBL Assessment of (Domestic) Food Organics Management

This document is provided by the Department of Environment and Conservation NSW (DEC) as an information resource. It is intended to provide help to Councils in their decision analysis process when considering waste management options.

The NSW government, through the Waste Avoidance and Resource Recovery Strategy 2006 (the Strategy) has set a resource recovery targets for municipal waste of 66% by 2014. Many Councils have been investigating the best local solution, including regional solutions, to address this target.

To help inform Council decision making processes DEC is producing a series of information resources. These resources will help enable councils to determine what is the best *fitness for purpose* suite of activities that will deliver their community expectations and reach the Strategy target.

One opportunity that Councils may wish to investigate is the potential to address food organics in their waste stream. Typically food organics make up between 17% and 21% of the total domestic waste stream in NSW, or up to 30% of the garbage stream (approx. 200kg per household per year). Building upon the tonnages diverted through best practice of kerbside recycling, Councils may wish to investigate the merits of recovering this fraction of the waste stream as to further increase resource recovery and sustainable waste management practices.

Separate collections of food organics are provided to households on a large scale in a number of countries overseas, mostly in Europe but also in Canada and in the U.S. The majority of these systems provide a combined collection service for food organics co-collected with garden organics.

This report will assist Councils that are considering the option of separate collection and processing of organics in NSW, in particular the collection (and processing) of food organics together with garden organics.

The report also considers the processing of organics as part of the residual waste stream (garbage) through Alternative Waste Treatment (AWT) Technology.

The report is the third in a series of Triple Bottom Line (TBL) assessments commissioned by DEC on aspects of domestic waste management. The other two reports are:

- *Assessment of Domestic Waste and Recycling Systems (DEC 2004)*-an integrated assessment of the technical, financial, environmental and social costs and benefits associated with different domestic waste and kerbside recycling systems and
- *Assessment of Garden Organics Collection Systems (DEC 2005)*-an analysis of options for garden organics management

It is recommended that this *TBL Assessment of (Domestic) Food Organics Management* report be read in the context of the two previous reports and not considered in isolation.

This report is an analysis of opportunities regarding the collection and processing of organics. In using the report's findings to inform the decision analysis process for determining the most suitable waste management system(s) for a Council, the following must be taken into account:

- This report includes the waste levy charges as the basis for the Financial Assessment calculations for the scenarios that apply to councils within the leviable area. The figures utilised represent the waste levy charge for 2010/11.
- There are currently only a limited number of facilities available for the processing of food/organics. Available processing capacity for collected organics needs to be factored in to council's decision to introduce a service.

- The report assumes Mechanical Biological Treatment (MBT) outcomes on a mixed waste delivers an end product that meets acceptable use requirements imposed by regulatory authorities.
- This report is not a DEC policy document. This report was prepared by Hyder Consulting Pty Ltd on the behalf of DEC as an information resource for Councils.

Collection and Processing Systems Analysed

The report has analysed a number of collection system scenarios and processing/disposal options for both Garden Organics (GO) and Food Organics (FO).

The organics collection systems analysed are:

- No garden organics collection;
- Fortnightly garden organics collection; and
- Weekly biowaste (i.e. garden and food organics) collection.

In order to estimate the impacts and benefits of each of these systems, they must be considered in the context of the total domestic waste management service so domestic garbage and kerbside recyclables systems have also been included in the analysis.

The assumed garbage and kerbside recyclables services are120L MGB (Mobile Garbage Bin) garbage collected weekly (or fortnightly where biowaste is separately collected) and 240L MGB for recyclables collected fortnightly (commingled containers and paper/cardboard). This is consistent with the base case analysed in the *Assessment of Domestic Waste and Recycling Systems* (DEC, 2004).

In addition to the assessment of the organics collection options and processing systems, each waste management system was also separately assessed assuming collected garbage is either disposed at a landfill or processed through a MBT facility.

A summary of systems assessed is provided in Table 1 below.

Table 1. Summary of systems assessed for alternative organics collection options

Scenario	Garbage Collection	Garbage Disposal	Organics Collection	Organics Processing
LF Weekly	weekly	landfill	no collection	None
GO + LF weekly	weekly	landfill	GO fortnightly	Open windrows
Biowaste + LF weekly	weekly	landfill	FO & GO weekly	Enclosed
Biowaste + LF fortnightly	fortnightly	landfill	FO & GO weekly	Enclosed
MBT Weekly	weekly	MBT	no collection	None
GO + MBT weekly	weekly	MBT	GO fortnightly	Open windrows
Biowaste + MBT weekly	weekly	MBT	FO & GO weekly	Enclosed
Biowaste + MBT fortnightly	fortnightly	MBT	FO & GO weekly	Enclosed

GO Source separated garden organics
FO Source separated garden organics
Biowaste Mixed source separated garden and food organics
LF Landfill
MBT Mechanical Biological Treatment

Each of the eight scenarios above has been analysed separately for councils with high garden organics generation (ie 175kg/household/year or more) and councils with low garden organics generation (ie less than 175kg/household/year). The total number of scenarios assessed is therefore 16.

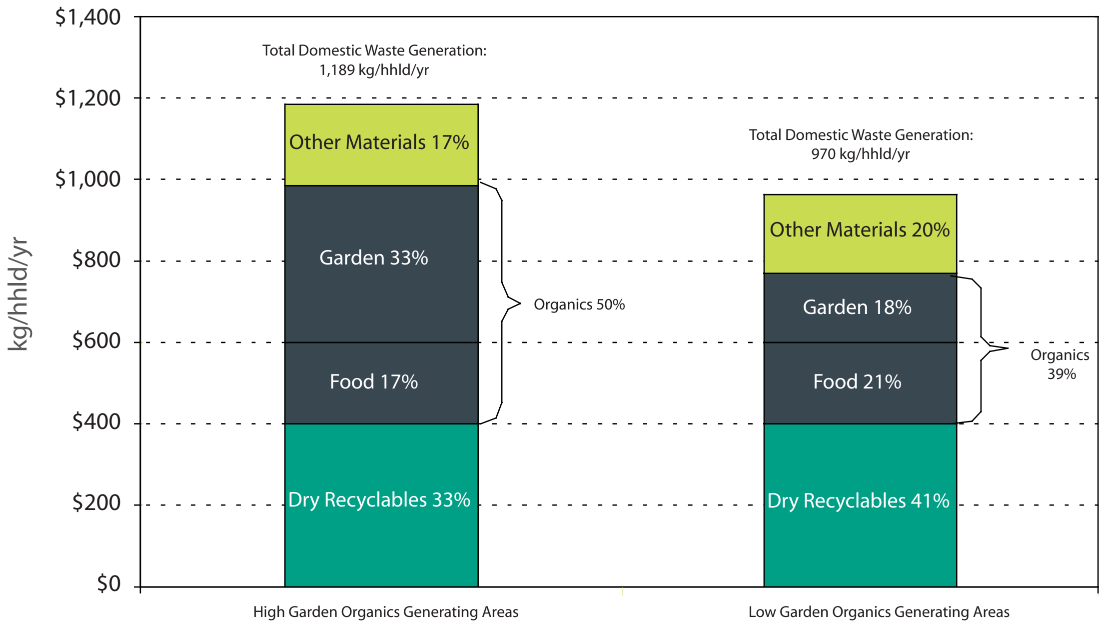
Assumptions used in the study

This document has been provided utilising a number of assumptions in its model calculations. If Councils wish to investigate the co-collection of Food Organics and Garden Organics they should include in their model calculations the unique variables for their situation, as this will have an effect on the financial and environmental assessments.

General assumptions that have been included in the calculations are;

- It has been assumed that a mobile, rigid container (MGB) is provided for collections.
- It has also been assumed that co-collection of food organics with garden organics will necessitate a change in the collection frequency from fortnightly for garden organics collection to weekly. This should be kept in mind particularly in the financial assessment of the various scenarios.
- The assumed quantities of organics, dry recyclables and other materials generated are as presented in Figure 1. This comprises total waste generated (recycled and disposed) per household and per year. In high garden organics generating areas, an estimated 50% of total waste generated is organics. In low garden organics generating areas, this reduces to 39%.

Figure I. Total Domestic Waste Generation (Organics, Dry Recyclables and Other Materials).



- It has been assumed that out of the total amounts generated that 90% of garden organics material is recovered and 55% of food organics is recovered. The recovery rates are derived from the waste profile built up through a significant body of work undertaken by DEC over the past few years. Derived quantities of garbage, organics, and recyclables recovered for each of the collection systems investigated are shown in Table 2.

Table 2. Quantities of collected garbage, organics and recyclables for alternative organics collection options (kg per household per year).

	High GO Generating Areas (> 175 kg)			Low GO Generating Areas (< 175 kg)		
Organics Collection System	**None**	**GO Fort'ly**	**Biowaste Weekly**	**None**	**GO Fort'ly**	**Biowaste Weekly**
Garbage	952	601	491	733	579	469
Organics Diverted	0	351	461	0	154	264
Recyclables Diverted	237	237	237	237	237	237
Total	***1,189***	***1,189***	***1,189***	***970***	***970***	***970***

- The quantities of garbage and recyclables separately collected and processed for the base case service are identical to those used in the two previous DEC studies (DEC, 2004; DEC, 2005).
- The estimate of costs for collection, processing and material delivery for the different systems was made using the Australian Waste and Recycling Cost Model (WRCM) developed by the Cooperative Research Centre for Waste Management and Pollution Control in association with EcoRecycle Victoria and Recycle 2000. The model enables the user to evaluate current and alternative collection systems to see the effect on yields and costs. A description of the model is provided in DEC (2005). Unless stated otherwise, the operational parameters used in the financial modelling for DEC (2005) remain unchanged.

Analyses Undertaken

This report has undertaken a series of analyses and assessments in the calculations of the various scenarios. The results are presented in varying formats.

- A direct financial assessment.
- A Life Cycle Analysis (LCA) with costs and benefits represented as Ecodollars (Eco$). This is consistent with the 2 previous reports, and has been included to ensure continuity.
- A Net-Cost Benefit Analysis. This represents the summation of Financial Costs/Savings and Environment Costs/savings.

Findings

General findings

The findings in this integrated (TBL) assessment report suggest that:

- Council areas that generate significant amounts of garden organics (i.e. 175 kg per household per year or more), should provide regular, containerised source separated collections for these materials.
- For Councils where households generate significant quantities of garden organics and/or where separate containerised collection services for these materials already exist, the inclusion of food organics can be considered cost-effective. However, a Council should also evaluate the socio-demographic profile of its community when considering the introduction of this type of service.
- The introduction of a co-collected food and garden organics service is likely to require the establishment of additional processing infrastructure.
- Councils with a low generation rate of garden organics (i.e. less than 175 kg per household per year) and where no regular, containerised collection system exists for these materials, may wish to consider the introduction of MBT services for residual wastes (garbage) as a higher priority.
- Residual waste (garbage) treatment prior to landfill disposal achieves significant additional environmental benefits in the medium term (5 years). Such technologies will be competitive in metro Sydney on a purely financial basis as a result of waste levy increases.

- The establishment of a co-collected food and garden organics service needs to be complemented and supported by comprehensive community education.
- Any barriers to community participation in the organics collection service, including source separation/ collection, need to be removed or minimised. This may include the provision of kitchen tidy bins. Education and communication to explain the "how to's" of the new system, as well as its underlying environmental rationale, are vital to the success of any food and garden organics collection service.
- It should be recognised that behavioural change is often difficult to achieve and will take time. While the sense of "doing the right thing" and force of habit may be sufficient to motivate on-going participation in kerbside recycling schemes, these may not in themselves be strong enough factors to motivate further effort in a time-poor society.
- Councils need to carefully consider all the aspects associated with the introduction of a co-collected food and garden organics collection service. An option may be to first generally promote the opportunity to participate in a source segregated food organics collection service and then *provide it on a limited basis to those households that volunteer.*
- Using multi criteria analysis, some clear trends are evident:
  - Separation of organics (both food and garden) is generally preferable; and
  - MBT options rank higher than landfill options.

Financial Assessment

The cost of providing a weekly combined food and garden organics collection service is estimated to be in the range $60 to $76 per household per year. This compares to a cost of providing a fortnightly garden organics only collection service of $31 to $45 per household per year. These raw costs do not take into account avoided garbage collection and disposal costs.

If these costs are included, and given the assumption that the co-collection of food and garden organics will necessitate a weekly collection frequency, the following picture emerges and is summarised in Table 3. The Cost variation for each scenario is listed, representing the deviation from the cost of disposing all materials to landfill. These calculations incorporate the waste disposal levy for the year 2010/11.

Table 3. Cost of alternative organics collection scenarios measured against the base case scenario*

	Scenario	Collection Frequency	Cost Variance (per household per year)
High GO Generating Areas (> 175 kg)	GO Garbage	Fortnightly Weekly	-$12
	GO & FO Garbage	Weekly Weekly	0
	GO & FO Garbage	Weekly Fortnightly	-$15
Low GO Generating Areas (< 175 kg)	GO Garbage	Fortnightly Weekly	+$7
	GO & FO Garbage	Weekly Weekly	+$17
	GO & FO Garbage	Weekly Fortnightly	+$2
Regional Councils	GO Garbage	Fortnightly Weekly	+$11
	GO & FO Garbage	Weekly Weekly	+$33
	GO & FO Garbage	Weekly Fortnightly	+$17

* Base case scenario assumes weekly disposal of garbage including GO and FO) to landfill

Financial Assessment-High Garden Organics Generation

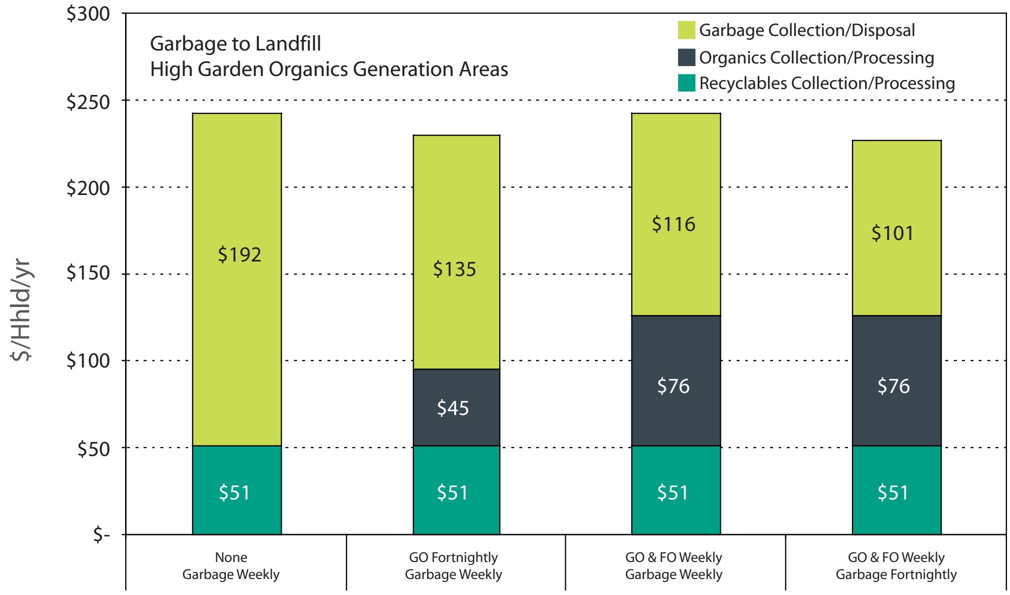
For councils with ***high garden organics generation*** a separate fortnightly collection of garden organics will be less expensive ($12 per household per year) than disposal to landfill (with garbage).

For these councils (see also Figure I below), the co-collection of food organics (with garden organics) will cost the same as sending all organics to landfill in the garbage (i.e. an extra $12 per household per year). This assumes a weekly collection frequency for both organics and garbage. However, a simultaneous change in the garbage collection frequency from weekly to fortnightly would make this option $15 per household per year less expensive than sending all organics to landfill.

Processing of residual mixed waste (garbage) through MBT is less expensive than landfill for all scenarios (by $19 per household per year).

The provision of a separate garden organics service combined with MBT for the residual would result in an additional small cost reduction. Inclusion of food organics (food and garden organics collection) would be slightly more expensive with a weekly garbage service and slightly less expensive with a fortnightly garbage service.

Figure I. Waste Management Costs, High GO Generation, Garbage to Landfill.



Financial Assessment-*Low Garden Organics Generation*

For councils with ***low garden organics generation*** the separate bin-based fortnightly collection of garden organics will be $7 per household per year more expensive than disposal to landfill (with garbage).

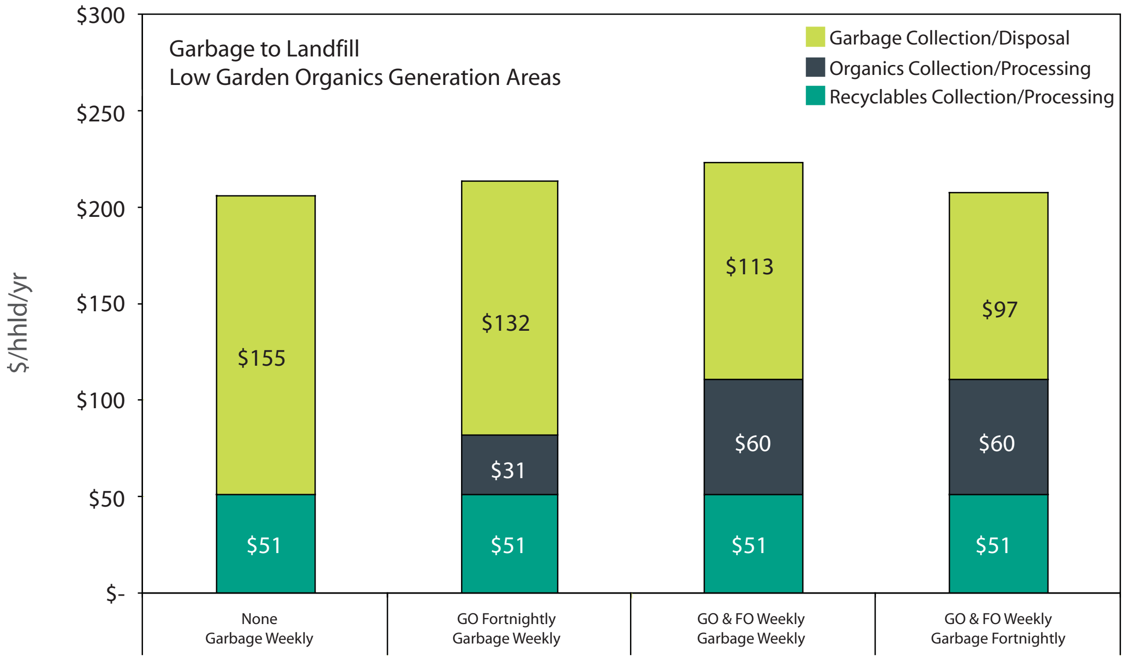
For those councils (see also Figure II below), the co-collection of food organics (with garden organics) will cost $17 per household per year more than sending all organics to landfill. This would reduce to $2 per household per year if garbage collection frequency was reduced to fortnightly.

The introduction of MBT processing for garbage would reduce the overall domestic waste management costs by $15 per household per year.

A separate garden organics collection service along with MBT for the residual would increase these costs by $11 per household per year, however, the total costs would still be $4 per household per year lower than the base case (all organics to landfill).

Food and garden organics collection would add $22 per household per year (or $7 net over landfill) with a weekly garbage service and $7 per household per year (or $8 net below landfill) with a fortnightly garbage service.

Figure II. Waste Management Costs, Low GO Generation, Garbage to Landfill.



Financial Assessment-*Regional Councils*

For ***regional councils*** a lower landfill gate fees results in the Base Case (Landfill Only) option being the least expensive. A separate (fortnightly) garden organics collection would add $11 per household per year, and a (weekly) food and garden organics collection $33 per household per year ($17 if the garbage collection frequency is reduced to fortnightly).

The provision of MBT processing for garbage would increase costs significantly (around $40 per household per year). It is noted however, that these results are heavily dependent on the assumptions regarding landfill and MBT gate fees in regional areas. It is possible that landfill fees will rise above currently assumed levels and MBT fees could fall below those assumed for regional areas. This would provide results more comparable to those in metropolitan areas.

Sensitivity analyses show relatively little impact on the results under the agreed assumptions, with one exception – the analysis confirms that the scheduled waste levy increases (modelled to 2010/11) will make processing of garbage ('residual waste') and systems for separating organics from the domestic waste stream 'commercially viable'.

Environmental Assessment

The environmental assessment of system alternatives builds upon the Life Cycle Assessment (LCA) work and environmental economic valuations of organics undertaken in recent years. The subsequent environmental economic valuation results in one single indicator for environmental performance – the 'Ecodollar' (Eco$).

In the context of this report, the 'Ecodollar' is used to make the results more meaningful to more people, and primarily indicates the *relative* environmental performance of different scenarios. It is important to note that this valuation is not intended to represent financial transaction costs but rather to assist the wider economic considerations forming the basis for the development of the Triple Bottom Line Assessment, which is the primary goal of this study. Valuations of environmental aspects are an emerging field and the subject of vigorous debates.

The key outcomes of the environmental assessment are as follows (see also Figure III):

- The separation of garden organics provides a significant improvement in environmental performance over landfilling of these materials. Inclusion of food organics enhances this performance;
- The provision of MBT (without food and garden organics separation) achieves an even higher environmental performance (assuming acceptable product is produced by MBT).

A combination of both services (MBT and separate food and garden organics management) provides the best outcome.

- When expressed in 'Ecodollar' (Eco$) terms, the environmental benefits are as follows:
  - Eco$30-55 per household per year for food and garden organics collection:
  - Eco$50-65 per household per year for MBT processing of garbage; and
  - Eco$60-85 per household per year for food and garden organics collection services plus MBT processing of garbage.

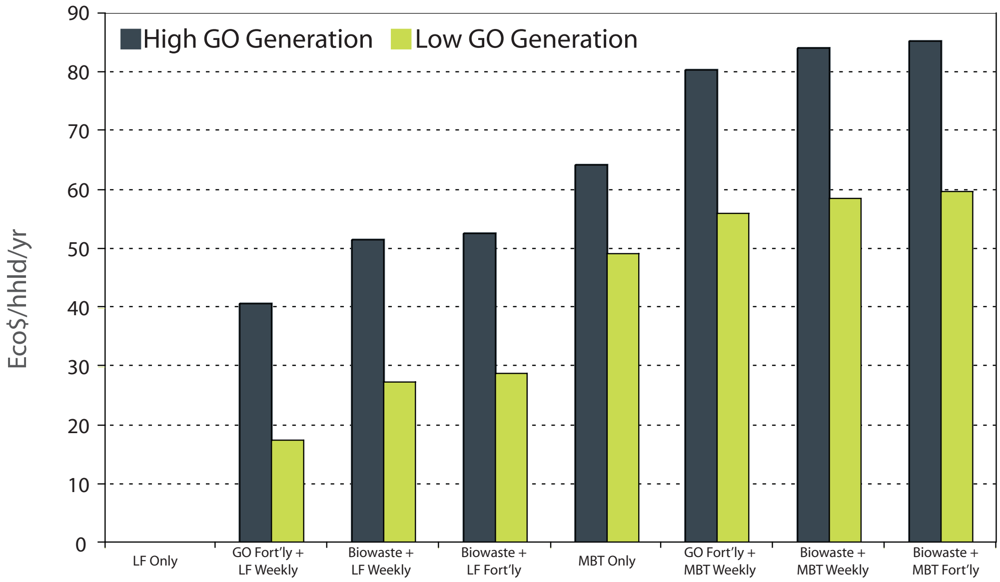


Figure III. Scenario Comparison for high and low GO generation

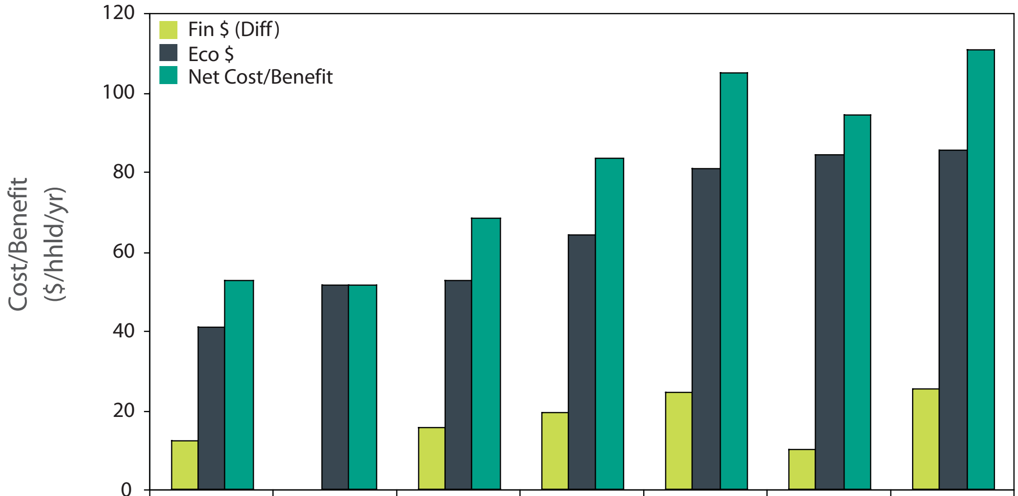
Cost-Benefit Analysis

In the cost-benefit analysis (incorporating financial and environmental costs and benefits), costs are shown as negative numbers, benefits as positive numbers.

Cost-benefit analysis reveals the following:

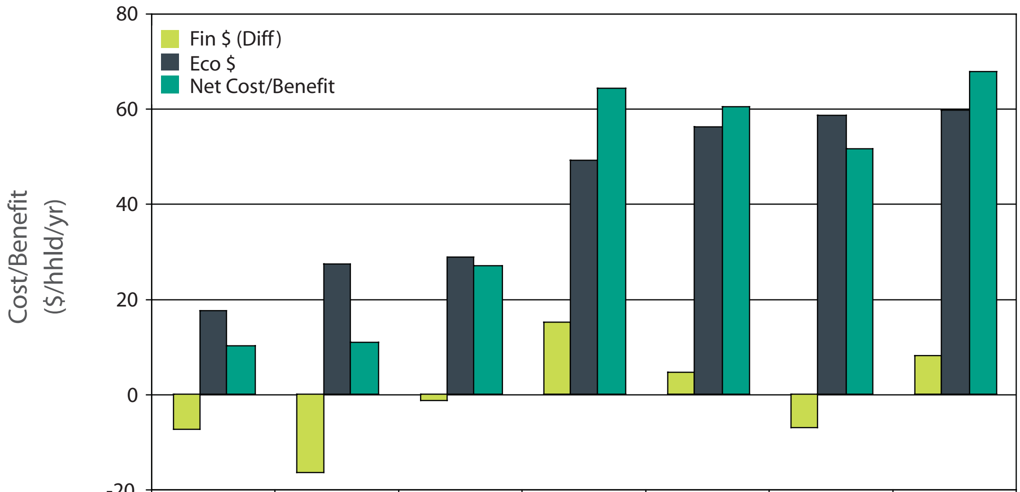
- For councils with high GO generation all options are less expensive than the 'Landfill Only' option (see also Figure IV below).
- For councils with low GO generation all options are less expensive than the 'Landfill Only' option (see also Figure V below). However, the environmental benefits are also substantially reduced due to the relatively low yields.
- Source separation of organics always achieves better environmental outcome (calculated Eco$) than not separating these materials.
- The higher environmental benefits of inclusion of food organics in a separate organics collection are counterbalanced by higher collection and processing costs (assuming the co-collection of food and garden organics necessitates a weekly collection frequency) unless garbage collection frequency is reduced to fortnightly.
- All scenarios featuring MBT achieve higher overall benefits than scenarios with landfill (of untreated waste).
- For regional areas, the net benefits are considerably lower compared to in metropolitan areas as a result of the low landfill gate fees.

Figure IV. Cost benefit analysis results for high GO generation ($ per household per year) against the Base Case.



	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	12	0	15	19	24	10	25
Eco $	41	51	53	64	81	84	85
Net Cost/Benefit	53	51	68	84	105	94	111

Figure V. Cost benefit results for low GO generation ($ per household per year) against the Base Case.



	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	-7	-17	-2	15	4	-7	8
Eco $	18	27	29	49	56	59	60
Net Cost/Benefit	10	11	27	64	60	52	68

Social Assessment

Food organics collection will require additional time, effort and positive participation from the householder. Therefore, the collection system that is introduced will need to maximise the ease of participation in order to ensure high participation rates and yields and system performance.

It is likely that an additional container (for use in the kitchen) will be required in order to increase the "comfort" factor, and to reduce odour and nuisance for the householder.

Effective awareness and education programs together with the use of existing community groups will be important to ensure the details of the service changes are effectively communicated to all householders.

A flexible approach to garbage collection frequency may be required, especially during the initial stages of the implementation program, to help overcome any preconceived concerns that the residents may have with a reduction in the garbage collection frequency, which may have an effect on participation levels.

Next Steps

The *TBL Assessment of (Domestic) Food Organics Management* in conjunction with the *Assessment of Domestic Waste and Recycling Systems* and *Assessment of Garden Organics Collection Systems* provides an overview and a framework for Councils to inform an analysis of their waste management system in relation to food and garden organics.

This report has illustrated that in a number of circumstances there are tangible economic benefits in the scenarios investigated. Additionally, when Cost-Benefit analysis is undertaken, incorporating environmental benefits, all scenarios illustrate a positive Net Cost/Benefit.

If Councils are considering the option of separate collection and processing of organics in NSW, in particular the collection (and processing) of food organics together with garden organics, they are encouraged to calculate their own economic and environment benefits.

Contents

1 INTRODUCTION 1

2 SYSTEMS CHARACTERISATION 2

2.1 Abbreviations & definitions 2

2.2 Collection and Processing Systems Analysed 2

2.3 Waste Profile Derivation 3

3 INTERNATIONAL REVIEW 6

3.1 United States of America 6

3.2 Canada 9

3.3 Europe 11

3.4 Australia 13

3.5 Contamination Issues 16

4 FINANCIAL ASSESSMENT 17

4.1 Modelling Approach 17

4.2 Results 18

4.3 Discussion and summary of results 26

5 ENVIRONMENTAL COST BENEFIT ASSESSMENT 29

5.1 Method 29

5.2 Environmental Value of GO and Biowaste 32

6 LCA RESULTS – ECO$ MODEL 36

6.1 Scenarios Assessed 36

6.2 Contribution of Impacts to Single Indicator 36

6.3 Sensitivity Analysis – Scenario 4 39

7 LCA RESULTS – ENVIRONMENTAL MODELS 41

7.1 Greenhouse Gases 41

7.2 Human Toxicity 42

8 LCA INTERPRETATION AND EXPANDED VALUATION 44

8.1 Interpretation 44

8.2 Expanded Valuation – Proxy Values 45

9 COST-BENEFIT ANALYSIS 48

9.1 Results 48

Contents

10 SOCIAL ASSESSMENT....54

10.1 Social Impacts Identification 54

10.2 Impact Assessment Framework 54

10.3 Social Impact Assessment Results 56

11 COMMUNITY ACCEPTANCE OF FOOD ORGANICS COLLECTION 59

11.1 Community-Based Social Marketing Theory 59

11.2 General Comments 63

12 MULTI-CRITERIA ASSESSMENT....64

12.1 Methodological Background 64

12.2 'Technical' Scores 66

12.3 Results 67

13 CONCLUSIONS AND RECOMMENDATIONS 68

13.1 Conclusions 68

13.2 Recommendations.... 71

14 REFERENCES 72

APPENDIX A

Details of Environmental Assessment Methodology 75

APPENDIX B

Financial Sensitivity Analyses 78

APPENDIX C

Threshold Capacities for Biowaste Treatment Facilities.... 83

APPENDIX D

Impact of Co-Collection of Biowaste on MBT Facilities.... 96

APPENDIX E

Site Specific Impacts for Biowaste Treatment Facilities 97

1 Introduction

The debate over the relative merits of different systematic approaches to waste and recyclables collection and processing continues. Its key issues are:

- Growing range of available waste/recyclables collection and processing technology options, including Alternative Waste Treatment (AWT);
- Increasing economic competitiveness of AWT against landfill disposal;
- On-going concerns of many local government representatives with regard to waste management costs;
- Community expectations with regard to alternatives to landfill disposal; and
- Growing appreciation that waste management and recycling decisions need to be based on holistic evaluation of full technical, financial, environment, and social costs and benefits.

In 2003, Nolan-ITU was commissioned by the NSW Jurisdictional Recycling Group (NSW JRG) and the Publishers National Environment Bureau (PNEB) to conduct a study of the technical, financial, environmental and social costs and benefits associated with different domestic waste and kerbside recycling systems inclusive of collection and processing. The final report, *Assessment of Domestic Waste and Recycling Systems*, was published by the Department of Environment and Conservation NSW (DEC) in 2004.

In a second stage, Nolan-ITU was commissioned by the DEC to extend the assessment to include options for garden organics management resulting in the *Assessment of Garden Organics Collection Systems (2005).*

This report is the result of a third stage: Hyder Consulting (now incorporating Nolan-ITU) was commissioned to incorporate into the TBL assessment the management of food organics from domestic sources, as a co-collection with garden organics. This report is the result of assessing a range of alternative systems. It builds upon Life Cycle Assessment (LCA) work and environmental economic valuations of organics undertaken by Nolan-ITU and others in recent years.

It is important to note that the dollar valuation of environmental performance is not intended to represent financial transaction costs but rather to assist the wider economic considerations forming the basis for the development of the Triple Bottom Line Assessment which is the primary goal of this study.

Valuations of environmental aspects are an emerging field and subject of vigorous debates. In the context of this report, 'ecodollars' should be seen as a way of making the results more meaningful to more people and should be used primarily to indicate the relative environmental performance of different scenarios.

The project is designed to achieve the following objectives:

- Assist Local Government in decision making when considering the introduction of food organics collection and Alternative Waste Treatment (AWT); and
- Present the findings in a form consistent with the previous two studies, and also with the Independent Assessment of Kerbside Recycling (2001) for the National Packaging Covenant Council.

2 Systems Characterisation

2.1 Abbreviations & Definitions

Biowaste	Mixed source separated garden and food organics
GO	Source separated garden organics
FO	Source separated garden organics
DALY	Disability Adjusted Life Years
LCA	Life Cycle Assessment
MCA	Multi-Criteria Assessment
MBT	Mechanical Biological Treatment
AWT	Alternative Waste Treatment
Recovery rate	Percentage of organics separated from the waste stream and processed into useful products.

2.2 Collection and Processing Systems Analysed

The organics collection systems analysed in this study are:

- No garden organics collection;
- Fortnightly garden organics collection; and
- Weekly biowaste (i.e. garden *and* food organics) collection.

It has been assumed that a mobile, rigid container is provided for collections.

To estimate the impacts and benefits of the above systems, they need to be considered in the context of the total domestic waste management service. Accordingly, domestic garbage and kerbside recyclables systems have also been included in the analysis.

The assumed garbage and kerbside recyclables services are consistent with the base case analysed in the *Assessment of Domestic Waste and Recycling Systems* (DEC, 2004). This service comprises:

Garbage:	120L MGB collected weekly (and fortnightly where biowaste is separately collected).
Kerbside Recyclables:	240L MGB collected fortnightly (commingled containers and paper/cardboard).

Each organics management scenario has been analysed assuming the above garbage and kerbside recycling systems are in place.

In addition to the assessment of the alternative organics collection and processing systems, each waste management system was separately assessed assuming collected garbage is either disposed at a landfill or processed through a MBT facility.

A summary of systems assessed is provided in Table 2.1 Note that all eight scenarios have been modelled for

- Councils generating high quantities of garden organics; and
- Councils generating low quantities of garden organics;

The total number of scenarios is therefore 16.

Table 2.1 Summary of Scenarios Assessed

Scenario	Garbage Collection	Garbage Disposal	Organics Collection	Organics Processing
LF Weekly	weekly	landfill	no collection	n/a
GO + LF weekly	weekly	landfill	GO fortnightly	Open windrows
Biowaste + LF weekly	weekly	landfill	FO & GO weekly collection	Enclosed
Biowaste + LF fortnightly	fortnightly	landfill	FO & GO weekly collection	Enclosed
MBT Weekly	weekly	MBT	no collection	n/a
GO + MBT weekly	weekly	MBT	GO fortnightly	Open windrows
Biowaste + MBT weekly	weekly	MBT	FO & GO weekly collection	Enclosed
Biowaste + MBT fortnightly	fortnightly	MBT	FO & GO weekly collection	Enclosed

GO Source separated garden organics
FO Source separated garden organics
Biowaste Mixed source separated garden and food organics
LF Landfill
MBT Mechanical Biological Treatment

2.3 Waste Profile Derivation

2.3.1 Methodology

The waste profile is based on the work undertaken in the following studies:

- *Assessment of Domestic Waste and Recycling Systems* (DEC, 2004);
- *Study of Local Management Costs for Garden Organics* (DEC, 2003); and
- *Assessment of Garden Organics Collection Systems* (DEC, 2005).

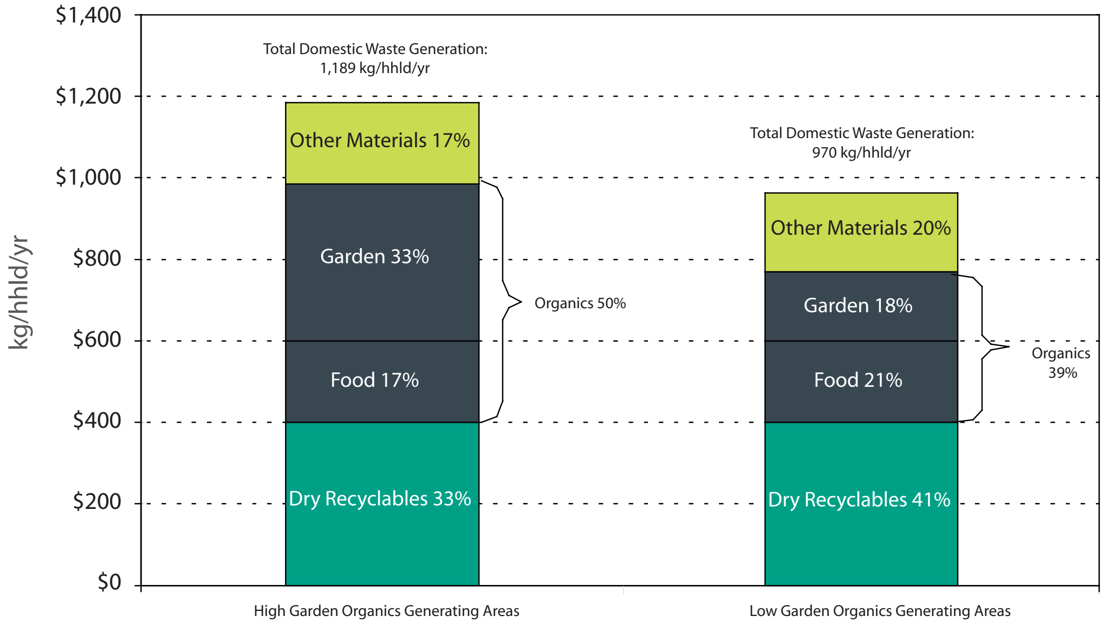
In DEC (2005), two GO generation scenarios were modelled, a high and a low scenario. The high GO generation scenario was based on observed garden organics recovery rates from NSW councils employing fortnightly collection of garden organics from 240 L Mobile Garbage Bins (DEC, 2003). The low GO generation scenario was based on the base case waste profile developed as part of DEC (2004).

For this study the quantities of garbage and recyclables separately collected and processed for the base case service are identical to those used in the two previous studies undertaken by Nolan-ITU.

2.3.2 Generation

The quantities of organics, dry recyclables and other materials are presented in Figure 2.1. Note this comprises total waste generated (recycled and disposed) per household and year. In high garden organics generating areas, an estimated 50 percent of total waste generated is organics. In low garden organics generating areas, this reduces to 39 percent.

Figure 2.1 Total Domestic Waste Generation (Organics, Dry Recyclables and Other Materials).



2.3.3 Streaming

Derived quantities of garbage, organics, and recyclables separately collected for each of the collection systems investigated are shown in Table 2.2 and Figure 2.2. Organics collection quantities have been estimated based on the following recovery rates:

Garden Organics: 90 percent
Food Organics: 55 percent

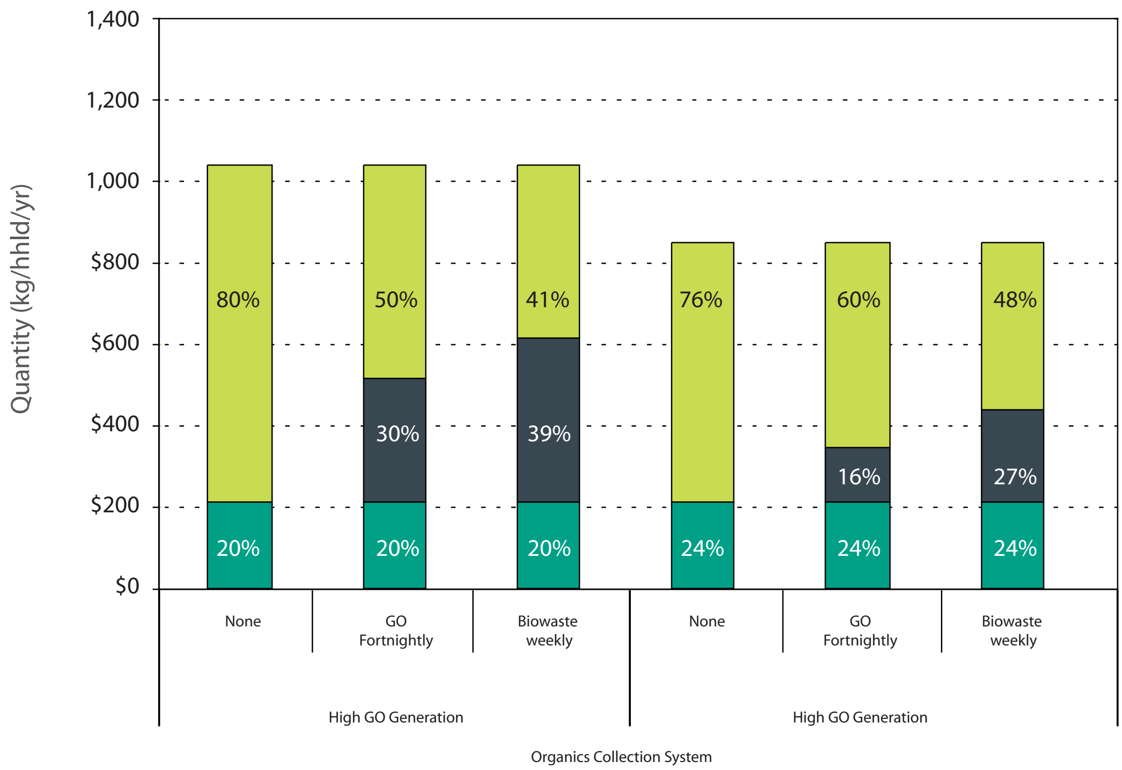
The recovery rate of 55 percent for food organics may appear low to some readers however, it was chosen for the following reasons:

- Evidence from countries/municipalities that provide separate collection services for food organics (for details see Section 3);
- Kerbside recycling has been practised on a large scale in Australia for over a decade. The current average recovery rate across Australia is 47 percent (Nolan-ITU, 2005).

Table 2.2 Quantities of Collected Garbage, Organics and Recyclables for Alternative Organics Collection Options (kg/hhld/yr).

	High GO Generating Areas			Low GO Generating Areas		
Organics Collection System	None	GO Fort'ly	Biowaste Weekly	None	GO Fort'ly	Biowaste Weekly
Garbage	952	601	491	733	579	469
Organics Diverted	0	351	461	0	154	264
Recyclables Diverted	237	237	237	237	237	237
Total	**1,189**	**1,189**	**1,189**	**970**	**970**	**970**

Figure 2.2 Garbage, Organics and Recyclables Collected per System



3 International Review

Residential collection of food organics has been well established in parts of Europe since the early 1990s and is increasingly being used in the US and Canada to achieve landfill diversion targets. Food organics collection is also growing quickly in the UK, following delays caused by the restrictions imposed after the outbreak of foot and mouth disease in 2000.

This section summarises the international experience in kerbside collected food organics management in three regions: United States, Europe (including the UK) and Canada. The following factors have been considered:

- Types of food organics collected;
- Food organics generation rates;
- Kerbside collection systems and configurations used; and
- Typical yields and participation rates.

As each region treats food organics differently, terms specific to the region are used where applicable.

Food organics is also known as food residuals (in the US and Canada) and falls into a broader classification known as household or residential organic waste (in both the US and Europe), which can include small scale yard trimmings, and other paper based compostables products that are frequently co-collected with food organics. In the Netherlands where only vegetable and fruit waste is collected, food organics is known as either VF or VFG (when some yard trimmings are added to the mix). In addition, the general term, biowaste, is used in Europe to cover all these various permutations of food-based waste streams.

These terms are differentiated from "green waste", which refers specifically to organic wastes that are generated from gardens, parks and green cuttings. It can be presented at kerbside in the case of yard trimmings, but bulk waste is frequently collected through other seasonal pick up or drop off systems.

3.1 United States of America

In the US, early efforts to reduce the amount of household organics going to landfill, initiated up to 20 years ago, focussed not on source separation, but on the composting of the entire municipal waste stream (MSW), with pre-processing steps to allow recyclables to be removed. However, the more recent trend has been towards the collection of source separated household organics, with composting of MSW continuing to occupy a niche market, particularly in heavily touristed areas or where landfill capacity is severely limited (Goldstein, 2005a). During the 1990s, significant success was achieved with diverting garden organics, including yard trimming and bulk green waste, from landfill to composting facilities. Focus on source separation of food organics is now increasing, particularly on the west coast, where San Francisco has led the way with its three stream sorting programme, which has achieved an overall recycling rate of 63 percent (Farrell, 2005).

Nationwide, food recovery is still in its infancy, with recent estimates of 3 percent having been reported (Speigelman, 2006). The most prominent trend is to combine food organics with existing green waste kerbside collection to form a commingled household organics stream. Where green waste collections are not offered, or offered as a periodic rather than weekly service, food organics is being collected as a separate stream.

The decision to offer a food organics collection service at kerbside has frequently followed the development of a commercial and industrial food organics programme. This means that composting facilities equipped to process food organics are already available with economics based on larger feedstock volumes than kerbside alone can provide.

Desktop studies have identified the following cities and regions as currently offering kerbside collection of household organics, either through a regular service or a pilot programme:

- Alameda County, California
- San Francisco, California
- Hennepin County, Minnesota
- Minneapolis/St Pauls, Minnesota
- MacKinac Island, Michigan (no data reported)
- Hutchinson, Minnesota (no data reported)
- Swift County, Minnesota (no data reported)
- King County, Washington State
- Seattle, Washington State

Food organics is being diverted from landfill in other regions through programmes in public institutions such as schools and universities, through residential drop-off centres, as well as the commercial and industrial collection mentioned above (for example Portland, Oregon run a commercial-only food organics programme). Data from such collections has not been included as it is outside the scope of this study.

3.1.1 Materials Collected in the Food Organics Stream

Most jurisdictions offering food organics collection allow residents to add a range of soiled paper products, and many commingle the collection with yard trimmings. Some jurisdictions even extend collection to include diapers and pet waste. The most common food exclusions are meat and dairy. Some specific examples based on available data are provided in Table 1 (Goldstein, 2005b; Jaimez, 2005; Emerson, 2003; Farrell 2005).

State	Region	Food	Other
California	Alameda County	All types	Soiled paper Yard trimmings
California	San Francisco	All types	Soiled paper Yard trimmings
Minnesota	Hennepin County	All types	Soiled paper
Washington State	Seattle	Vegetative, bread, pasta, grains, coffee grounds	Soiled paper
Washington State	King County	All types	Soiled paper Yard trimmings

3.1.2 Collection Systems

Most jurisdictions which offer food collection provide residents with a kitchen pail, usually 2 gallons (approximately 8 litres) in capacity. Some jurisdictions encourage residents to line the pails with either biodegradable or conventional plastic bags, or wrap food organics in paper. The problem of plastic contamination is discussed in more detail in Section 3.4.

Food organics is then set out with whatever other household organics are accepted in either a dedicated bin (most often 30-38 gallon (114-144 litres) capacity), clear biodegradable bags or combined with garden organics in a large single bin (up to 90 gallons (341 litres)), where a garden organics service already exists. Some municipalities are using ‘ventilated containers’ to allow for moisture and weight loss.

Collection frequency of food organics is almost exclusively weekly, except in Seattle, which has fortnightly collections. In some cases, a reduction in the frequency of garbage collection from weekly to fortnightly has accompanied the introduction of a kerbside household organics collection system.

Available data is summarised in Table 3.2

Table 3.2 Kerbside Collection Systems in the US.

State	Region	Collection System (all based on 3 streams)	Bin Liner	Collection Frequency	Garbage Collection
California	Alameda	commingled green bin + kitchen pail	Unknown	Weekly	Unknown
California	San Francisco	32 gall green bin + kitchen pail	Optional but must be biodegradable	Weekly	Weekly
Minnesota	Hennepin County	38 gallon bin + kitchen pail (placed at kerbside in bags only)	Biodegradable	Weekly (fortnightly being considered)	Fortnightly offered
Minnesota	Minn/St Pauls	Clear biodegradable bags only	N/A	Unknown	Unknown
Washington	King County	Large bin + pail	Optional but must be biodegradable	Weekly	Unknown
Washington	Seattle	90 gallon bin	No	Weekly	Unknown

3.1.3 Yields and Recycling Rates

Data on yields of food organics from collection systems in the US is patchy and variable. Most of the data that has been published was collected during trial periods of limited duration or combined with garden organics data. In addition, most jurisdictions report figures on a different basis. Table 3.3 summarises what information is available and as far as possible, the data has been extrapolated to produce a weekly household yield of food organics and soiled paper.

Table 3.3 Estimated Yields from Kerbside Collection in US.

Region	Basis	Raw Data	Estimated Yield (kg/hhld/wk)
Alameda, CA	Annual figures for regular collection	6500 tons pa[1] from 264,000 hhlds	0.95
San Francisco, CA	Weight per drive by for regular collection	8 lb/hhld/wk	1.45[2]
Hennepin County	Tonnage in 16 months of extended pilot	137 tons from 1200 hhlds	3.3
Minneapolis/St Pauls	Total tonnage in 6 month trial period	12.5 tons from 900 hhlds	0.5

[1] Weight for food organics and soiled paper only
[2] Using an assumed set out rate of 40 percent

No data on recovery rates (as a function of total organics present in the waste stream) or percentage food organics in the household organics stream was found.

3.1.4 Set-out and Participation Rates

Estimates of participation in food organics collection (as opposed to green waste collection) have been made in a number of cases, usually in the early trial periods. Participation is measured by two parameters:

- Set out rate – percentage of households who put their food organics out for collection in any given week;
- Monthly participation rate – it is generally considered that if a household is participating in the programme, they will place their food organics out at least once per month. Monthly participation rates therefore give an estimate of the total percentage of households who are participating in the programme overall. It is usually higher than the set-out rate.

Specific findings are given below.

Table 3.4 Set out and Participation Rates.

Region	Set out (% eligible households)	Monthly participation (% eligible households)
Alameda County	-	20-30[3]
San Francisco	40	60
Hennepin County	20-35	42-48[4]
Minneapolis/St Pauls	-	46
Kings County	-	10-25
Seattle	-	62

[3] Peak rate in some areas is 50 percent
[4] Over one year, participation rates of 74 percent were achieved

Desktop studies carried out in Vermont have suggested that across the US and Canada generally, participation rates could be as high as 80 percent, accompanied by set out rates of around 50 percent (Plunkett, 2001).

3.2 Canada

Source separation of organics, including food organics, dates back to 1994 when Lunenburg County in Nova Scotia launched a full scale residential organics collection programme and opened the first source separated composting facility in North America (Friesen, 2001). Since then, food organics collection at kerbside has become widespread and the following jurisdictions now offer programmes, using different collection models:

- Guelph, Northumberland, Pembroke, Hamilton, Toronto, Markham, Durham, Niagara, St Thomas, Ottawa, all in Ontario
- Saint John and Moncton, New Brunswick
- Edmonton, Alberta

3.2.1 Materials Collected

A large range of materials are accepted together with food organics. In some areas, yard waste is collected commingled with household organics. However, because of the significant difference in the amount of yard waste that is generated in the winter months in Canada, a significant number of jurisdictions prefer to collect it separately. This means that a smaller bin can be used for household organics. Examples are shown below.

Table 3.5 Examples of Materials Collected.

State	Region	Food	Other
Ontario	Toronto	All types	Soiled paper, diapers, pet waste, sanitary products
Ontario	Niagara	All types	Yard trimmings
Ontario	Hamilton	All types	Soiled paper, diapers, yard trimmings
Nova Scotia		All types	Soiled paper Yard trimmings
Ontario	Markham	All types	Soiled paper, towelling and tissues, paper food packaging, paper coffee cups and plates, household plants, diapers and sanitary products, animal waste and bedding, pet food

3.2.2 Collection Systems

A range of collection systems exist in Canada, depending on whether food organics is commingled with yard waste. A variety of collection models have also emerged, with varying frequency of organics and garbage collection, and number of streams. The conventional three stream system, involving recyclables, organics and garbage, is common but another model, called "wet/dry recycling", has also been implemented in a number of communities, mainly for cost reasons and to enhance diversion (in the wet/dry system there is no natural garbage stream), although this model has not been without its problems. Information on the different models, where available, is summarised below (Sinclair, 2002; Smith, 2000; Friesen, 2001). Several other regions, including Ottawa, are in the process of piloting food organics collection systems.

Table 3.6 Kerbside Collection Systems in Canada.

State	Region	Collection System	Collection Frequency	Garbage Collection
Nova Scotia		64 gallon aerated cart + 1 gall kitchen pail	Fortnightly	Fortnightly
New Brunswick	Saint John	Unknown	Fortnightly	Fortnightly
Ontario	Pembroke	Unknown	Fortnightly	Fortnightly
Ontario	Guelph	2 stream (wet/dry), yard waste separate	Weekly (wet)	Weekly (dry)
Ontario	Northumberland	2 stream (wet/dry), yard waste separate	Weekly (wet)	Weekly (dry)
New Brunswick	Moncton	2 stream (wet/dry), yard waste separate	Weekly (wet)	Weekly (dry)
Alberta	Edmonton	2 stream (wet/dry), yard waste separate	Weekly (wet)	Weekly (dry)
Ontario	Toronto	13 gall bin + 2 gall kitchen pail, yard waste separate	Weekly	Fortnightly
Ontario	Markham	13 gall bin + 2 gall kitchen pail, yard waste separate	Weekly	Weekly
Ontario	Niagara	Still being trialled – different models	Weekly	Weekly
Ontario	St Thomas	Unknown	Fortnightly	Weekly
Ontario	Hamilton	37 gallon (140L) bins + kitchen pail		

3.2.3 Yields and Recycling Rates

Jurisdictions in Canada almost exclusively collect more than food organics in their kerbside household organics programme, and therefore all data available (collected almost exclusively from trial periods) incorporates, as a minimum, the weight of the commingled soiled paper products.

In Ottawa, where an organics programme is being piloted, a generation rate of 9 kg/month of organics from each household was observed during the winter months, when no garden organics is generated. This equates to 2.1 kg per week of non-garden organic waste.

In Toronto, where food organics is collected with a range of soiled paper products but separately to yard trimmings (which are placed at kerbside in plastic bags), trial data of 8.8lbs or 4kg per week from each household has been reported.

In Hamilton, Ontario, which trialled household organics collection over a one year period between 2002 and 2003, average household yield was 100-150kg over the year, equating to 1.9-2.9 kg per week.

Based on the assumption that 90 percent of the organics diverted is food organics, per household yields range from 1.7-3.6 kg of food organics per week.

3.2.4 Participation Rates

Little quantitative data has been found on set out and participation rates in Canada. However, results from the pilot programme being run in Ottawa (started in 2002) demonstrated that set out rates were increased in situations where a kitchen pail was provided for food organics and where fortnightly rather than weekly garbage collection was offered. In general they found that the retention of a weekly garbage service did not encourage participation in the organics programme (Sinclair, 2002).

Available data is summarised in Table 3.7.

Table 3.7 Set out and Participation Rates.

Region	Set out (% eligible households)	Monthly participation (% eligible households)
Ottawa (trial data only)	48 (23-65)	-
Hamilton (trial data only)		50-70

3.3 Europe

Europe has led the way internationally in the collection and processing of source separated household organics. In the mid-1980s, pilot projects were initiated in Germany, Austria, Switzerland and Netherlands, with the aim of composting the organic waste fraction of municipal waste. Since then, significant work has been done in optimising collection systems, increasing public participation and developing processing technology and standards.

In 1999, EU Directive 99/31/CE targeted a reduction in disposal of the biodegradable fraction of MSW over the next 15 years. To date programmes have been initiated in a number of European countries aimed at implementing source separation for organic waste. The table below summarises the state of affairs in 2001, demonstrating that the Netherlands, Austria, Germany and Switzerland have led the way in introducing source separation for food organics.

Table 3.8 Implementation of source separation for organic waste (Amlinger, 2001).

Country	Stage
Greece, Ireland, Portugal	No specific regulation; no incentive for system setup
Spain, UK, France	Regulations only for MSW compost; first local projects
Sweden, Finland, Belgium (Wallonia)	Preparation of regulation in progress; promotion of separation collection system started
Italy, Denmark and Norway	Regulations enacted, implementation of system in full progress
The Netherlands, Belgium (Flanders), Germany, Austria, Switzerland	Regulations enacted; implementation of system almost completed (65-80%)

Collection practices in Europe range from separate door to door collection of source separated household organics (such as prevails in Italy) to co-collection with garden organics in a single commingled bin (as is common in Austria). In the UK, most jurisdictions including food organics have added it to existing green waste collection.

3.3.1 Materials Collected

The organic fraction of MSW collected varies from country to country in Europe, including (Barth, 1998):

- Household and garden organics, called VF (vegetable and fruit) or VFG (vegetable, fruit and garden) residues, e.g. the Netherlands;
- Pure organic household wastes, including material of animal origin, e.g. Sweden; and
- Organic household waste including material of animal origin as well as certain amounts of garden organics, e.g. Germany, Austria.

In the UK food organics collection is still in its infancy and data is only available from a small number of pilot studies. However, a number of jurisdictions have commenced regular food organics collection and examples are summarised below.

County	Area	Food Types	Other
Somerset	Bath and NE Somerset	Meat, fruit, vegetables, bread, pasta, cereal, tea and coffee, dairy and egg shells	Nil
Kent	Tonbridge and Malling (pilot only)	Uncooked vegetables and fruit	Nil
London	Ealing	All food	Newspaper to wrap food
London	Richmond	All food	Newspaper to wrap food
London	Haringey	All food	Nil
London	Barnet	All food	Yard trimmings
Buckinghamshire	High Wycombe	All food	Soiled paper and cardboard

Additional councils collect kitchen waste but details are not known (Eunomia, undated).

3.3.2 Collection Systems

In general, two collection systems are in place in Europe:

- Collection of source separated food organics and other household organics in small dedicated bins, excluding yard waste; and
- Collection of all organic waste including household organics and yard waste in a single (larger) collection bin.

The first system is the typical model employed in Italy, where collection using small containers and "biobags" (watertight bags that completely contain food organics) occurs "door to door" as often as 5 days per week. This intensive collection system has been adopted to address the different properties of food organics as opposed to yard waste (for example, its higher putrescence and moisture, and bulk density) and to improve the ease of participation for households, which it is believed has raised participation rates and yields. Recent trials in Spain have followed this system.

The second system is the more common model found e.g. in Austria and the UK where green waste has traditionally been collected at kerbside. Typically larger bins (140-240L) are used and collection frequencies vary. In parts of Europe, large volume road containers are also used, particularly for multi unit dwellings. In some cases, these road containers are by "invitation only", in other words they required key-access, a system mainly implemented to ensure minimum contamination.

In general, the experience in Europe has been that food organics collection is most successful when carried out door to door and integrated into the total waste management system. This may involve adjusting frequencies and volumes in other parts of the system and maximising yields of food organics (through appropriate system design) so that the fermentability of the residual waste is significantly reduced (Favoino, 2003).

3.3.3 Yields and Recycling Rates

Theoretical calculations carried out in Austria in 1995 estimated the maximum annual yield of food organics to be 80 kg per person or 1.5 kg/person/week, with a range of 55 to 95 kg per person (Amlinger, 2001). These calculations assuming that bulk yard waste would be collected separately, and that 15-20 kg per person (around 10-12%) would remain in the garbage stream, even under the best logistic and motivational conditions.

Actual yields for Austria were reported for 2001, 8-10 years after the introduction of food organics collection (Amlinger, 2001). Food organics is collected together with small yard trimmings suitable for addition to a biobin (dedicated bin for food and garden organics). Total annual arisings ranged from 24-74 kg per person, with an average of 48 kg across all of Austria. From the 1995 calculations, food organics was assumed to make up between 55 and 66 percent of the bio bin arisings, which equates to food organics generation of between 0.5 and 0.6 kg per person per week with a possible peak value of 0.9 kg per person. This represents recovery rates between 33 percent and 60 percent.

Studies in Italy have measured the yields of food organics for the two types of collection systems. Results are shown below. Recovery rates have been calculated based on the theoretical Austrian calculations.

Table 3 9. Performance of collection systems in Italy (Favoini, 2000).

System	Yield: Food organics (kg/p/wk)[5]	Recovery rate (%)
Door to door	0.8-1.25	53-83
Road container (commingled yard waste)	0.3-0.6	20-40

[5] Calculations assume collection 5 days/week and a household size of 2.7

It is claimed that figures collected in Italy are consistent with yields experienced in Spain (Favoino, undated). Although overall data for Spain was not available, pilot trials in Catalonia have reported food collection rates (per person) of 200 g per day (1.4 kg per week). Study leaders also concluded that while commingled organic waste collection enhances overall yields of organic material, the yield of food organics is reduced when it is co-collected with garden organics (Favoino, undated). In places where food organics is collected together with garden organics, garden organics typically makes up 40-70 percent of organics collection weight.

In the UK, food organics in household garbage has been estimated at 194 kg per household per year. This is equivalent to 1.4 kg per person per week, assuming a household size of 2.7. In one borough in the east of England, recycling rates of 29 percent have been reported (Eunomia, undated). However, ongoing yields of between 50 and 75 percent (or 0.7-1 kg per person per week) are being projected as feasible in the UK, depending on whether the food organics collection is commingled with garden organics or a dedicated food organics programme is implemented (Eunomia, undated). Recent experience of regular collection in Somerset has demonstrated yields of 1.9 kg per household per week, or 0.7 kg per person if a household size of 2.7 is assumed (Rowan, 2005).

In central Europe with less frequent organics collection and collection via road containers, percentage of food remaining in the residual garbage stream has often been reported at 30-50 percent (Favoino *et al*, 2004). High figures have particularly been reported in the Netherlands where meat and fish are excluded from food collection (Favoino et al, 2004). In contrast, it is claimed that Italy has achieved residuals of 15 percent because of the high collection frequencies and use of watertight "biobags" (Favoino, 2001). In Austria, where food organics collection has been established for over ten years, garbage generally contains 11-23 percent residual organics, averaging 17 percent nationwide (Amlinger, 2001).

3.3.4 Set out and Participation Rates

Ten years after the biobin was introduced in Austria, average participation rates have been measured at 43 percent, with a range between 34-49 percent (Amlinger 2001).

Extended trials in Somerset in the UK have demonstrated participation rates of between 20 and 50 percent (Maslen, 2005). Estimates offered by UK councils based on anecdotal data have suggested participation rates as high as 50-90 percent (Eunomia, undated). Trials carried out in Spain have observed participation rates between 40 and 70 percent (European commission, 2000).

Participation rates have not been reported for Italy but studies have concluded that cutting down the collection frequency for the residual garbage stream is an important factor in increasing participation (Favoino, undated).

3.4 Australia

At present, there are only few councils in Australia offering a combined food and garden organics collection system. Examples are presented below.

City of Burnside

In October 2005, the City of Burnside, SA commenced a 'Bio-Organics Trial' comprising 1,775 households, 61 percent traditional homes and 39 percent units and flats, located across six suburbs. This corresponds to approximately 10 percent of the city's total population.

During the trial kitchen food scraps have been diverted using a kitchen bench-top basket lined with a biodegradable liner-bag. The mixed garden and food organics have been collected on a fortnightly basis.

Audits have shown 75 percent of households are presenting a green organics bin at kerbside for collection. Of these, 80 percent also place food organics in the green organics bin. This suggests that 60 percent of households participating in the trial are separating food organics.

The kerbside audits also showed that 36.3 percent of food organics were diverted from landfills. The average quantity of food organics was 2.47 kg per household and fortnight. Further, the audits showed that 38 percent of participating households diverted more than 90 percent of the food organics from their residual waste bin into the green organics bin.

The contamination rate of green organic bins was 2.79 percent (by weight). Contamination within the liner-bags was negligible and where present it predominantly comprised incidental wrappers. (City of Burnside, 2006)

Chifley

In 2001, a household organics collection trial was conducted over ten months in Chifley, ACT. The trial was designed to determine the potential to collect food and kitchen organics from residential dwellings. Kitchen tidy bins were provided for the trial to assist with the separation and storage of food and kitchen waste.

A survey over a six week period showed a 90 percent participation rate. On average, 4.3 kilograms were collected per household and week. Bin contamination levels were as low as 1.3 percent (by volume) over the first five months but increased over school holiday periods and resulted in an average of 9.2 percent over the last six months. The trial showed that approximately 60 percent of household organics can be collected. (NoWaste by 2010, 2001)

Colac-Otway Shire

The Shire of Colac-Otway, VIC, states that a combined food and garden organics waste collection service for residential properties has been in operation for nine to ten years. (Colac-Otway Shire, 2006)

Port Macquarie – Hastings Council

In 2001, Port Macquarie – Hastings Council introduced a fortnightly combined food (fruit and vegetables) and garden organics collection. In July this year, the service will change to a weekly collection along with the provision of kitchen tidy/ corn starch bags. This change is the result of the Domestic Organics Collection Trial conducted in 2003, aiming to increase the capture of organic food organics and green organics.

About 26,000 households, or 70,000 people, are serviced by the biowaste collection system. All organic wastes go to the Remondis Organic Resource Recovery Facility (ORRF) at Cairncross Waste Management Facility, to produce compost. (Port Macquarie-Hastings Council, 2006, Midwaste, 2004a; 2004b & Nolan-ITU, 2004)

During the 2003 Domestic Organics Collection Trial in Hastings, four trial areas were established and audited over a four months period. Each area consisted of about 300 premises. The four trial systems were:

- **Trial 1:** Regular fortnightly 240 litre green bin service;
- **Trial 2:** Existing organics MGBs were replaced with new MGBs with Cleanaway's Bio-inserts, which aim to reduce odours and increase available storage space by allowing the decomposition process to begin in the MGB;
- **Trial 3:** Organics MGBs were collected weekly instead of fortnightly with the aim of reducing odours and increasing available capacity; and
- **Trial 4:** Compostable paper bags and compostable cornstarch bags were provided.

The results from the trial are presented in Table 3.10 below. The highest food recovery was achieved with the compostable bags, Trial 4. The trial showed a 33.3 percent increase in organic capture when going from fortnightly to weekly collection.

Table 3.10 Trial results.

	Collection Frequency	Average Organic bin weights (kg)	Food (fruit & vegetables) in the organics bin
Trial 1	Fort'ly	19.69	0.63%
Trial 2	Fort'ly	15.10[1]	1.8%
Trial 3	Weekly	16.34	1.2%
Trial 4	Fort'ly	16.34	4.62%

[1] Material dries out

Hence, based on the food organics recovery figures from trial 4, which proved most successful, and the 33.3 percent increase in organic materials diverted when going form fortnightly to weekly collection, the fruit and vegetables expected to be diverted amounts to 1.2 kg per household and fortnight. Assuming a total domestic waste quantity and composition as used in this report (see Section 2.3), this represents a 16 percent food (fruit and vegetable) waste recovery rate. (Port Macquarie-Hastings Council, 2006)

Lismore City Council

Lismore City Council provides a weekly organics collection system with 10,442 urban domestic services and 1,314 non domestic (business) services.

The kerbside organics collection system can accept all food scraps, garden organics, paper and cardboard. Food scraps can be wrapped in newspaper or placed directly into the bin. Use of a kitchen tidy for food scraps is promoted to help kitchen separation.

According to Lismore Council, prior to this system being introduced, organics made up more than half of the garbage, around 75 percent in most households and businesses. With the current system 6,289 tonnes of organics are received per annum.

All organic material goes to the Tryton worm farm which accepts 7,000 tonnes per annum (Lismore City Council, 2006).

Shire of Nillumbik

The Shire of Nillumbik, VIC, started a combined food and garden organics collection in July 2003, resulting in a very high total waste recovery rate (Nolan-ITU, 2004).

Coffs Harbour City Council, Bellingen Shire Council and Nambucca Shire Council

Coffs Harbour City Council has had positive results in food organics collection trials conducted as part of the kerbside organics service. A new composting facility is currently under construction in Coffs Harbour which will receive waste from Coffs Harbour City Council, Bellingen Shire Council and Nambucca Shire Council, with a combined population of 90,000. The organics, including all food and garden organics, will be collected on a weekly basis while general garbage and recyclables will be collected fortnightly. (Coffs Harbour City Council, 2006 & Midwaste, 2004b)

Camden Council

Camden Council provides 3 bin waste management system to its urban residents. All three bins are collected on a weekly basis. The garden organics bin is for organic garden material such as leaves, twigs and grass clippings, as well as fruit and vegetable scraps. The council advices its residents to wrap the fruit and vegetable scraps in newspaper to help keep bins free of insects or fruit flies. (Camden Council, 2006)

3.5 Contamination Issues

In general, when accompanied by a well designed collection system and adequate community education, contamination in food organics collected from kerbside appears to be very low and cause no problems at composting facilities. Most often information on contamination tends to be general with comments such as "contamination is not really a problem" or levels stated at generally less than 5 percent. Where specific data has been identified, it is shown below.

Country	Contamination Range (% weight)
Italy (Favoino, 2000)	0.1-6.3
St Edmondbury, UK (Eunomia, undated)	6.2
Castle Morpeth, UK (European Commission, 2000)	1%
Baix Camp, Spain (European Commission, 2000)	<5%
Kristiansand, Norway (Ohr, 1998)	1.5%
Catalonia, Spain (Herbolzheimer, 1999)	2%

Contamination is controlled in a number of jurisdictions by an active enforcement programme at kerbside where loads are visually inspected by the contractor and rejected if contamination is noted. The container is marked with a sticker giving the reason for rejection. Active enforcement at kerbside is often needed if garbage collection frequency is reduced following the implementation of food collection (Eunomia, undated).

High levels of contamination have also been observed when multi-family dwellings have been included in collection programmes (Eunomia, undated; Farrell, 2005). San Francisco, which led the way with residential food organics collection in the US, has opted to include only single family residences in their collection programmes because of the contamination difficulties that medium and high density housing can introduce.

Plastic bag waste appears to be the most prominent contamination problem for food organics collection services, with its main impact being as a visual/physical contaminant. There are three possible solutions:

1. Use a conventional plastic bag as a bin liner and separate plastic at the processing facility;
2. Use of a biodegradable plastic bag; or
3. Use no plastic bags – encourage residents to wrap food organics in paper and carry out an active bin cleaning programme.

The use of watertight bags to contain the food organics and line the bins prior to collection has been found to assist in eliminating the nuisance factors of odour and pests, to keep the bins clean and reduce the need for frequent cleaning, and to offer the option of delivering food organics separately to garden organics (even when a single 240L bin is used at kerbside). Conventional plastic bags also retain their strength and can be placed directly on the roadside or within the provided bin. However, if plastic bags are used, it would be necessary to install additional equipment at the front end of the composting process to remove them from the food organics stream.

In some places, residents are encouraged to either use kraft bags or wrap the food organics in paper (when a bin is used for collection). Paper or paper bags have the disadvantage of not being waterproof and suffer reduced strength over time due to moisture in food. However, they pose no contamination issues during subsequent processing. Biodegradable plastic bags have been trialled in the US, but performance, cost and availability have been significant barriers to their widespread implementation.

It has been argued that the purity of food organics collected separately tends to get lower in more highly populated areas. However, studies in Italy have found no such correlation, concluding instead that it is more dependent on the collection system and frequency that is adopted than on the size of the community (Favoino, undated).

4 Financial Assessment

4.1 Modelling Approach

4.1.1 Introduction

The estimate of costs for collection, processing and material delivery for the different systems was made using the Australian Waste and Recycling Cost Model (WRCM) developed by the Cooperative Research Centre for Waste Management and Pollution Control in association with EcoRecycle Victoria and Recycle 2000. The model enables the user to evaluate current and alternative collection systems to see the effect on yields and costs. A description of the model is provided in DEC (2005).

The model requires input of a number of key operational parameters as follows:

- Crew size and labour costs;
- Truck capacities;
- Truck pick-up times;
- Collection area characteristics;
- Landfill disposal cost and gate fees for Alternative Waste Treatment (AWT) facilities;
- Organics processing costs; and
- Set out rates.

Unless stated otherwise, the operational parameters used in the financial modelling for DEC (2005) remain unchanged.

Organics Processing Costs

Garden organics processing costs have been based on those documented in the Study on Local Government Management Costs for Garden Organics (DEC, 2003). Median gate/processing fees for surveyed metropolitan Sydney Councils in this study were $44/tonne.

For scenarios where garden and food organics are collected together, processing costs have been assumed at $70/tonne to allow for increased environmental controls and the need to process in an enclosed facility.

4.1.2 Financial Base Case, Regional Scenario and Sensitivity Analyses

All costs and fees are given in 2006 dollar terms[6]. For the base case, landfill and transfer station gate fees are based on actual 2006 fees (WSN, 2006) but with the waste levies as per 2010/11 (DEC, 2006). This has been done because the objective of the report is to provide councils assistance in their planning and decision making where medium term costs are more relevant than current prices. For MBT processing, a gate fee of $110/t has been assumed. To determine a transfer station gate fee for wastes destined for MBT, the same price differential has been applied as currently exists between transfer stations and landfills i.e. $15/t. Further, it is assumed that, as an average across metropolitan Sydney, 70 percent of garbage is delivered to a transfer station and 30 percent directly to either landfill or MBT.

For the regional scenario, a landfill gate fee of $65/t, a composting fee of $35/t for GO composting and $65/t for biowaste composting have been assumed.

Three sensitivity analyses are carried out for the financial assessment as follows:

1. The MBT gate fee is increased from $110/t to $130/t. All other parameters are kept constant.
2. Processing costs for garden organics are increased from $44/t to $54/t.
3. MBT and landfill fees are as per previous study (DEC 2005) to enable a direct comparison.

[6] I.e. costs, fees and prices for 2010/11 are not indexed to include inflation. Any such increases due to inflation would apply in equal proportions to all costs and fees.

A compilation of gate fees and processing costs for the base case and the three sensitivity analyses are presented in Table 4.1 Deviations from the base case are highlighted.

Table 4.1 Per tonne gate fees and processing costs in 2006 $ terms.

	Base Case	Regional	Sensitivity 1	Sensitivity 2	Sensitivity 3
	Gate Fee	Gate Fee	Gate Fee	Gate Fee	Gate Fee
Landfill Direct	$130	$65	$130	$130	$76
Landfill via Transfer Station	$145	-	$145	$145	$93
MBT Direct	$110	$110	$130	$110	$85
MBT via Transfer Station	$125		$145	$125	$102
Processing Cost					
GO Composting	$44	$35	$44	$54	$44
Biowaste Composting	$70	$65	$70	$70	$70

4.2 Results

The results for each of the scenarios investigated are presented below. System costs are presented on a $/hhld/yr basis, separately for the garbage, organics and kerbside recyclables components, and as a total. The net cost of providing a separate organics collection service has been derived based on the difference between the total system cost and the system cost without a separate organics service (i.e. no separate collection of organics, i.e. organics included in the garbage stream).

Also shown for each scenario are the average proportions of garbage, organics and kerbside recycling costs (including contamination).

It is noted that the results represent averages for the systems studied. The averages mask a wide variation in estimated system costs: within each system category, across different regions; and at the operational level, where local influences are important. The average data have been used to draw broad conclusions, but at a local level cost variations from these averages may be significant.

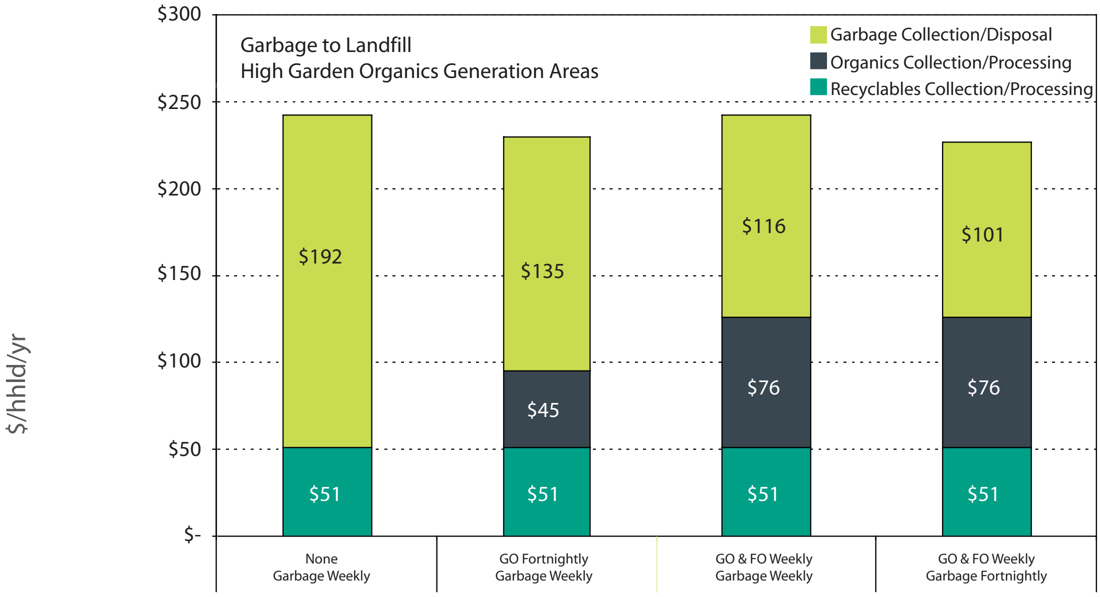
4.2.1 Base Case Scenario

High GO Generating Areas – Garbage to Landfill

Table 4.2 Waste Management Costs, High GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		Weekly	Weekly	Weekly	Weekly
$ Per Household Per Year					
Garbage	Collection	$57	$50	$47	$32
	Disposal/Processing	$134	$85	$69	$69
Organics	Collection	-	$29	$43	$43
	Processing	-	$15	$32	$32
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$243***	***$231***	***$243***	***$228***
LF Only Cost		$243	$243	$243	$243
Net Cost of Organics Recycling		***$0***	***-$12***	***$0***	***-$15***
% Garbage		80%	51%	41%	41%
% Organics		0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%

Figure 4.1 Waste Management Costs, High GO Generation, Garbage to Landfill.

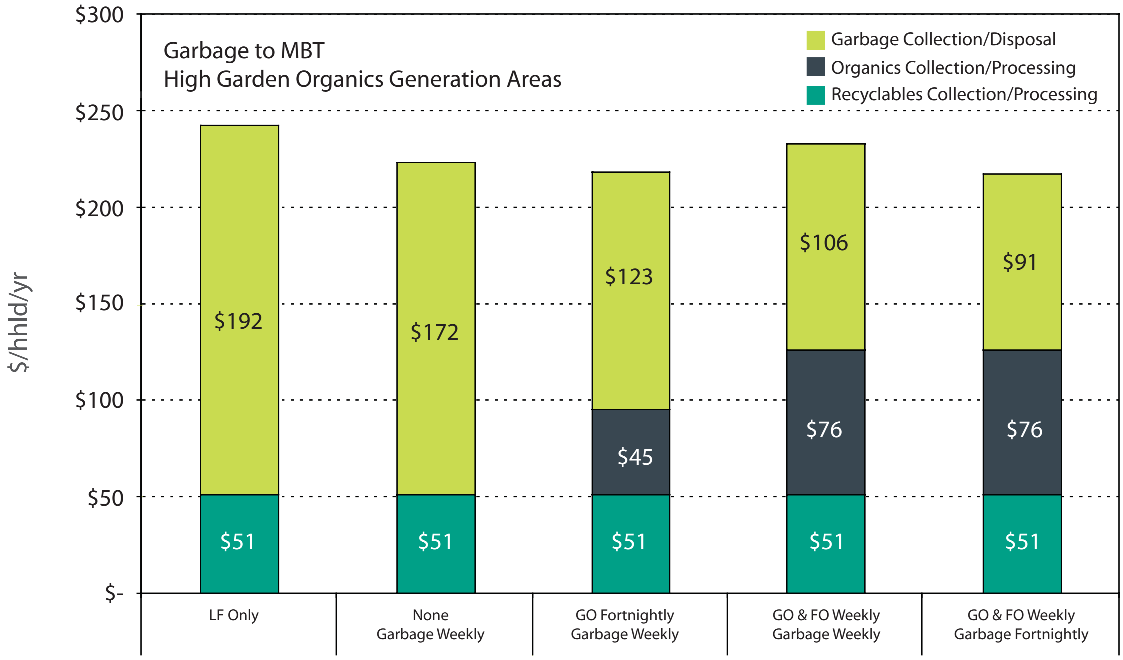


High GO Generating Areas – Garbage to MBT

Table 4.3 Waste Management Costs, High GO Generation, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		LF Weekly	MBT Weekly	Weekly	Weekly	Weekly
$ Per Household Per Year						
Garbage	Collection	$57	$57	$50	$47	$32
	Disposal/Processing	$134	$115	$73	$59	$59
Organics	Collection	-	-	$29	$43	$43
	Processing	-	-	$15	$32	$32
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$243***	***$224***	***$219***	***$233***	***$218***
MBT Weekly Cost			$224	$224	$224	$224
Net Cost of Organics Recycling			***$0***	***-$5***	***$9***	***-$6***
LF Only Cost		$243	$243	$243	$243	$243
Costs Change Compared to LF		***$0***	***-$19***	***-$24***	***-$10***	***-$25***
% Garbage		80%	80%	51%	41%	41%
% Organics		$0	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 4.2 Waste Management Costs, High GO Generation, Garbage to MBT.

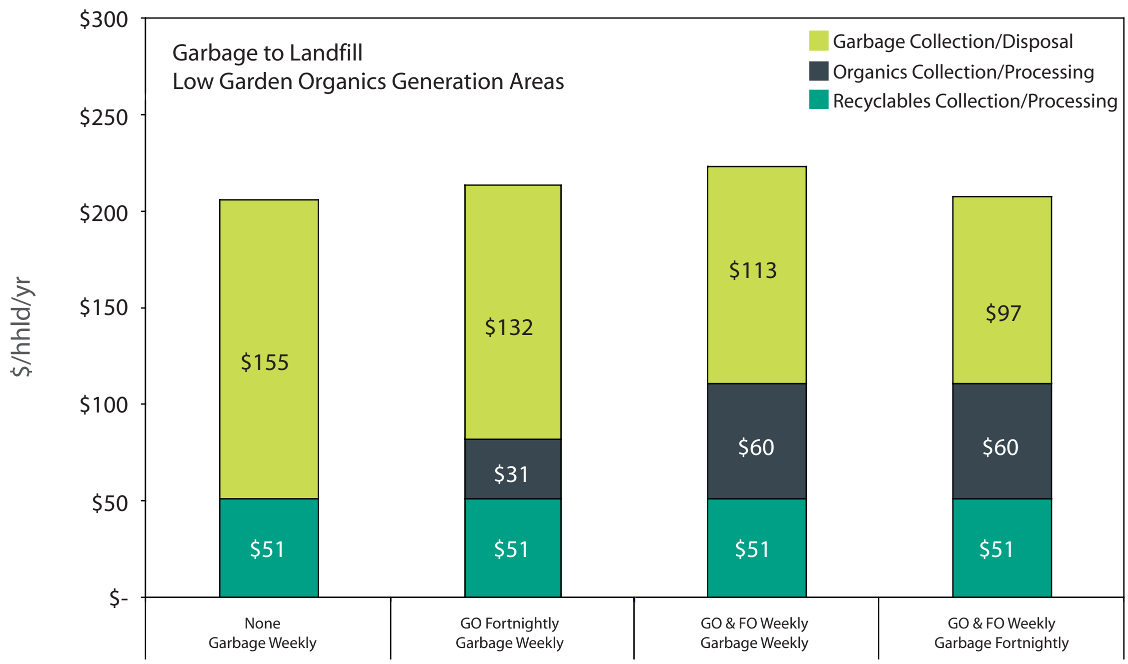


Low GO Generating Areas – Garbage to Landfill

Table 4.4 Waste Management Costs, Low GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		Weekly	Weekly	Weekly	Weekly
$ Per Household Per Year					
Garbage	Collection	$52	$50	$46	$31
	Disposal/Processing	$103	$82	$66	$66
Organics	Collection		$24	$41	$41
	Processing		$7	$18	$18
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$207***	***$214***	***$223***	***$208***
LF Only Cost		$207	$207	$207	$207
Net Cost of Organics Recycling		***$0***	***$7***	***$17***	***$2***
% Garbage		76%	60%	48%	48%
% Organics		0%	16%	27%	27%
% Recyclables (incl. contamination)		24%	24%	24%	24%

Figure 4.3 Waste Management Costs, Low GO Generation, Garbage to Landfill.



Low GO Generating Areas – Garbage to MBT

Table 4.5 Waste Management Costs, Low GO Generation, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		**LF Weekly**	**MBT Weekly**	**Weekly**	**Weekly**	**Weekly**
$ Per Household Per Year						
Garbage	Collection	$52	$52	$50	$46	$31
	Disposal/Processing	$103	$88	$70	$57	$57
Organics	Collection			$24	$41	$41
	Processing			$7	$18	$18
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$207***	***$192***	***$202***	***$214***	***$199***
MBT Weekly Cost			$192	$192	$192	$192
Net Cost of Organics Recycling			***$0***	***$11***	***$22***	***$7***
LF Only Cost		$207	$207	$207	$207	$207
Costs Change Compared to LF		***$0***	***-$15***	***-$4***	***$7***	***-$8***
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 4.4 Waste Management Costs, Low GO Generation, Garbage to MBT.

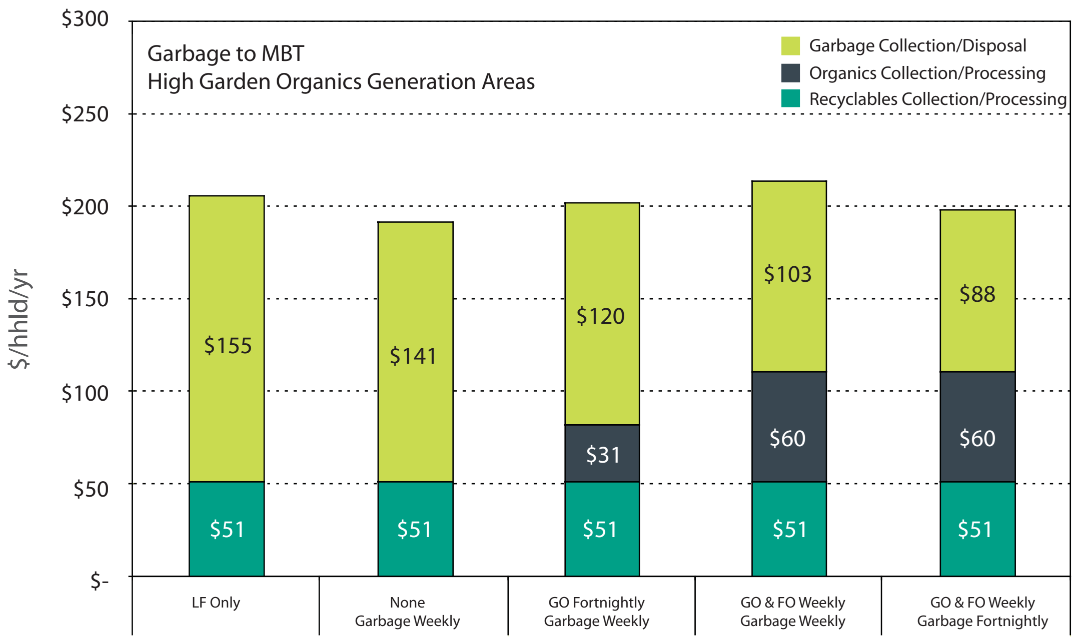
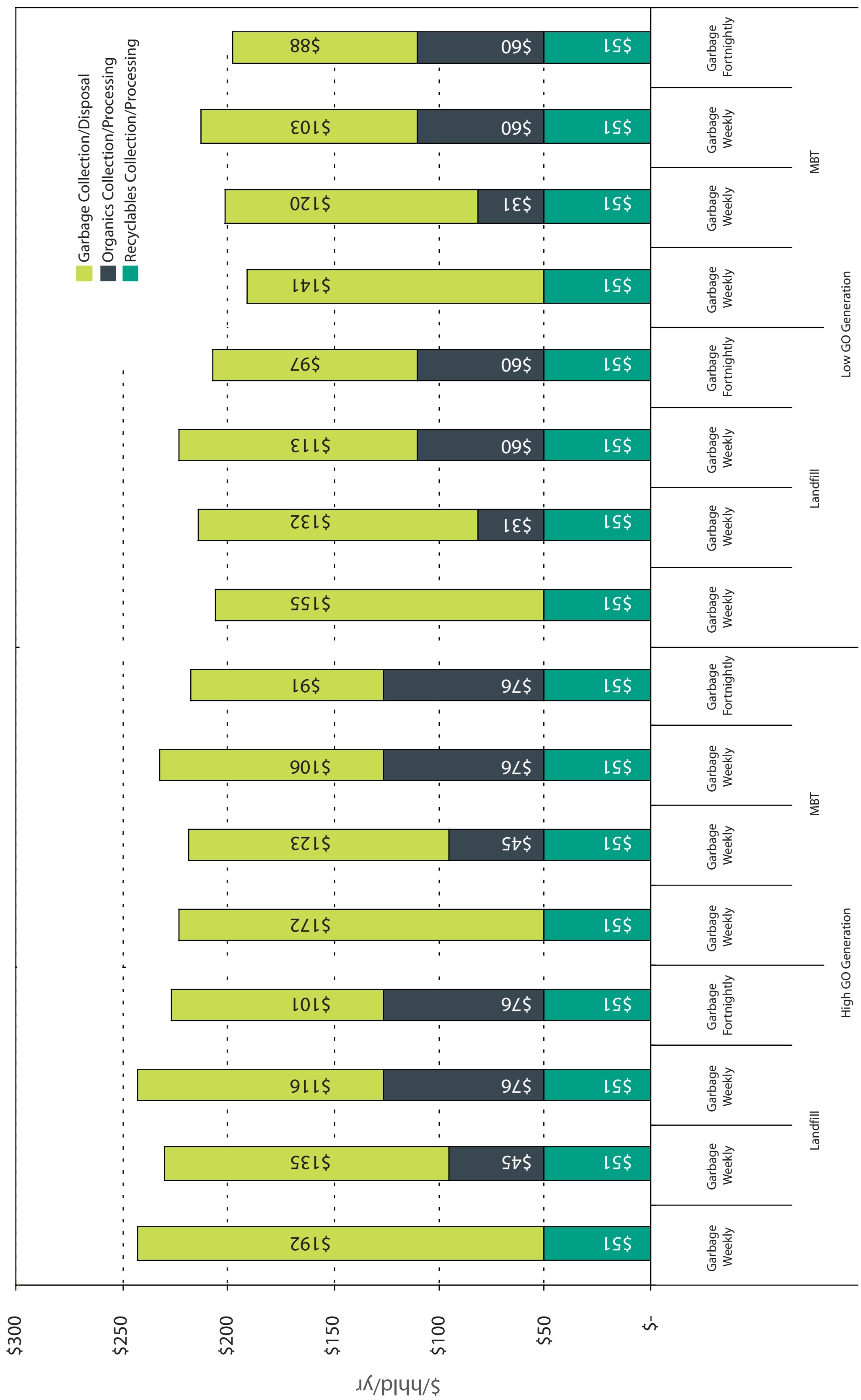


Figure 4.5 Waste Management Costs: Summary for all Systems Investigated – Base Case.



4.2.2 Regional Areas

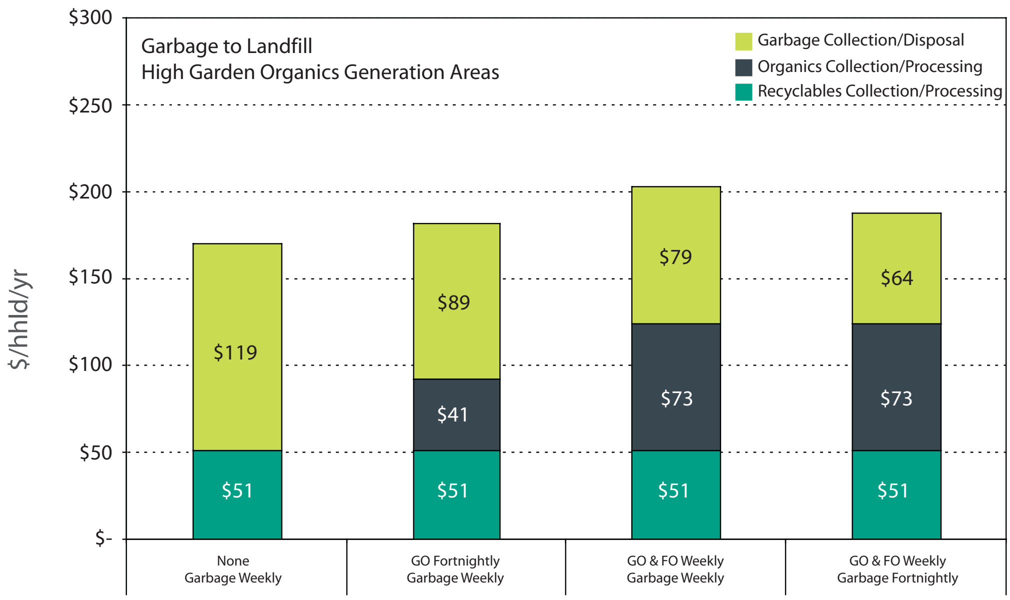
For regional areas, only the high garden organics waste profile is presented here.

Garbage to Landfill

Table 4.6 Waste Management Costs, High GO Generation, Garbage to Landfill – Regional.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		Weekly	Weekly	Weekly	Weekly
$ Per Household Per Year					
Garbage	Collection	$57	$50	$47	$32
	Disposal/Processing	$62	$39	$32	$32
Organics	Collection	-	$29	$43	$43
	Processing	-	$12	$30	$30
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$171***	***$182***	***$203***	***$188***
LF Only Cost		$171	$171	$171	$171
Net Cost of Organics Recycling		***$0***	***$11***	***$33***	***$17***
% Garbage		80%	51%	41%	41%
% Organics		0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%

Figure 4.6 Waste Management Costs, High GO Generation, Garbage to Landfill – Regional.



Garbage to MBT

Table 4.7 Waste Management Costs, High GO Generation, Garbage to MBT – Regional.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		LF Weekly	MBT Weekly	Weekly	Weekly	Weekly
$ Per Household Per Year						
Garbage	Collection	$57	$57	$50	$47	$32
	Disposal/Processing	$62	$105	$66	$54	$54
Organics	Collection			$29	$43	$43
	Processing			$12	$30	$30
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$171***	***$213***	***$209***	***$225***	***$210***
MBT Weekly Cost			$213	$213	$213	$213
Net Cost of Organics Recycling			***$0***	***-$4***	***$12***	***-$3***
LF Only Cost		$171	$171	$171	$171	$171
Costs Change Compared to LF		***$0***	***$43***	***$39***	***$55***	***$39***
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 4.7 Waste Management Costs, High GO Generation, Garbage to MBT – Regional.

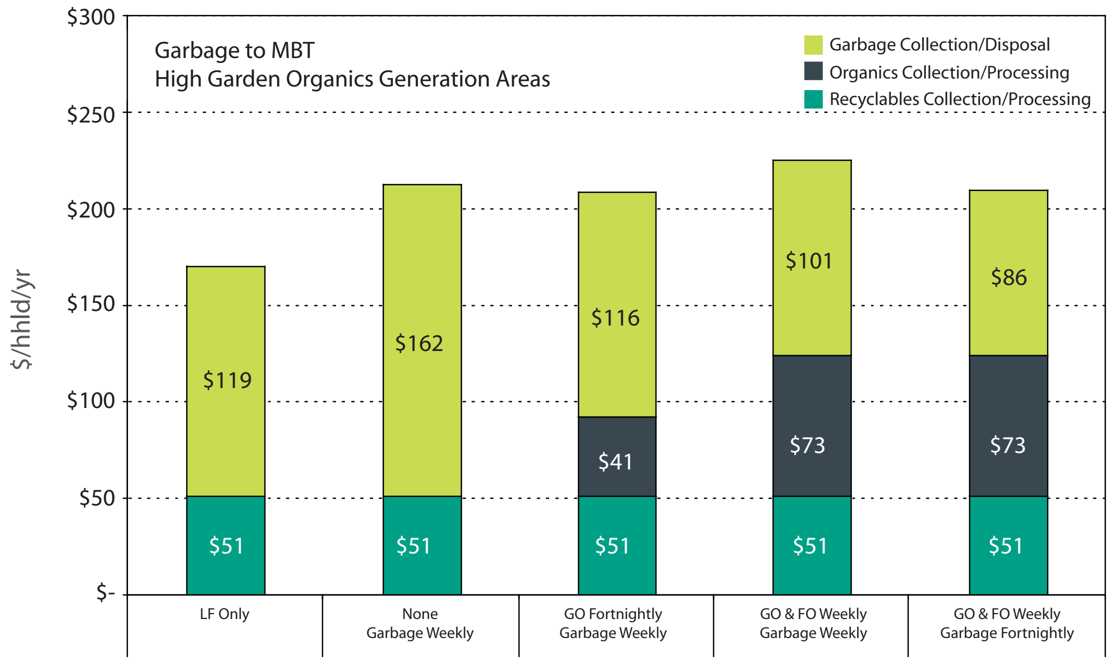


Figure 4 .7

4.3 Discussion and summary of results

4.3.1 Base Case Scenario

In summary, the cost of providing a weekly combined food and garden organics collection service is estimated to be in the range $60/hhld/yr to $76/hhld/yr. This compares to a cost of providing a fortnightly garden organics only collection service of $31/hhld/yr – $45/hhld/yr.

These costs do not take into account the avoided garbage collection and disposal costs. Table 4.8 summarises the results of the net cost changes. The following picture emerges:

- Processing of residual mixed waste (garbage) through MBT is less expensive than landfill, for all scenarios.

High Garden Organics Generation

- For councils with **high garden organics generation**, the separate collection of garden organics will be less expensive ($12/hhld/yr) than disposal to landfill (with garbage).
- For those councils, the co-collection of food organics (with garden organics) will cost the same as sending all organics to landfill (with garbage). A concurrent reduction of the garbage collection frequency from weekly to fortnightly would make this option $15/hhld/yr less expensive than no organics collection service at all.
- The introduction of MBT processing for garbage would reduce the overall domestic waste management costs by $19/hhld/yr. A separate garden organics collection service would further reduce the costs by $5/hhld/yr. Biowaste collection would add $5/hhld/yr with a weekly garbage service and reduce by$6/hhld/yr with a fortnightly garbage service.

Low Garden Organics Generation

- For councils with **low garden organics generation**, the separate collection of garden organics will be $7/hhld/yr more expensive than disposal to landfill (with garbage).
- For those councils, the co-collection of food organics (with garden organics) will cost $17/hhld/yr more than having no organics collection service at all. This would reduce to $2/hhld/yr in case of a fortnightly garbage collection.
- The introduction of MBT processing for garbage would reduce the overall domestic waste management costs by $15/hhld/yr. A separate garden organics collection service would further increase these costs by $11/hhld/yr however, the total costs would still be $4/hhld/yr lower than the base case. Biowaste collection would add $22/hhld/yr (or $7 net) with a weekly garbage service and $7/hhld/yr (or $8 net saving) with a fortnightly garbage service.

As the cost of garbage treatment/disposal increases (through MBT) the net cost of organics collection reduces (i.e. the [higher] avoided costs of garbage treatment makes organics recovery cheaper).

Table 4.8 Summary of financial assessment.

Organics Collection	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection	**Weekly**	**Weekly**	**Weekly**	**Weekly**
High, LF				
Net Cost of Organics Recycling	*$0*	*-$12*	*$0*	*-$15*
High, MBT				
Net Cost of Organics Recycling	*$0*	*-$5*	*$9*	*-$6*
Costs Change Compared to LF	*-$19*	*-$24*	*-$10*	*-$25*
Low LF				
Net Cost of Organics Recycling	*$0*	*$7*	*$17*	*$2*
Low MBT				
Net Cost of Organics Recycling	*$0*	*$11*	*$22*	*$7*
Costs Change Compared to LF	*-$15*	*-$4*	*$7*	*-$8*

4.3.2 Regional Scenario

The lower regional landfill gate fees and organics processing costs (for details refer Table 4 1) result in total system costs for high GO generating areas of $171 to $225 and $151 to $207 with low GO generation.

The cheapest option is a landfill only scenario. A separate (fortnightly) GO collection is $11/hhld/yr more expensive. A (weekly) biowaste collection is $33/hhld/yr more expensive, reducing to $17 if the garbage collection frequency is reduced to fortnightly.

The provision of MBT processing for garbage would increase costs by around $43/hhld/yr. Additional organics collection services do not significantly alter the total waste management costs.

It is noted however, that these results are heavily dependent on the assumptions regarding landfill and MBT gate fees. For regional centres, it is possible that landfill fees rise above currently assumed levels (of $65/t) whereas it appears feasible that MBT's may be established at lower gate fees than those assumed here ($110/t), due to potentially lower land, siting and approval costs as well as perhaps somewhat more relaxed requirements concerning environmental controls due to less sensitive sites.

4.3.3 Sensitivity Scenario 1 – MBT more expensive

For a case where the gate fee for MBT processing rises to $130/t (from the $110/t assumed in the base case), the options with and without MBT show similar costs, and all organics collection options are similar in costs to those in the base case where garbage is disposed to landfill.

Table 4.9 Summary of Sensitivity Analysis #1 – MBT more expensive.

Organics Collection	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection	Weekly	Weekly	Weekly	Weekly
High G, LF				
Net Cost of Organics Recycling	*$0*	*-$12*	*$0*	*-$15*
High GO, MBT				
Net Cost of Organics Recycling	*$0*	*-$12*	*$0*	*-$15*
Costs Change Compared to LF	*$0*	*-$12*	*$0*	*-$16*
Low GO, LF				
Net Cost of Organics Recycling	*$0*	*$7*	*$17*	*$2*
Low GO, MBT				
Net Cost of Organics Recycling	*$0*	*$7*	*$17*	*$2*
Costs Change Compared to LF	*$0*	*$7*	*$17*	*$1*

4.3.4 Sensitivity Scenario 2 – GO composting more expensive

A rise in gate fees for composting of garden organics from $44/t to $54/t does not significantly alter the outcomes of the financial assessment for any of the options. For councils with high GO generation, such an increase would reduce the cost advantage of separate GO collection over landfilling of GO from $12/hhld/yr to $8/hhld/yr. The ranking of the options does not change.

Table 4.10 Summary of Sensitivity Analysis #2 – GO processing more expensive.

Organics Collection	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection	Weekly	Weekly	Weekly	Weekly
High G, LF				
Net Cost of Organics Recycling	*$0*	*-$8*	*$0*	*-$15*
High GO, MBT				
Net Cost of Organics Recycling	*$0*	*-$1*	*$9*	*-$6*
Costs Change Compared to LF	*-$19*	*-$21*	*-$10*	*-$25*
Low GO, LF				
Net Cost of Organics Recycling	*$0*	*$9*	*$17*	*$2*
Low GO, MBT				
Net Cost of Organics Recycling	*$0*	*$12*	*$22*	*$7*
Costs Change Compared to LF	*-$15*	*-$3*	*$7*	*-$8*

4.3.5 Sensitivity Scenario 3 – MBT and landfill fees as per previous study

This analysis shows the greatest differences to the options analysed under the base assumptions. This is not surprising considering the significant increase in the landfill levy over the next five years (which were not known for the previous study).

Without the announced increase in the waste disposal levy, all options considered are more expensive than the landfill only option. This includes the MBT options for garbage and all options for organics collection.

In other words, what the analysis confirms is that the waste disposal levy increase will make processing of garbage ('residual waste') and most options for separating organics from the domestic waste stream 'viable' in a financial sense.

Table 4.11 Summary of Sensitivity Analysis #3 – MBT and LF fees as per previous study.

Organics Collection	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection	Weekly	Weekly	Weekly	Weekly
High G, LF				
Net Cost of Organics Recycling	*$0*	*$5*	*$22*	*$7*
High GO, MBT				
Net Cost of Organics Recycling	*$0*	*$2*	*$18*	*$3*
Costs Change Compared to LF	*$9*	*$10*	*$27*	*$11*
Low GO, LF				
Net Cost of Organics Recycling	*$0*	*$15*	*$29*	*$14*
Low GO, MBT				
Net Cost of Organics Recycling	*$0*	*$13*	*$27*	*$12*
Costs Change Compared to LF	*$7*	*$20*	*$34*	*$18*

5 Environmental Cost Benefit Assessment

5.1 Method

5.1.1 Method overview

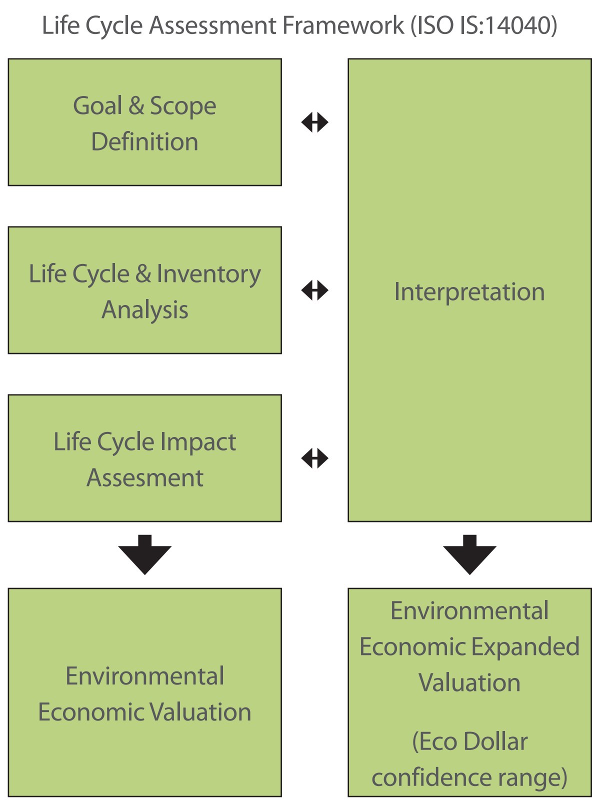
The environmental assessment of system alternatives has been conducted within the broader framework of an economic assessment. It aims to define and value the environmental externalities (or non-financial costs) associated with source-separated organics collection and processing within various management strategies for municipal solid waste.

The environmental assessment has involved the application of Life Cycle Assessment and environmental economic valuation methods consistent with the NSW Jurisdictional Recycling Group's research into alternative mixed waste and recycling systems (DEC, 2004) and the National Packaging Covenant study of kerbside recycling in Australia (Nolan-ITU and SKM Economics, 2001). Methodology details are provided in Appendix A. The analysis is also consistent with Department of Environment and Conservation's *Alternative Waste Treatment Technologies Assessment Methodology and Handbook* (2003b) and the findings of the *Life Cycle Inventory and Life Cycle Assessment for Windrow Composting Systems* (ROU, 2003).

The application of the environmental economic assessment within the LCA methodology framework is shown in Figure 5.1.

In addition to the environmental economic assessment, an expanded valuation has been conducted within the interpretation phase of Life Cycle Assessment. This provides a final value that takes account of some known data gaps and limitations of the approach.

Figure 5.1 LCA method (ISO 14 040, 1998) – application within the economic assessment.



As suggested by Figure 5.1, the results of the LCA are presented as an environmental economic valuation of the system under review (in Ecodollars) as well as an expanded valuation that stems from the LCA interpretive phase (also in Ecodollars) which is presented as a confidence range.

5.1.2 Objectives

The environmental assessment has sought to provide:

1. Environmental cost benefit valuation of source-separated biowaste management, including collection, composting and compost application.

2. Comparative analysis of options for the management of the garbage stream (with and without source-separated biowaste organics collection and composting). This includes the technology options of MBT and landfill.

3. Provide an indication of the order of magnitude of results derived from an expanded cost benefit valuation *proxy* valuation data that reflects known data gaps and methodological limitations.

Data

The assessment has involved the application of a vast amount of data from local and international research and industry experience that have been built into LCA modelling systems.

The main LCA inventory data sources are:

- Eunomia Research & Consulting. (2002). *Economic Analysis of Options for Managing Biodegradable Municipal Waste*, final report to the European Commission.
- Nolan-ITU. (1998). *Biowaste Processing Life Cycle Assessment and Environmental Valuation (Proposed Enclosed Biowaste Processing Facility at Lucas Heights)*, for Waste Service NSW and the Southern Sydney Waste Board.
- DEC. (2004). *Assessment of Domestic Waste and Recycling Systems*, for the NSW Jurisdictional Recycling Group and Publishers National Environment Bureau.
- Nolan-ITU and Access Economics. (2002). *Organic Waste Economic Values Analysis;* for the Department of Industry and Trade, Environment Protection Agency.
- RMIT & Nolan-ITU. (2003). *Life Cycle Assessment of Waste Management Options in Victoria*, for EcoRecycle Victoria.
- Sonesson, U. (1997). *The Orware Simulation Model for Compost and Transport LCA Sub-models*, Swedish EPA.

The environmental economic values are referenced from previous published and unpublished reports (Nolan-ITU, 2001; 2002 & 2003 and DEC, 2004 & 2005).

Compost application benefits have been updated to reflect water use benefits from a recent report prepared for the Department of Environment and Conservation (ROU, 2003). Data sources and updates for compost application benefits are detailed in Table 5.3.

5.1.3 Assumptions

The assumptions for the environmental assessment have been based mainly on work undertaken in previous studies as documented in Section 14: References, and Appendix A. This study has been commissioned as an 'extension' to the *Assessment of Domestic Waste and Recycling Systems* (DEC, 2004) and *Assessment of Garden Organics Collection Systems* (DEC, 2005) and the majority of assumptions are therefore similar. Key parameters and additional assumptions are summarised below.

Landfilling

The environmental impacts of landfill (and benefits through avoided landfill) have been modelled as per the LCA of Waste Management Options (RMIT & Nolan-ITU, 2003). This comprised modelling material specific and generic emissions for each component in the residual (garbage) stream. The (long known) weakness of this methodology is that the impacts of landfilling are underestimated as the total emissions to air and water calculated with this model do not include a range of trace contaminants monitored and reported in a number of international studies. An extension to account for these pollutants would also require a modification to the impact model i.e. the *Nolan-ITU Environmental Economic Valuation Model* which allows consolidation of environmental performance results into a single indicator expressed as a 'monetary value'.

Mechanical Biological Treatment (MBT)

A generic MBT facility has been assumed for the treatment of domestic waste (i.e. the contents of the garbage bin) prior to landfilling. Mass balance and emissions data have been used from both local – Nolan-ITU has undertaken a number of studies for technology providers in Australia – and international sources (refer Section 14: References, and Appendix A).

The key characteristics of the assumed MBT plant are: mechanical separation of metals, homogenisation, intensive aerobic processing (fully enclosed) over a four week period with subsequent less intensive stabilisation/maturation over an additional four weeks, screening and refining, production of stabilised residues for landfill (45% of input), production of low grade compost (19% of input), 6% recyclate recovery, gas generation from landfilling of stabilised residues reduced by 90% compared to untreated garbage, leachate generation from landfilling of stabilised residues reduced by 85% compared to untreated garbage, and biofiltration of process air from the plant. Energy usage was reduced from averages for aerobic MBT to account for the possibility of partial anaerobic digestion of input.

The environmental benefit of low grade compost generated by the assumed MBT technology is predominantly from avoided landfill impacts. The only assumed application benefits are from carbon sequestration in soils. The impacts of heavy metals are also taken into account based on actual concentrations analysed in MSW-derived compost.

No fertiliser replacement or potential pesticide savings have been considered as it has been assumed that this compost is not applied to agricultural land but only for land rehabilitation/recultivation and similar purposes.

GO and Biowaste Collection and Composting

With the additional source separation of food organics there are a number of parameters that change in the environmental modelling based on differences in characteristics between garden and food organics.

Collection systems have been modelled assuming average council sizes for metropolitan Sydney.

As in the previous study (DEC, 2005) collected GO is assumed to be processed by open windrow composting whereas the inclusion of food organics requires composting in an enclosed facility. Energy usage (and relevant emissions) during processing (shredding, turning etc.) has been documented in a number of studies, most recently in ROU (2003). Compared to open windrow composting, enclosed composting requires active aeration and, hence, significant use of electricity. The environmental impact of the actual building is commonly known to make up less than five percent of the total impact and has not been included in the modelling. The ventilation has been accounted for through the inclusion of 90 MJ/t of input[7].

It is noted that anaerobic digestion technologies for biowastes are able to generate considerable surplus electricity which would be an added advantage. A separate modelling was beyond the scope of this study, however this is just one of several reasons why the results of the environmental assessment can be deemed conservative.

Use of compost has been assumed in a range of intensive agricultural applications. The environmental benefits of GO and biowaste recovery, conversion to compost (open windrow composting & enclosed composting) and compost application are described in Section 5.2.

For metropolitan options, the use of a bulking and transfer facility has been assumed with subsequent transport in a $50m^3$ bulk haul vehicle to a composting facility. Distance of final product to market has been assumed at 20km, with a sensitivity modelled at 100km (no significant difference). For collection and transport of garbage, GO and biowaste, a range of assumptions had to be made based on different collection and unloading times[8]. For the high and low GO generation scenarios there are five collection types:

- Garbage collection and transport;
- Garbage collection and transport when GO has been separated;
- Garbage collection and transport when biowaste has been separated;
- GO collection and transport; and
- Biowaste collection and transport.

[7] Mean value between digestion (zero MJ) and figure given in Eunomia (2002) (180MJ).
[8] These differences have also been considered in the financial modelling.

Another difference is the input output ratio for compost generation as food organics, and hence biowaste, generates less final product than GO. For the high GO generation scenario one tonne of GO is set to result in 700 kg of compost while one tonne of biowaste generates 650 kg compost. Corresponding figures in the low GO generation scenario are 700 and 600 kg compost for GO and biowaste respectively (as the mixture in the feedstock is different).

Finally, the nutrient content in biowaste derived compost differs from GO derived compost. This is summarised in Table 5.1 below.

Table 5.1 Nutrient content in GO respectively food/garden compost derived compost (% compost).

Nutrient / Compost type	Nitrogen (N)	Phosphorus (P)	Potassium (P)
GO compost	1.0-2.0	0.1-0.4	0.1-0.4
Food/garden compost	1.5-3	0.2-0.6	0.2-0.6

Kerbside Recycling

For the purpose of this report, kerbside recycling has been held constant across all options modelled. Environmental impacts/benefits of kerbside recycling have not been included in the reported results. These are documented separately in the report on *Assessment of Domestic Waste and Recycling Systems* (DEC, 2004).

Further assumptions can be found in Section 4.1.1.

5.2 Environmental Value of GO and Biowaste

The environmental assessment component of the study has sought to define and value the environmental externalities (or non-financial costs and benefits) of source-separated GO waste and biowaste collection and composting so that they may be incorporated into the holistic (TBL) assessment of domestic waste management options.

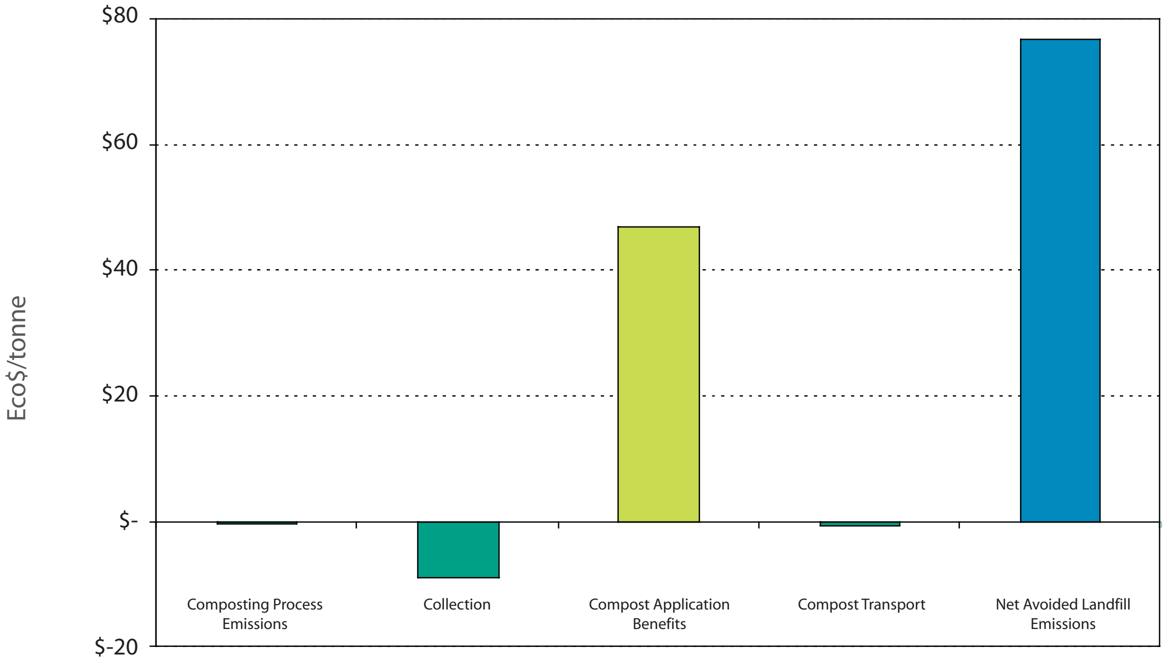
5.2.1 Valuation Overview

The environmental value of biowaste recycling is estimated to be $115 per tonne of source-separated biowaste. This value is comprised of *resource savings* as well as the full range of environmental impact categories associated with avoided product credits, including air and water pollution and global warming potential. The estimate is based on extensive data analysis using the method of life cycle assessment and environmental economic valuation. The contribution of the various aspects is listed in Table 5.2 and Figure 5.2.

Table 5.2 The Environmental Value of biowaste compost. (Eco$/t source-separated biowaste).

Life Cycle Aspect	Value
Composting process emissions	-0.14
Collection	-8.72
Compost application benefits	47.11
Compost transport	-0.57
Net Avoided landfill emissions	76.86
Net Benefit	***114.54***

Figure 5.2 The Environmental Value of Compost ($/t of source-separated biowaste).



In the LCA interpretation phase conducted as part of this study (Section 6) the potential for bias in the interpretation was investigated. Based on this the estimated environmental value of $115 per tonne was found to be conservative. An expanded valuation, conducted for the previous study and using proxy values to account for some of the known data gaps, yielded an environmental value of garden organics recycling of $277 per tonne.

5.2.2 Compost application benefits – valuation overview

Much of the environmental value of organics composting is associated with compost application benefits. Table 5.2 indicates that, of the Eco$115 per tonne benefit per tonne of source-separated *input*, Eco$47 is associated with the benefits of compost application to soil (the remainder being avoided landfill credits). This benefit translates to Eco$73 per tonne of compost end product (i.e. *output* from enclosed composting) with the main benefits arising from moisture retention in soil and the fertiliser value of nutrients in compost. The environmental components of the valuation are presented in Table 5.3. Note the benefits listed in Table 5.3 relate to compost application benefits only (per tonne of compost) and not the overall waste management life cycle system costs and benefits as presented in Table 5.2 (per tonne of biowaste i.e. *before* it is compost).

Table 5.3 Derivation of Compost Application Benefits ($/tonne compost).

Environmental Category	Value $/t compost	Data source
Water Retention	$23.75	Water valuation adapted from Hassall and Associates, *Forward* By Francis Grey (1998); Submission to IPART (Bulk Water Pricing) on behalf of World Wide Fund for Nature (WWF) – Australia, Australian Conservation Foundation (ACF), Nature Conservation Council of NSW (NCC) and Pers Comms. Warwick Smith (WWF) March 2001. (Nolan-ITU, 2001) Water calculations updated based on grapevine intensive agricultural application (ROU, 2003) This value is consistent with applied average (Nolan-ITU, 2002) of $22.70/t compost.
Soil Structure Improvement	$1.69	Calculated from Land and Water Resources Research Development Council, Land and Water Audit, 1993. Assumes annual cost of soil structure decline at $200 Million (Nolan-ITU, 2001).
Acidification	$2.55	Calculated (Nolan-ITU, 2002). Assumes annual cost of soil acidity $300 Million.
Salinity	$2.06	Calculated (Nolan-ITU, 2002). Assumes annual cost of salinity $243 Million. Hill, R. J. 1997.
Avoided phosphate depletion	$28.78	Assumes fertiliser substitution of 20 kg/ t compost (Nolan-ITU, 2003).
Avoided Urea (N)	$7.82	Avoided urea production modelled (RMIT & Nolan-ITU, 2003)
Avoided KCl (K)	$0.07	Avoided potassium mining (RMIT & Nolan-ITU, 2003)
Nitrous Oxide Emissions	$1.21	Calculated (RMIT & Nolan-ITU, 2003)
Increased yield	$0.97	Potential increased generation for a number of crops has been modelled (RMIT & Nolan-ITU, 2003).
Avoided Pesticide	$1.82	Avoided pesticide (RMIT & Nolan-ITU, 2003). Proxy valuation suggests this benefit is much higher.
Carbon Soil Sequestration	$2.72	Carbon Sequestration assumes 10% of degradable, available organic matter in compost is sequestered over the life of the application (RMIT & Nolan-ITU, 2003)
Total	**$73.44**	

5.2.3 Externalities not considered

In this study considerable effort has been made to derive (where not available) and apply economic values for the various benefits of GO and biowaste-derived compost. However quantification and valuation of all benefits has not been possible. A good example of this is the medium and long term benefits of compost application on the (micro)organism communities within soils ('soil health'). Some environmental cost benefits of compost application that remain unvalued by this approach are listed in Table 5.4.

Table 5.4 Environmental Cost Benefits of Compost that remain External.

External Benefits
Pollutant retention and assimilation
Soil conditioning – porosity and aeration
'Soil health' and vitality
Micronutrient supply

5.2.4 Compost Application Data

A number of assumptions are discussed and documented together with references for further reading are provided in the previous report (DEC 2005). These include the following parameters:

- Water Loss Saving
- Environmental Economic Value of Water
- Soil structure, Acidification & Salinity
- Nitrous Oxide Emissions
- Carbon Sequestration through Compost Application

The fertiliser displacement assumptions are repeated below. These have been extended to account for different nutrient contents when food organics is co-collected with garden organics.

Fertiliser displacement

The fertiliser value of compost is mainly due to the release of nutrients as organic matter continues to decompose. Normally, high levels of nutrients become available in semi-mature compost. Composts that are considered mature generally have lower levels of fertiliser value as the mineral nutrients and humic substances become only gradually available over a number of seasons through the further decomposition of organic matter in the field.

The use of compost as a fertiliser is presented in Table 5.5. The main fertilising value of compost is for nitrogen (N), phosphorus (P) and potassium (K). Its value as an NPK fertiliser is dependant upon the quality of the materials used.

The N levels for garden organics derived compost are presented as being around 1-2 percent and 1.5-3.0 percent for food organics derived compost. N levels for garden organics (1.5%) have been assumed for this study. It can be expected that 40 percent of the N will be available over 5 years for a single application of compost. The value of the organic N is estimated as an equivalent fertiliser to Ammonium Nitrate which is worth $384/t and contains 33 percent N.

The P levels are estimated to be around 0.1-0.4 percent for garden organics derived compost and 0.2-0.6 percent for food organics derived compost. It can be expected that all of the P will become available over five years after a single application. The value of P is estimated as an equivalent fertiliser to Superphosphate which is worth $255/t and contains 9 percent P.

K levels in composts were estimated to be similar to P. The value of K is estimated as an equivalent fertiliser to Potassium Sulphate which is worth $650/t and contains 50 percent K.

Table 5.5 Fertiliser Value – Yearly benefit over five years of a single application of compost.

Additional benefits currently not reflected in market prices (as an approx. $/t value)	1 tonne of Garden Organics Derived Compost	1 tonne of Garden and Food Organics Derived Compost
Fertiliser replacement value equivalent to:		
- Ammonium Nitrate	$0.93 – $1.86 N	$1.40 – $2.79 N
- Superphosphate	$1.13 – $2.26 P	$1.7 – $3.40 P
- Pot. Sulphate	$0.52 – $1.04 K	$0.78 – $1.56 K

The figures presented are a typical guide (Source: Nolan-ITU internal)

Mineralisation rates, loss rates and other relevant aspects of the three key nutrients NPK are presented in the previous report. These have not been changed and are therefore not repeated here.

6 LCA Results – Eco$ Model

In this section, the results of the environmental economic valuation are presented and discussed. Assumptions on GO generation and recovery quantities are presented in Section 2.3.

The approach used for the study was based on the modelling of Life Cycle Inventory Data using the SimaPro LCA software package, followed by application of two different impact assessment methods in order to interpret this data. The main method used is the Eco Dollar Model developed for the National Packaging Covenant study into recycling, the *Independent Assessment of Kerbside Recycling in Australia* (Nolan-ITU & SKM, 2001).

6.1 Scenarios Assessed

The main options compared are as follows:

Scenario	Garbage Collection	Garbage Disposal	Organics Collection	Organics Processing
LF Weekly	weekly	landfill	no collection	n/a
GO + LF weekly	weekly	landfill	GO fortnightly	Open windrows
Biowaste + LF weekly	weekly	landfill	FO & GO weekly collection	Enclosed
Biowaste + LF fortnightly	fortnightly	landfill	FO & GO weekly collection	Enclosed
MBT Weekly	weekly	MBT	no collection	n/a
GO + MBT weekly	weekly	MBT	GO fortnightly	Open windrows
Biowaste + MBT weekly	weekly	MBT	FO & GO weekly collection	Enclosed
Biowaste + MBT fortnightly	fortnightly	MBT	FO & GO weekly collection	Enclosed

GO Source separated garden organics
FO Source separated garden organics
Biowaste Mixed source separated garden and food organics
LF Landfill
MBT Mechanical Biological Treatment

These eight options are all analysed for both a high and a low garden organics generation. The total number of scenarios assessed is hence 16.

6.2 Contribution of Impacts to Single Indicator

As described in the previous section, the environmental economic valuation derives a single indicator (in this case, an "Eco$" value) from a number of environmental impact categories. The single indicator ('Eco$') is provided to assist the wider economic considerations forming the basis for the development of the Triple Bottom Line Assessment which is the primary goal of this study. It can be a useful tool but should not be seen as the final expression of the LCA as it is not ISO 14042 compliant to aggregate the results in this way.

The relative contributions of the categories within the environmental-economic damage valuation model are comparable with the normalisation values calculated for EcoRecycle Victoria (RMIT and Nolan-ITU, 2003), although care must be taken in comparing these two different impact models.

Figure 6.1 and Figure 6.3 illustrate the contributions of the various impact categories for high and low GO generation for each of the scenarios. A comparison of the options showing aggregate figures is provided in the following section.

Figure 6.1 Eco-Cost/Benefit Breakdown of Different Options – High GO generation.

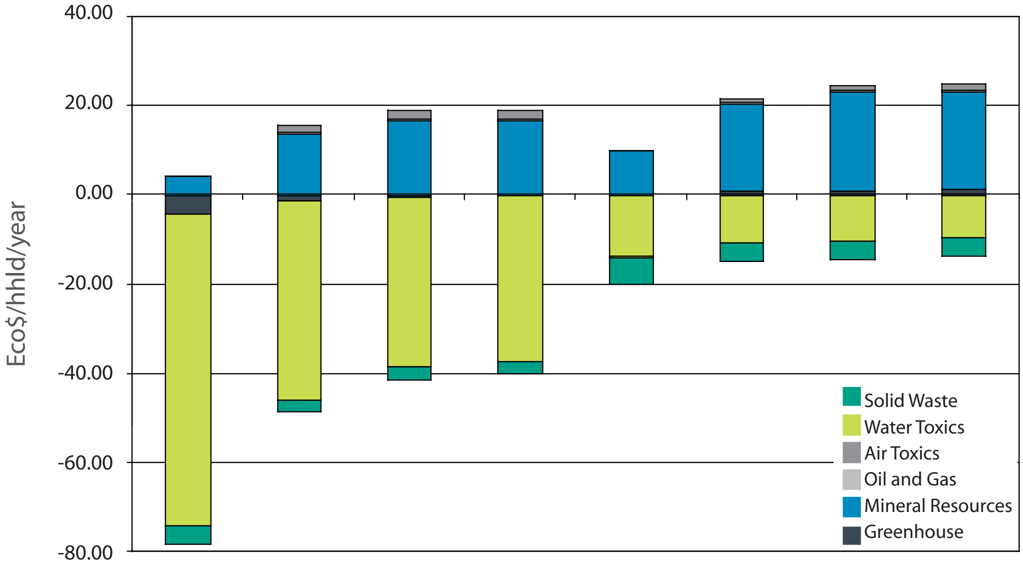
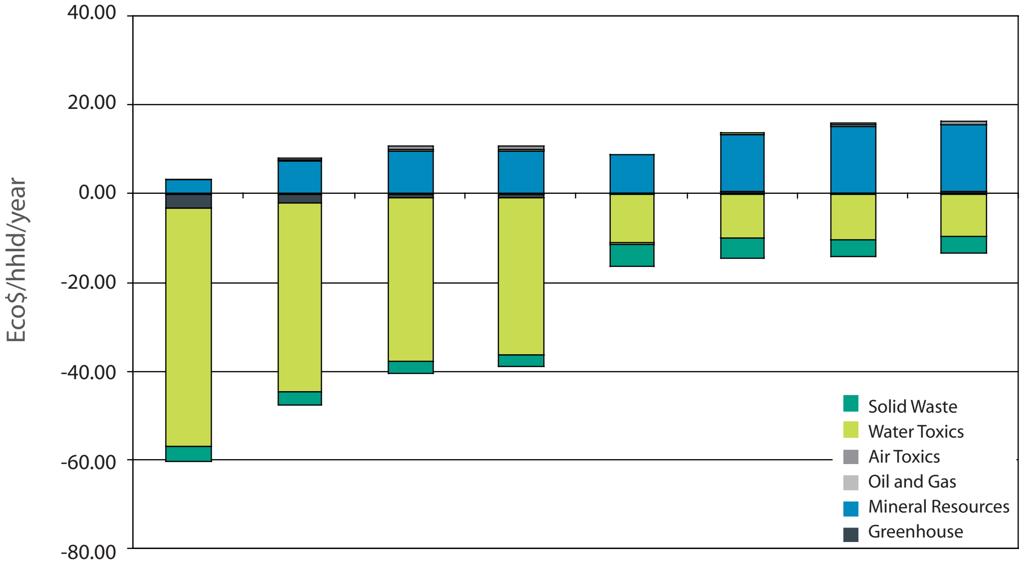


Figure 6.2 Eco-Cost/Benefit Breakdown of Different Options – Low GO generation.



Assumptions regarding garden organics generation and recovery rates are described in Section 2.3.3.

Figure 6.3 illustrates the results for the scenarios with high and low GO generation. In this figure, the base case (where garbage is sent to landfill and no organics collected separately) has been set at zero. This provides for easier comparison and is consistent with the two previous studies.

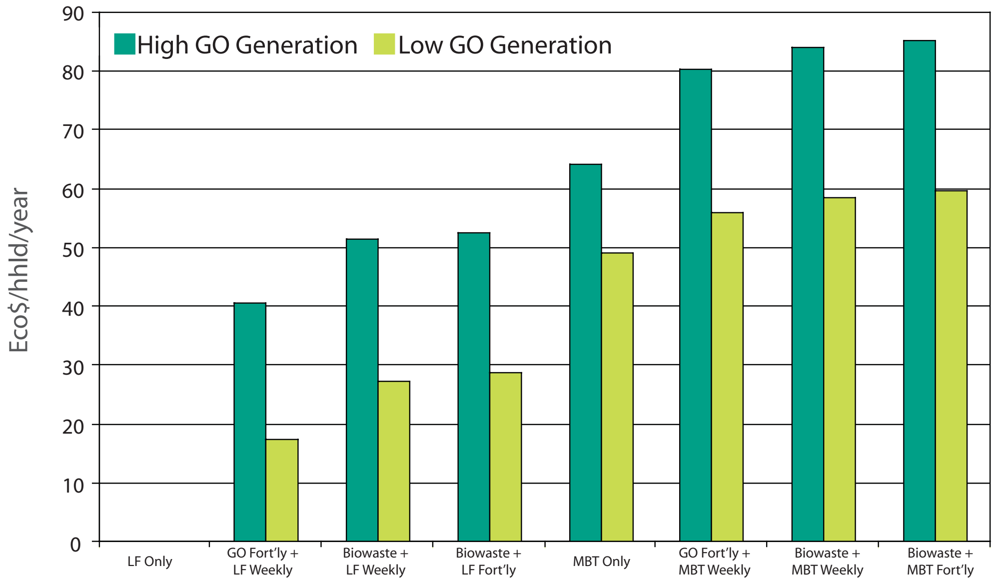
For the high garden organics scenarios, the benefits amount to between Eco$41/hhld/yr for a fortnightly containerised GO collection for the garbage to landfill scenario to Eco$85/hhld/yr for a scenario with weekly biowaste collection combined with MBT treatment of garbage with a fortnightly collection. The corresponding benefits for the low GO generation yield scenarios are Eco$18 and Eco$60/hhld/yr (all figures rounded).

It can be seen that the inclusion of GO, or biowaste, collection and composting combined with landfilling of garbage is a lower performing option than the use of MBT without organics collection. However, regardless of the fate of the garbage (residual waste), it is always environmentally superior to have a separate collection of garden organics. The main reason for this is that the treatment of all organics, garden and food organics, in MBT processing facilities provides high benefits through reduced emissions from landfilling the stabilised materials, with recovery of some dry recyclable materials providing additional benefits.

Table 6.1 Scenario Comparison for high and low GO generation (Eco$/hhld/yr).

	High GO Generation	Low GO Generation
LF Only	0	0
GO Fortnightly + LF Weekly	40.66	17.58
Biowaste + LF Weekly	51.43	27.35
Biowaste + LF Fortnightly	52.78	28.70
MBT Weekly	64.17	49.24
GO Fortnightly + MBT Weekly	80.60	55.98
Biowaste + MBT Weekly	84.29	58.67
Biowaste + MBT Fortnightly	85.28	59.66

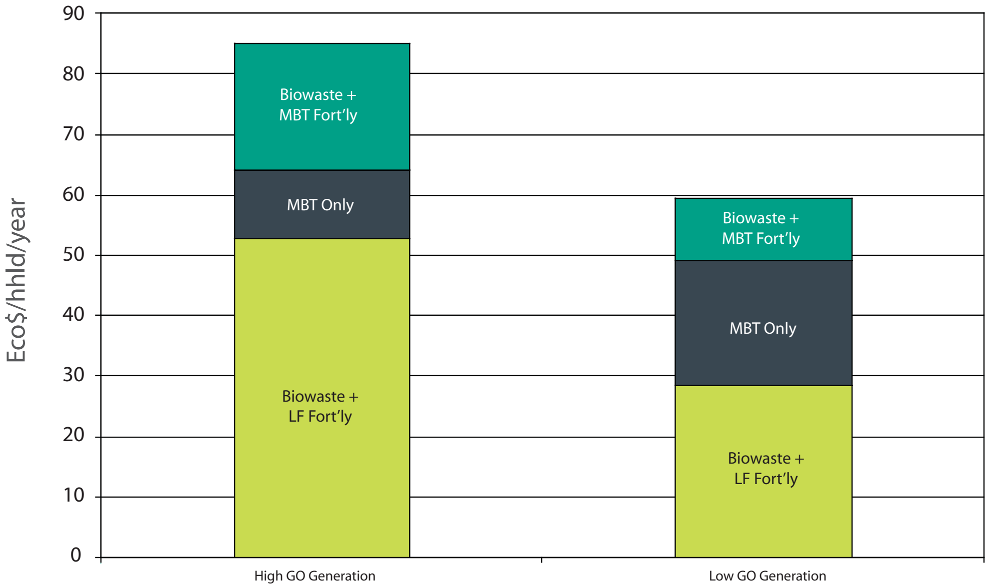
Figure 6.3 Scenario Comparison for high and low GO generation.



To further summarise and simplify the results, the contribution of the two key activities (MBT and organics separation) to the overall environmental performance is shown in Figure 6.4. The key outcomes are as follows:

- Separation of biowaste provides a significant improvement in environmental performance.
- The provision of MBT (without biowaste separation) achieves an even higher environmental performance (22% better).
- A combination of both services (MBT and separate biowaste management) provides the best outcome (64% improvement).

Figure 6.4 Scenario for selected scenarios to facilitate interpretation.

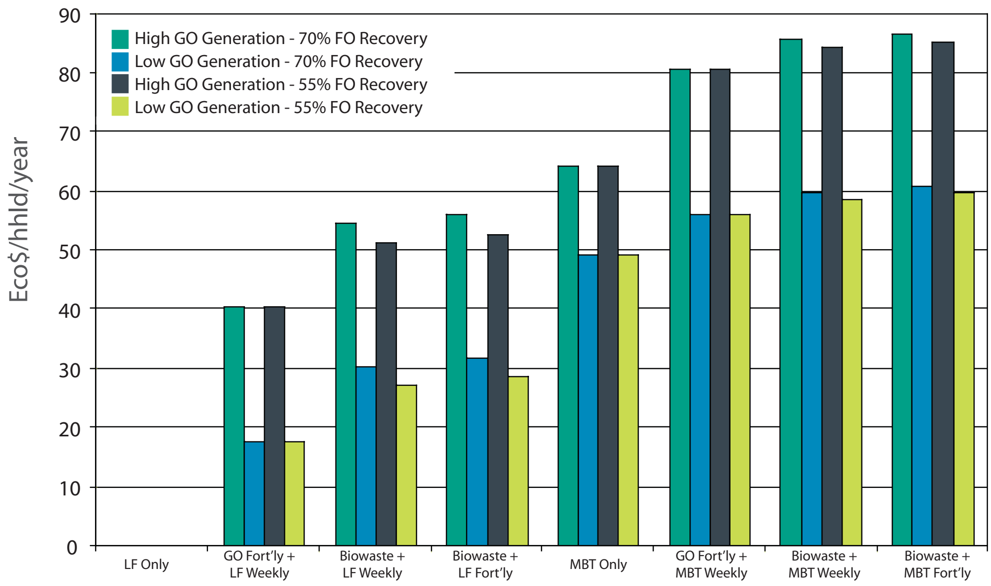


6.3 Sensitivity Analysis – Scenario 4

Although unlikely to be achievable in the foreseeable future, the scenarios in Section 6.1 have also been modelled assuming a 70 percent recovery rate for food organics instead of 55 percent. The garden organics recovery rate is kept at 90 percent. The change therefore only affects the four biowaste scenarios.

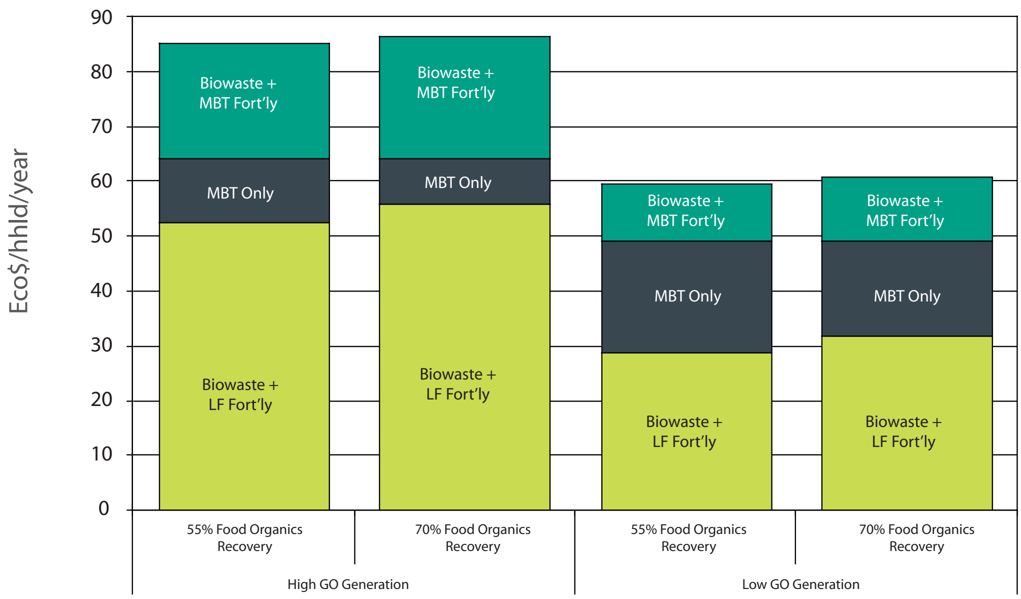
Figure 6.5 presents the net environmental benefits for all scenarios for the higher recovery rate, with the base case shown for comparison reasons. For the four biowaste scenarios, the environmental benefit increases between $1.20 and $3.40/hhld/yr.

Figure 6.5 Scenario Comparison for high and low GO generation – Base Case vs. Sensitivity Scenario 4.



To highlight the main differences, key scenarios are presented in Figure 6.6 showing slightly higher benefits achieved through higher (theoretical) food organics recovery.

Figure 6.6 Scenario for selected scenarios to facilitate interpretation – Base Case vs. Sensitivity Scenario 4.



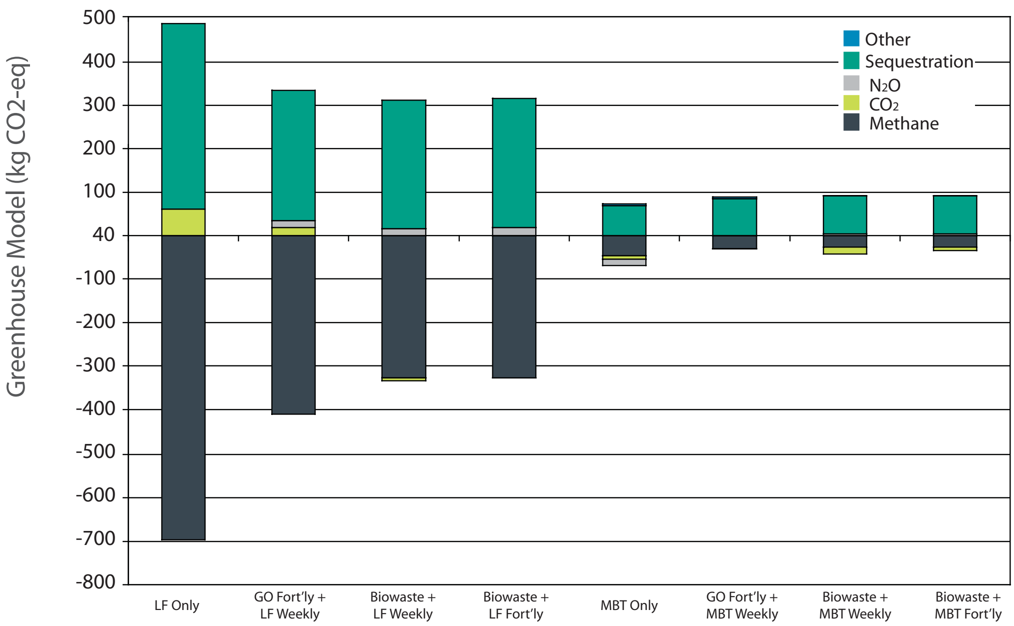
7 LCA Results – Environmental Models

The LCA results can also be interpreted using other methods or models and looking at other impact categories. This has been done here to indicate the convergence of Nolan-ITU's environmental economic valuation ('Ecodollar model') with other impact models. The two categories assessed here are Global Warming Potential and Human Toxicity. To estimate the global warming potential, a more sophisticated *Greenhouse Model* (developed by RMIT) was used. Human toxicity impacts/benefits were assessed using the *Eco Indicator 99* method which is widely used in Europe.

7.1 Greenhouse Gases

Global warming savings are presented for each scenario in Figure 7.1 and Figure 7.2 The three main greenhouse gases are CO_2, N_2O and methane. An additional greenhouse factor shown is carbon sequestration that occurs when carbon embodied in organic material such as timber, paper or food is placed in landfill and a portion of this material is assumed not to degrade. Carbon is also sequestered when organic material is used as compost as some of it becomes part of the soil humus. Results are expressed as CO_2 equivalents.

Figure 7.1 Greenhouse gas emissions/savings by substance (kg CO2eq/hhld/yr) – High GO generation.



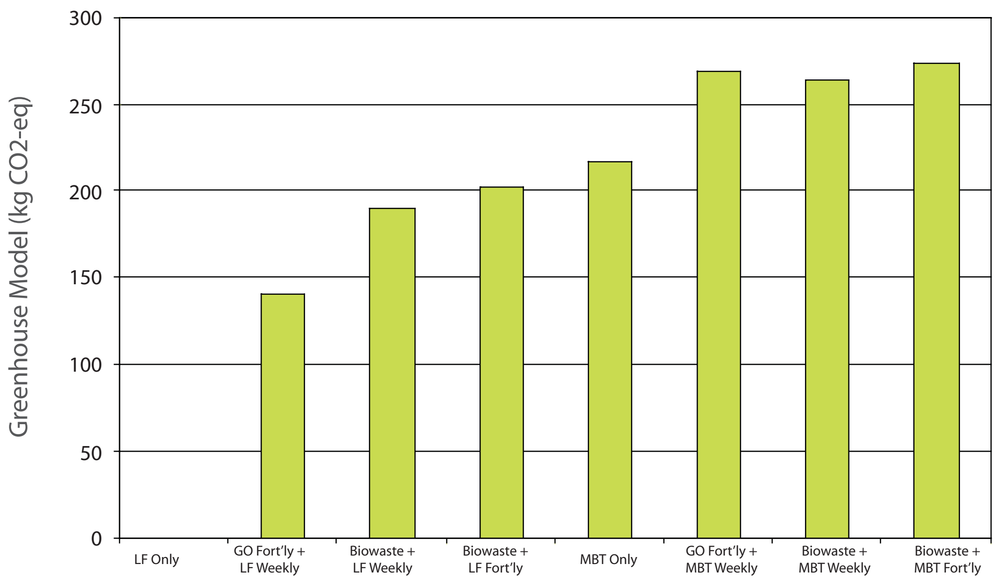
As seen in Figure 7.1 the main impact for all scenarios is associated with methane emissions while the benefit is generated through sequestration. The graph further indicates that there is a net greenhouse gas *emission* (i.e., a negative saving) occurring for all scenarios where garbage is sent to landfill untreated (methane emissions are greater than the greenhouse savings through electricity generation from the captured landfill gas). Although there are substantial greenhouse savings from organics recycling for scenarios where this occurs, these do not entirely offset the uncaptured landfill gas emissions. All MBT scenarios show net greenhouse savings which is due to the significant reduction of methane emissions through waste treatment, plus some savings through carbon sequestration from application of compost.

It should be acknowledged that:

- Consistent with international best practice methods (IPCC, 2001), non fossil CO_2 emissions are not accounted for in the greenhouse assessment method.
- Any change in current waste management practice would deliver greenhouse benefits arising, not only from the credits associated with recycling and alternative technologies (as illustrated by the figures above), but through the additional substantial benefits arising from avoided landfill.

When using the landfill only option as a benchmark, all alternative scenarios however show a significant benefit, Figure 7.2.

Figure 7.2 Total net greenhouse savings (kg CO2eq/hhld/yr) – High GO generation.



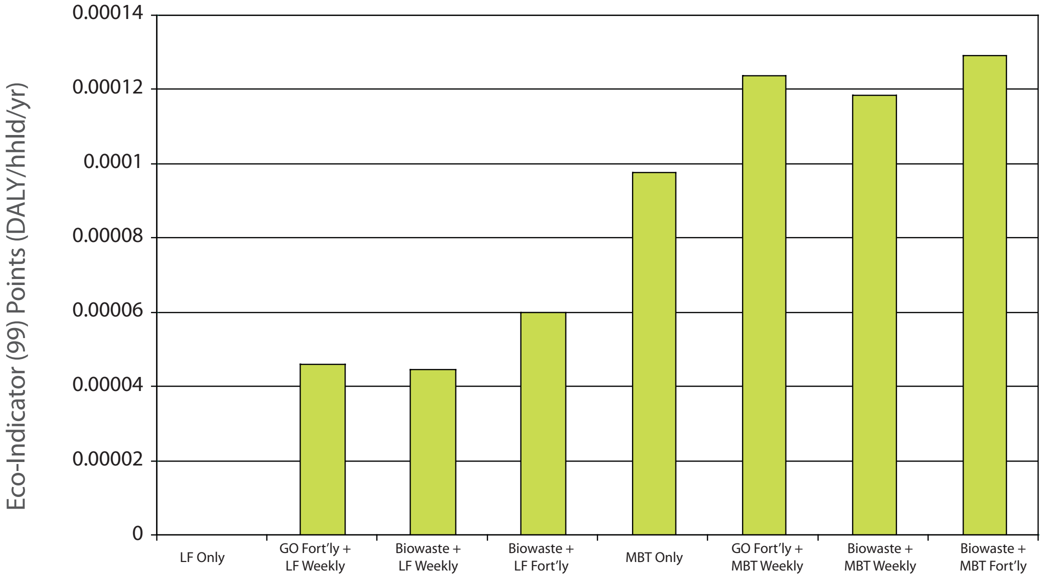
7.2 Human Toxicity

The human toxicity savings through the various scenarios are presented in Figure 7.3. In the Eco-indicator 99 method normalisation and weighting are performed at damage category level (endpoint level in ISO terminology). The unit for Human Health is DALY, Disability Adjusted Life Years. In (very) short, it expresses different disabilities caused by pollutants which are weighted and aggregated. Main contributing factors are carcinogens, respiratory organics, and respiratory inorganics. Air emission toxic substances to this environmental indicator include Se, PAHs, fluorides including HF, ethylene oxide, dioxin, Cr (VI) and As.

The method is based on European fate analysis and should only be used as a relative indicator of the human toxicity impacts of scenarios rather than as an absolute measure.

As Figure 7.3 shows there is a clear parallel between the Ecodollar results, the greenhouse results and the human toxicity results: Separation of organics yields significant benefits, MBT services achieve even higher benefits, and a combination of both provides optimal results in terms of environmental performance. The impact of collection frequency (i.e. traffic impacts) is somewhat higher in this impact category than for other methods (note difference between weekly and fortnightly garbage collection).

Figure 7.3 Human Toxicity Savings (DALY – EcoIndicator 99).



8 LCA Interpretation and Expanded Valuation

8.1 Interpretation

The international standards for life cycle assessment require that the final results of an LCA be interpreted so that any potential bias in the findings can be identified and recorded alongside the final results. For this study, an attempt has been made to identify any potential cause of bias in the results. Such bias is likely to arise from data gaps, differences in data quality or from limitations in the method due to the scope of the study. In order to understand the impact of any bias on the findings, a qualitative valuation has been made of the probable cost benefit that might be expected if the main causes of bias were removed.

Specifically, the potential for bias in this study includes:

- Gaps and inconsistent quality in inventory data;
- Limitations in the impact assessment method;
- Absence of social valuation weights; and
- Uncosted compost benefits.

8.1.1 Source of Bias in Results

Gaps and Inconsistent Quality in Inventory Data

Typically it was found that the data quality for well-established processes, such as electricity generation and transport, is higher than for processes that have been less studied, such as waste treatment. This has resulted, for example, in high benefits for electricity generation credits, while, in contrast, the impacts of the waste process (landfill) that generates them are not fully accounted for. Significant and known data gaps include:

- Landfill emissions of contaminants including dioxins and furans from flaring and diffuse emission, and emissions of trace organic contaminants.

Limitations in the Impact Assessment Method

The *Enviro-economic valuation method* used for this study was developed specifically and solely for the purpose of assessing the cost benefits of kerbside recycling (Nolan-ITU, 2001). This valuation method does not comprehensively cover all pollutants within the inventory data of this study and hence many of the cost benefits are not incorporated in the final assessment.

Social Weights

Triple bottom line analysis continues to advance in the way in which social preferences are incorporated into the final assessment. However, social preference variations that occur at intermediate steps in the assessment are difficult to incorporate. For example, the allocation of a social weight on local versus remote air pollutant release would be expected to change the final results through an increase in the *impact of process emissions from waste management* while reducing the *benefits associated with electricity offsets from coal fired power generation* (particularly in NSW where these emissions occur in less densely populated regions). It is noted that such geographical variations are generally not considered in life cycle impact assessment as the assessment models impacts *potentials* and not actual damage caused.

Compost Benefits Uncosted

In addition to limitations in the economic valuation method, impact assessment results are thought to inadequately capture the benefits of compost application to soil. While an effort is made to apply existing economic environmental values to assess the cost benefit of composted organics, the benefits are difficult to quantify and no data could be found on the potential economic value of some categories including:

- Pollutant retention and assimilation capacity by compost enhanced soils;
- Soil conditioning properties – porosity and aeration; and
- Micronutrient supply.

8.2 Expanded Valuation – Proxy Values

This section briefly presents estimated proxy values that consider some of the impacts where scientific data is not sufficiently reliable (or has not been analysed by the project team in sufficient detail) to be included in the base environmental assessment. Assumptions and method are discussed in the previous report (DEC, 2005). More work in this direction was undertaken in a study prepared for Global Renewables (Nolan-ITU, 2004a).

8.2.1 Landfill

The inclusion of proxy values changes the results and has consequences for the management of GO and biowaste. Importantly, the external (environmental) cost of landfill increases from about $74 per tonne to $239 per tonne. As landfill is avoided when organics are processed, this results in a greater credit for composting of GO and biowaste. The difference between the original and the expanded valuation using proxy values is shown in Figure 8.1.

Figure 8.1 Landfill Valuation (Eco $ per tonne) – Standard Eco Valuation versus Expanded Valuation.

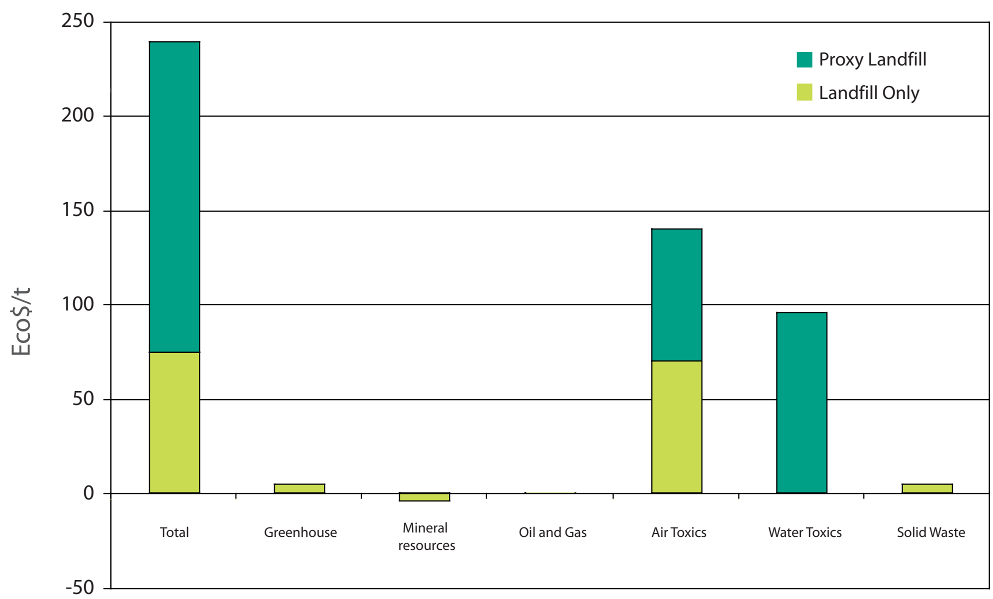
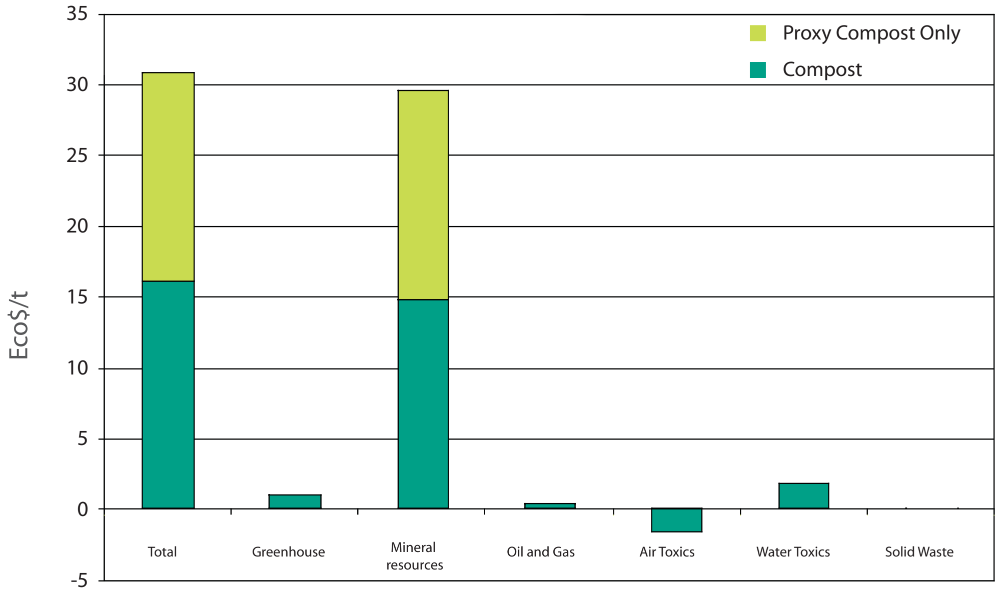


Figure 8 1.

8.2.2 Compost

In order to improve on the value which results from modelling using existing data and methods for this study a proxy value is applied to estimate avoided pesticide and disease suppression benefits. The modelled valuation of compost changes under the proxy valuation from less than $1 in the 'base case' valuation (when only known production impacts of pesticides is modelled) to $22.82 per tonne of compost in the expanded valuation.

Figure 8.2 Compost Valuation (Eco $ per tonne) – Standard Eco Valuation versus Expanded Valuation.

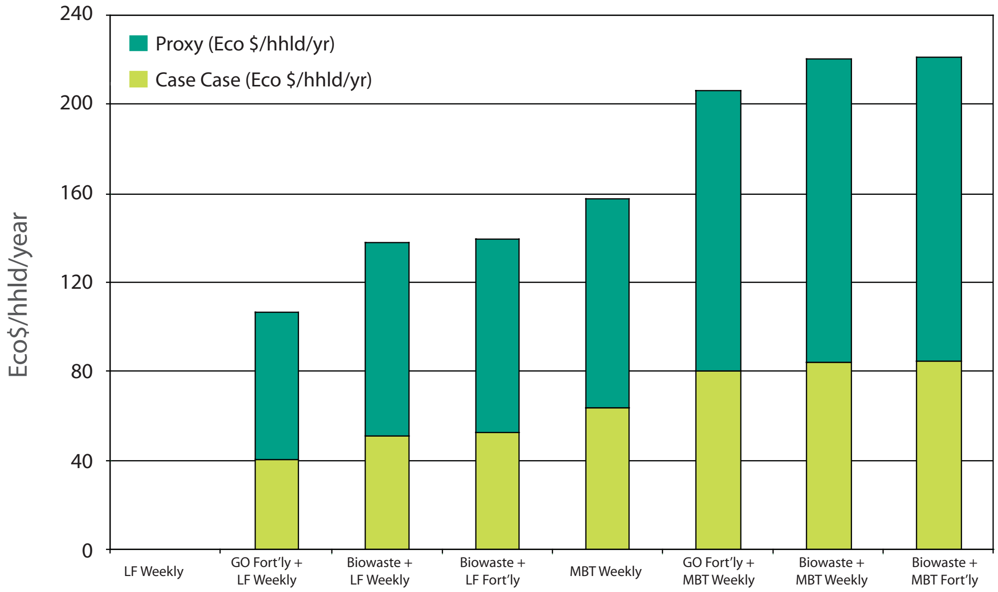


8.2.3 Scenario Comparison

Table 8.1 and Figure 8.3 show the scenario comparison when using proxy values (The original graph is Figure 6.3). As evident from the table and the graph, the benefits increase by 163 percent on average.

Valuation / Scenario	Standard	Proxy	Σ
LF Weekly	0	0	0
GO Fort'ly + LF Weekly	41	66	107
Biowaste + LF Weekly	51	87	138
Biowaste + LF Fort'ly	53	87	140
MBT Weekly	64	94	158
GO Fort'ly + MBT Weekly	81	126	207
Biowaste + MBT Weekly	84	136	221
Biowaste + MBT Fort'ly	85	136	222

Figure 8.3 Scenario comparison showing standard Eco$ valuation and added proxy valuation.



9 Cost-Benefit Analysis

This section presents the outcomes of a cost-benefit analysis of scenarios from the perspective of financial and environmental costs (expressed in dollar terms). Social costs have not been determined in dollar terms and hence have not been included here as there is insufficient literature and research conducted in Australia that would allow a robust monetary valuation of social factors.

Results are discussed based on the cost benefit analysis for the GO and biowaste separation scenarios assuming residual waste (garbage) is sent to landfill or to a MBT facility. It therefore looks at the different collection systems for the two different situations of either high or low garden organics generation. All results are compared to the base case system with no separate GO or biowaste collection and waste being landfilled.

9.1 Results

The results of the base case cost benefit analysis are presented in Section 9.1.1 and 9.1.2 below for the metropolitan and regional areas, followed by results from financial sensitivity analyses and the alternative food organics separation rate in Section 9.1.3.

9.1.1 Base Case

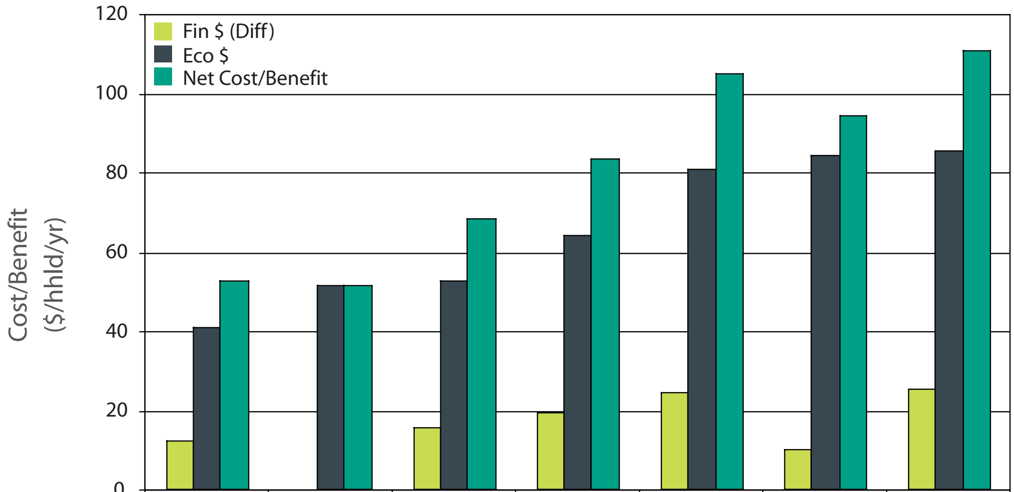
High Garden Organics Generation

Figure 9.1 illustrates costs, benefits and overall results of the different options. Costs are shown as negative numbers, benefits as positive numbers. Financial costs/benefits are represented by the purple bars, environmental costs/benefits by the green bars, and the overall cost benefit by the blue bars.

For councils with high GO generation, all options are less expensive than the 'Landfill Only' option (for details and discussion refer to Section 4.2.1). When combined with the environmental benefits – expressed in dollar terms[9] – all scenarios featuring MBT achieve higher overall benefits, than scenarios with landfill (of untreated waste). Source separation of organics always achieves better result than not separating these materials.

The higher environmental benefits of inclusion of food organics in a separate organics collection are 'equalized' by higher collection and processing costs unless garbage collection frequency is reduced to fortnightly.

Figure 9.1 Cost benefit results for high GO generation ($/hhld/yr) – Base Case.



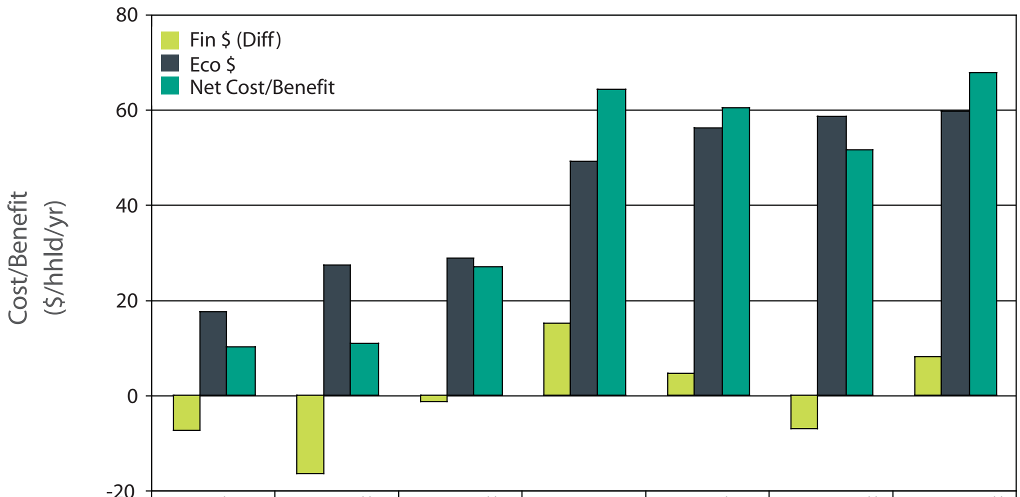
	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	12	0	15	19	24	10	25
Eco $	41	51	53	64	81	84	85
Net Cost/Benefit	53	51	68	84	105	94	111

[9] Dollar values do not represent actual financial transaction costs, and are given as an indication of environmental performance only

Low Garden Organics Generation

Figure 9.2 shows the results for councils with a low GO generation. The net financial costs of GO and biowaste collection and composting systems are higher due to the relatively low avoided garbage collection and disposal costs. The environmental benefits are also substantially reduced due to the relatively low yields. The results are relatively similar to those from the "high generation" scenarios presented above however, the overall cost benefits of the options with GO or biowaste collection are much lower. In other words this analysis suggests that, in councils with low quantities of garden organics generated, public funds may be more efficiently spent on residual waste treatment than on a separate GO/biowaste collection scheme.

Figure 9.2 Cost benefit results for low GO generation ($/hhld/yr) – Base Case.



	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	-7	-17	-2	15	4	-7	8
Eco $	18	27	29	49	56	59	60
Net Cost/Benefit	10	11	27	64	60	52	68

9.1.2 Regional

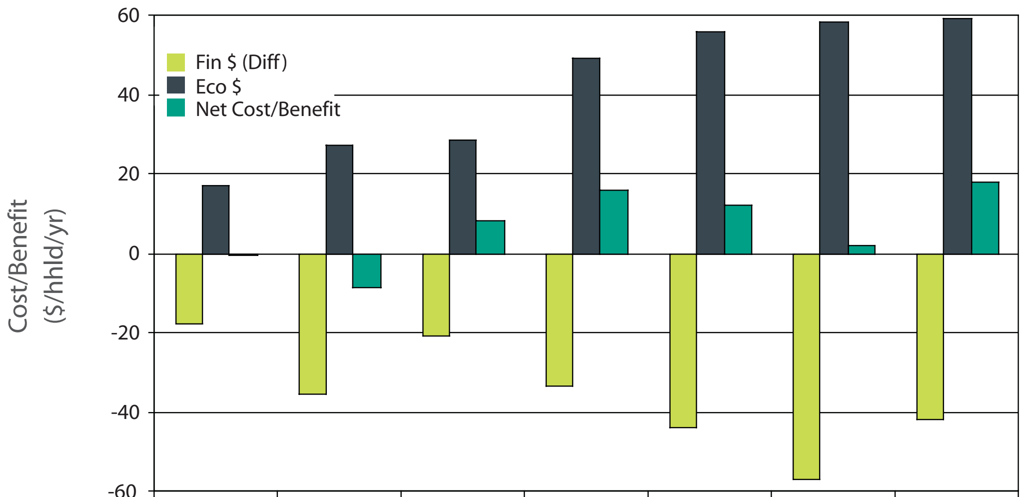
Figure 9.3 and Figure 9.4 show cost-benefits for regional areas with high respectively low GO generation. The net benefits are considerably lower compared to metropolitan areas as a result of the low assumed landfill gate fees.

A summary interpretation of these results would be as follows: In regional areas, enhanced environmental performance of waste management will have to be 'bought' as long as landfill prices are comparatively low. It appears that, for the foreseeable future, regional councils will have to weigh up whether available funds are best spent on enhancing waste management systems, or on alternative environmental programs.

Figure 9.3 Cost benefit results for high GO generation ($/hhld/yr) – Regional.

	GO Fort'ly + LF Weekly	Biowaste + LF Weekly	Biowaste + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste + MBT Weekly	Biowaste + MBT Fort'ly
Fin $ (Diff)	-11	-33	-17	-43	-39	-55	-39
Eco $	41	51	53	64	81	84	85
Net Cost/Benefit	29.18	18.72	35.40	21.31	42.06	29.50	45.81

Figure 9.4 Cost benefit results for low GO generation ($/hhld/yr) – Regional.



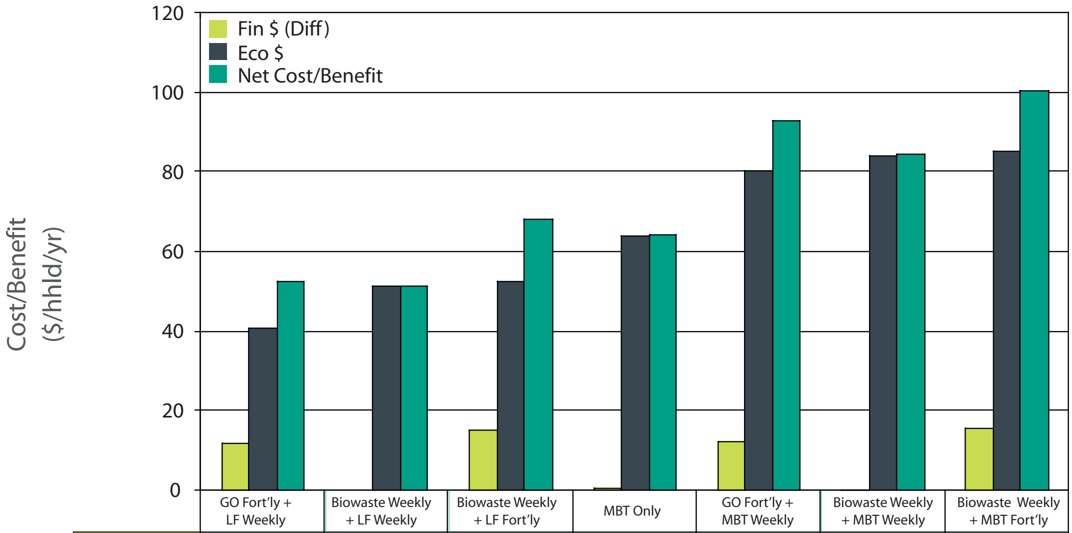
	GO Fort'ly + LF Weekly	Biowaste + LF Weekly	Biowaste + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste + MBT Weekly	Biowaste + MBT Fort'ly
Fin $ (Diff)	-18	-35	-20	-33	-44	-57	-41
Eco $	18	27	29	49	56	59	60
Net Cost/Benefit	-0.12	-8.06	8.40	16.26	12.21	2.15	18.25

9.1.3 Sensitivity Analysis

Sensitivity Scenario 1 – MBT more expensive

For councils with **high GO generation**, higher MBT gate fees result in a slightly lower net benefit for these four scenarios. However, as evident from Figure 9.5, the total net benefits for options with MBT are still higher than for all landfill options. The net benefits are between $9.80 and $19 lower than the base case with the biggest difference being for the MBT Weekly scenario.

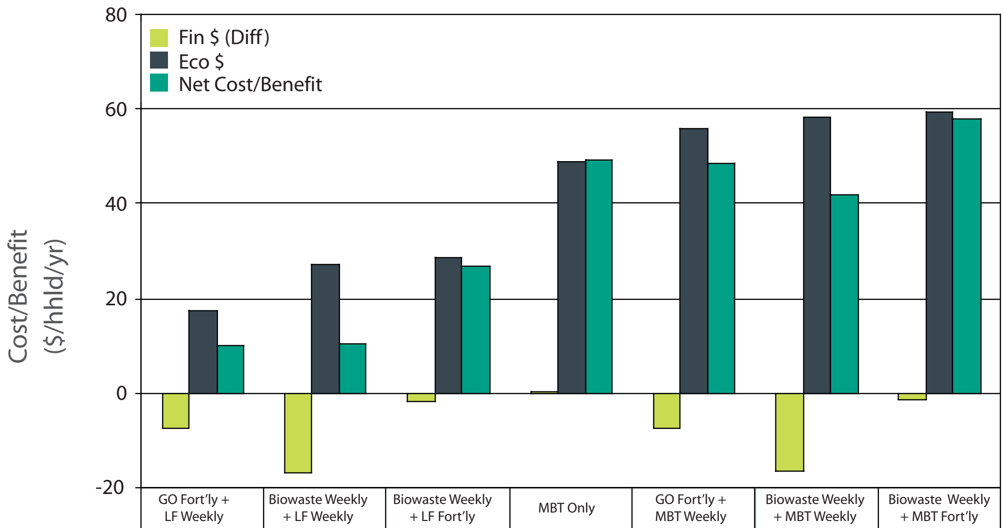
Figure 9.5 Cost benefit results for high GO generation ($/hhld/yr) – Sensitivity Scenario 1.



	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	12	0	15	0	12	0	16
Eco $	41	51	53	64	81	84	85
Net Cost/Benefit	53	51	68	64	93	84	101

For councils with low GO generation, the ranking does not change as shown in Figure 9.6.

Figure 9.6 Cost benefit results for low GO generation ($/hhld/yr) – Sensitivity Scenario 1.

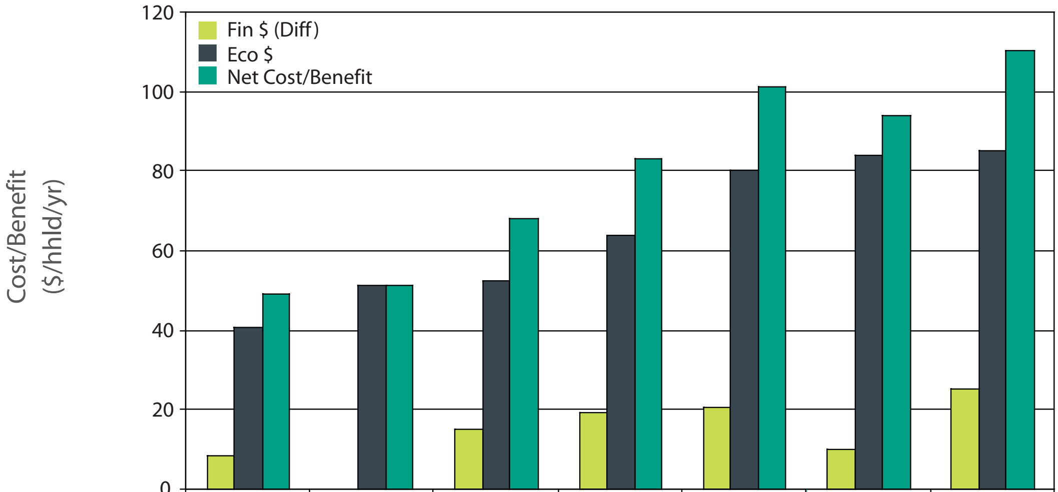


	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	-7	-17	-2	0	-7	-17	-1
Eco $	18	27	29	49	56	59	60
Net Cost/Benefit	10	11	27	49	49	42	58

Sensitivity Scenario 2

As expected with the higher GO composting cost scenario the monetary cost increases for the two GO scenarios resulting in $3.50 lower net benefits, There are no major changes to the overall picture when comparing to the base case, as illustrated in Figure 9.7[10].

Figure 9.7 Cost benefit results for high GO generation ($/hhld/yr) – Sensitivity Scenario 2.

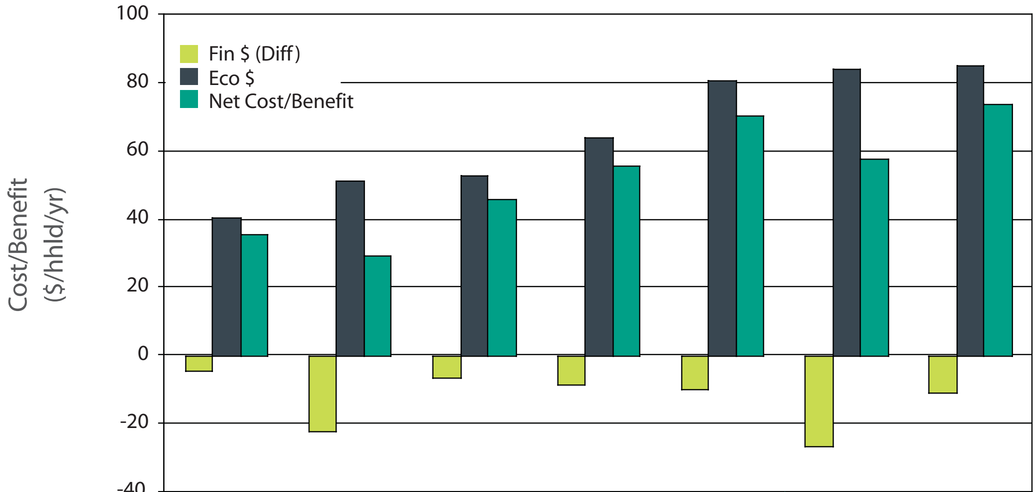


	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	8	0	15	19	21	10	25
Eco $	41	51	53	64	81	84	85
Net Cost/Benefit	49	51	68	84	101	94	111

Sensitivity Scenario 3 – Gate fees as per previous study

For councils with **high GO generation**, the cost benefit analysis based on disposal/processing fees as per the previous study shows, that even without the higher levy the MBT options result in higher net benefits compared to landfill (Figure 9.8). The ranking is remains the same but the differences are smaller.

Figure 9.8 Cost benefit results for high GO generation ($/hhld/yr) – Sensitivity Scenario 3.



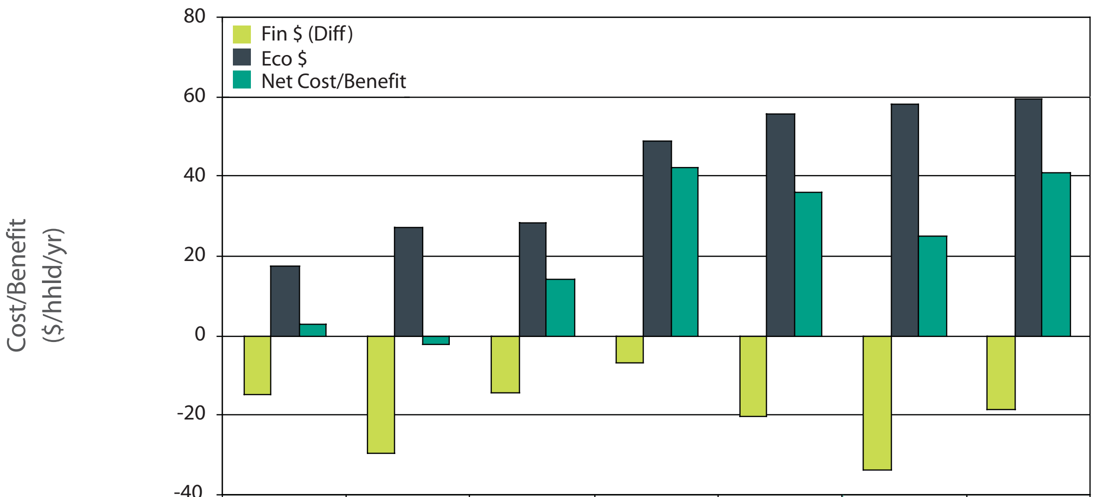
	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	-5	-22	-7	-9	-10	-27	-11
Eco $	41	51	53	64	81	84	85
Net Cost/Benefit	36	29	46	56	70	58	74

[10] Results for councils with low GO generation are not shown. The differences are negligible.

Low Garden Organics Generation

With low GO generation the cost benefit analysis shows slightly different results to the high GO generating councils (Figure 9.9). Nevertheless, the results are comparable to the respective base case, only with lower overall net benefit.

Figure 9.9 Cost benefit results for low GO generation ($/hhld/yr) – Sensitivity Scenario 3.

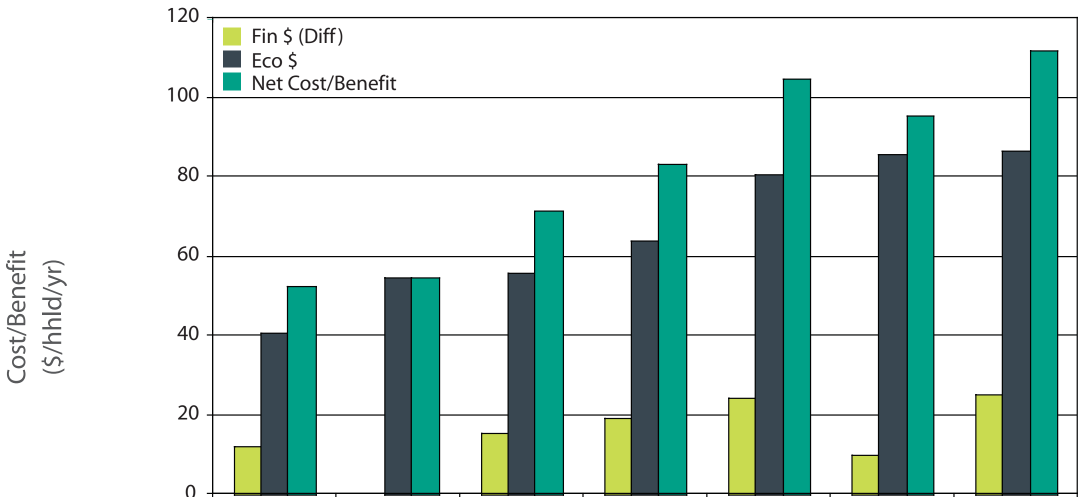


	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	-15	-29	-14	-7	-20	-34	-18
Eco $	18	27	29	49	56	59	60
Net Cost/Benefit	3	-2	14	43	36	25	41

Sensitivity Scenario 4 – higher food organics recovery

An increased food organics recovery rate (70% instead of 55%) results in increased benefits for the biowaste scenarios in the order of $1.20 to $3.40, as already discussed in the financial assessment. No other changes occur.

Figure 9.10 Cost benefit results for high GO generation ($/hhld/yr) – Sensitivity Scenario 4.



	GO Fort'ly + LF Weekly	Biowaste Weekly + LF Weekly	Biowaste Weekly + LF Fort'ly	MBT Only	GO Fort'ly + MBT Weekly	Biowaste Weekly + MBT Weekly	Biowaste Weekly + MBT Fort'ly
Fin $ (Diff)	12	0	15	19	24	10	25
Eco $	41	55	56	64	81	86	87
Net Cost/Benefit	53	55	71	84	105	96	112

10 Social Assessment

10.1 Social Impacts Identification

The approach taken to identifying the potential social impacts of extending kerbside collection services to include food organics was based on that used in previous studies, *Assessment of Domestic Waste and Recycling Systems* (DEC, 2004) and *Assessment of Garden Organics Collection Systems* (DEC, 2005). The impact categories were, therefore, drawn from the previously utilised Guidelines and Practices for Social Impact Assessment developed by US Government agencies.

As with both the former studies, the project team applied a "limited boundaries" approach to social impacts, concentrating on those most directly associated with the introduction of food organics collection, rather than wider macro-economic aspects. The overall list of social impact categories initially considered is below.

Individual and Family Impacts, e.g., degree of potential ***public perception*** of risk to health, safety and/or amenity from a waste system; concerns about displacement/relocation potential of waste system; potential to affect public trust in political and social institutions.
Residential Amenity, e.g., degree of ***physically measurable*** noise, odour, and dust from system and related traffic movements.
Householder Convenience, e.g., potential for system to be convenient and accessible to householders including bin types and collection frequencies
Employment, e.g., job creation
Occupational Health and Safety
Labour Relations
Community Relations, e.g., capacity of proponent to positively engage with community and compliment broader environmental education strategies

It is noted that not all of the impacts presented can be applied in a generic assessment of systems. For example, impacts/benefits arising in terms of employment, natural and cultural heritage, labour relations, and community relations are largely specific to individual circumstances, such as geographical locations. However, it was deemed important to describe all potential impacts for the future reference of waste management decision-makers in "real life" situations.

10.2 Impact Assessment Framework

As for the former studies, performance indicators have been applied for each impact category. Wherever possible, the performance indicators used a factual basis rather than a value judgement. The system of evaluation/assessment is outlined below.

Also, it should be highlighted that many social impacts associated with waste management are location-specific and dependent on a wide range of factors, including a local community's sensitisation to environmental issues, past historical experiences, nature of community institutions and socio-demographic profile. Some aspects are also linked to the reputation and/or performance of specific proponents. Moreover, public perception is not static and can vary at different stages of the development process.

Individual and Family Impacts

<u>Category explanation:</u> Degree of potential ***public perception of risk*** to health, safety and/or amenity from a waste system; concerns about displacement/relocation potential of waste system; potential to affect public trust in political and social institutions.

Table 10.1 Social Impact Assessment Criterion: Individual and Family Impacts.

Description	Score
No evidence of community perception of risk to health, safety and/or amenity; negligible consequences.	5
Some evidence of community perception of risk to health, safety and/or amenity, including sporadic representations from groups and individuals; low consequences.	4
Moderate evidence of community perception of risk to health, safety and/or amenity, including regular representations from groups and individuals; moderate consequences.	3
Significant evidence of community perception of risk to health, safety, and/or amenity, including regular representations from groups and/or individuals and development of local activism/opposition; high consequences.	2
Highly significant evidence of community perception of risk to health safety and amenity, including numerous representations from groups and individuals, media reports, local activism, and community-initiated meetings; extensive consequences.	1

Residential Amenity

Category explanation: Degree of ***physically measurable*** residential amenity impacts from system including noise, odour, dust, visual/aesthetic aspects, and traffic-related impacts. For this case, it is plainly the number of trucks passing through a street per week.

Table 10.2 Social Impact Assessment Criterion: Residential Amenity

Description	Score
No or limited discernible impact; negligible consequences.	5
Low number of total impacts; impacts can be mitigated and/or managed; low consequences.	4
Medium number of total impacts; impacts can be mitigated and/or managed; moderate consequences.	3
Medium number of total impacts; impacts difficult to mitigate and/or manage; high consequences.	2
High number of total impacts; impacts difficult to mitigate and/or manage; extensive consequences.	1

Householder Convenience

Category explanation: Potential for system to be ***convenient and accessible to householders*** including bin types and collection frequencies.

Table 10.3 Social Impact Assessment Criterion: Householder Convenience.

Description	Score
Weekly service; all bins highly mobile and easily handled by vast majority of community members	5
Fortnightly service; all bins highly mobile and easily handled by vast majority of community members	4
Weekly service; some bins highly mobile and easily handled by vast majority of community members	3
Fortnightly or less frequent service; some bins highly mobile and easily handled by vast majority of community members	2
Weekly, fortnightly or other service schedule; no mobile or easily handled bins (e.g., non-wheelie bin for garbage, crates or no receptacle for garden organics/recyclables)	1

Occupational Health and Safety

Category explanation: System track record/reputation in ***OH&S*** and degree to which OH&S issues have been historically addressed in system design and operating procedures; compliance with legislative provisions.

Table 10.4 Social Impact Assessment Criterion: Occupational Health and Safety.

Description	Score
System has exemplary track record in OH&S, including external recognition/accreditation of design and/or management elements.	5
System has evidence of exceeding compliance with applicable OH&S provisions in terms of either design and/or management elements.	4
System has evidence of compliance with all applicable OH&S provisions.	3
System has questionable track record on OH&S issues.	2
System has negative track-record in OH&S, including numerous claims.	1

10.3 Social Impact Assessment Results

This social impact assessment considers two aspects of a food organics collection service:

- A comparison with maintaining the status quo, i.e., having no food organics collection; and
- The impact of reducing the collection frequency of the residual garbage stream.

Table 10.5 Social Assessment Scores.

Criterion		GO Fort'ly	Biowaste Weekly	Biowaste Weekly		GO Fort'ly	Biowaste Weekly	Biowaste Weekly
	LF Weekly	LF Weekly	LF Weekly	LF Fort'ly	MBT Weekly	MBT Weekly	MBT Weekly	MBT Fort'ly
Individual and Family Impacts	4	5	5	3	4	5	5	3
Residential Amenity	5	4	4	3	5	4	4	3
Householder Convenience	4	3.5	3	3	4	3.5	3	3
OHS	4.5	4	3.5	4	4.5	4	3.5	4

A comparison between disposing of garbage to landfill versus utilising AWT has previously been carried out and was not repeated in this study (DEC, 2004a).

10.3.1 Individual and Family Impacts

Initial public concerns about food organics collection might be characterised by perceptions about the possibility of increased odour and increased potential for attracting vermin and rodents. These concerns have been common where such systems have been introduced overseas. A pro-active approach to addressing such concerns by ensuring a user-friendly collection interface (kitchen caddies with lids, use of bin liners etc) and encouraging residents to wrap their food organics in paper may serve to address concerns.

These negative aspects may be countered to some extent by the perception that the local community is being provided with an additional opportunity to make a direct contribution to improving the environment, particularly as it is intended that food organics will be linked to the existing garden organics collection service.

During pilots conducted in UK, concerns have also centred around the fortnightly bin collection frequency, mainly in summer months when the odour problems led to complaints from 18 percent of residents. Although these did not persist, low yields were experienced, possibly due to residents placing food organics in whichever bin was to be collected first. Because continued weekly garbage collection may reduce community complaints, this practice has been given a higher score compared with fortnightly garbage collection.

10.3.2 Residential Amenity

The baseline case of not introducing food organics collection service has no additional impact on local community and, therefore, scores highly.

The introduction of a weekly food organics collection service in conjunction with maintaining the weekly garbage service does not involve any additional truck movements. However, it may negatively impact residential amenity through increases in odour, debris or visual/aesthetic aspects resulting from separating food organics into a concentrated and, therefore, more fermentable organics stream. This could be limited by such things as bin linings, wrapping of food scraps, and washing of organics collection containers, but nevertheless merits a lower score.

A fortnightly garbage service would reduce the number of truck movements, thereby improving residential amenity. However, given that the residual garbage stream will continue to contain significant quantities of food organics, the reduction in garbage service to fortnightly could potentially have a greater negative impact on other aspects of amenity, particularly odour, thereby neutralising the benefit. Fortnightly garbage service has therefore been scored at a further lower level than a weekly garbage service.

10.3.3 Householder Convenience

The existing system with no separate food organics collection scores highest as it provides householders with access to a weekly service for waste management services. Source separation of food organics requires additional effort by the householder and has, therefore, been scored lower, with fortnightly garbage collection scoring lowest due to the reduced frequency of service.

Indeed, by a significant degree, the largest negative impact of introducing a separate and additional food organics collection is its impact on householder time. This is particularly the case in a society where virtually all studies point to the fact that people are or feel themselves to be increasingly "time poor". Householders will need to segregate food scraps from residual waste, may need to wrap food scraps, and may need to wash organics containers (both in-house type and kerbside-type). In addition to household labour, there is a possible increase in consumer costs through the purchase of kitchen caddies (where they are not freely distributed), bin liners, bin deodorisers and other articles needed to manage potential food organics segregation impacts.

Scores have been assigned assuming that a user-friendly containerisation service will be provided to householders. In both Europe and US, it is common practice to provide householders with either a dedicated food organics bin (typically 25-35L) or, in situations where the food organics is co-collected with garden organics, a smaller kitchen container (typically 7-10L or 2 gallon) to be used in conjunction with a 240L bin. In addition, some jurisdictions provide bin liners free of charge, although this is considerably rarer. Given that the model under consideration here is co-collection of food organics with garden organics, the scores here assume that householders will be provided with a kitchen caddy and encouraged to line the caddy to reduce the necessity of frequent cleaning and to increase the ease of transfer to the organics bin. If the decision is made not to provide containers, then significantly lower scores would have been assigned.

10.3.4 Occupational Health and Safety

The non-introduction of food organics collection service represents negligible additional impacts and therefore scores the highest. However, as the food organics does introduce additional bin/lifts into the waste management service, its score is slightly lower.

10.3.5 Overall Impacts

In summary, the following factors are key in considering the social impact of introducing food organics collection services:

- Food organics collection will require significant additional time and effort from the householder and therefore the collection system introduced will have to maximise the ease of participation in order to ensure high participation rates and yields;
- It is likely that an additional container (for use in the kitchen) will be required in order to increase the "comfort" factor, and to reduce odour and nuisance for the householder;
- Effective management of nuisance factors such as odour and vermin is likely to be vital to gaining community acceptance of food organics collection and to reducing residents' complaints;
- Effective education programs together with the use of existing community groups will be important to ensuring effective communication of service changes; and
- A flexible approach to garbage collection frequency may be required, especially in the initial stages of any program implementation to meet residents' concern and lower the perception barriers to participation.

.

11 Community Acceptance of Food Organics Collection

Concerns have been voiced within the Department of Environment and Conservation about community willingness to accept and participate in a separate food organics collection service. One view is that acceptance will depend on how well the new system is communicated and managed. The other view is that it will be poorly accepted and, at best, will take a long time to gain traction. Accordingly, the DEC requested that Hyder specifically address this issue as part of the system analysis.

The international review has demonstrated that food organics collection services are well established in other parts of the world, particularly in Europe and Canada, and gaining ground in the United States. In evaluating the relative success of such a system, it is necessary to consider participation levels, overall yields (on a per household or person basis), and quality of the collected product.

11.1 Community-Based Social Marketing Theory

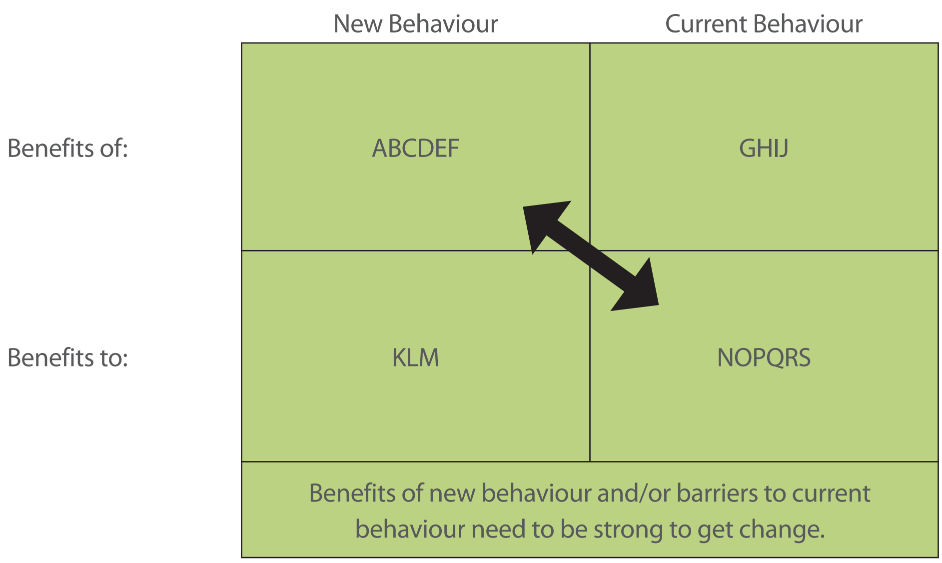
Conventional wisdom holds that sustainable behaviour can be fostered through the use of large scale information campaigns or by demonstrating that it is in the economic self-interest of a consumer to adopt a certain behaviour. However, repeated experience and now collected data show that this is not sufficient to drive behavioural change.

The degree to which householders are likely to participate and participate appropriately can, instead, be considered within the framework of Community-Based Social Marketing (CBSM) theory. This theory holds that people will engage in a new environmental behaviour when and if:

a. The benefits of the new behaviour exceed the benefits of the old behaviour;
b. The barriers to the old behaviour exceed the barriers to the new behaviour; and/or
c. Some combination thereof.

The Canadian environmental psychologist and academic, Dr Doug McKenzie Mohr, has proposed the following diagrammatic representation of the CBSM theory.

Figure 11.1 Community Based Social Marketing Model (Source: Doug McKenzie Mohr).



In order to assess the likelihood of acceptance of food organics collection, it is necessary to identify the factors that the community are likely to see as beneficial about the new service and the likely responses to changes in the relative barriers between the old and new behaviours. These cannot be seen in isolation, but rather as part of the overall waste management system. In particular, current consumption-related behaviours must be taken into account.

In Western countries, there is strong evidence that there is significant household food wastage and spoilage. Australians spent $5.3 billion (around $700 per household per year) on food we did not eat (Australia Institute, 2005). In the UK, food wastage amounts to £424 per person and year.

(This begs the question: if people are willing to let food organics spoil in general and incur the related economic and potential health consequences, is it at all possible to motivate them to segregate food organics for environmental gains?)

The following section summarises international and domestic experience with respect to food organics management practices, and develops a CBSM-based profile of benefits and barriers relevant to acceptance of food organics collection services.

11.1.1 Benefits and Barriers – International Experience

Overall, international experience has demonstrated that a high level of acceptance and understanding of the system combined with a high frequency of collection has yielded high capture rates and material purity.

The benefits and barriers inherent in the following factors are key in driving behavioural change:

- Ease of participation or "user-friendliness" of the system;
- Collection frequencies (of both food organics and residual garbage);
- Management of nuisance factors, such a odour and pests;
- Provision of education and awareness programmes, including the use of existing community groups;
- Enforcement techniques including mandatory participation, kerbside rejections.

Ease of Participation

Experience in Europe has universally acknowledged that the user-friendliness is a vital barrier to be overcome. Factors such as door-to-door service, the types of containers offered and providing the containers and service free-of-charge are specifically cited.

Experts in Italy claim that frequent door-to-door collection service promotes participation and enhances yields due to its "user-friendly" interface. In addition, in almost all jurisdictions offering food organics collection in Europe or North America, it has been found necessary to provide some type of kitchen container free of charge to the householder to increase the ease of participation. The container is usually sized so that it must be emptied into the organics bin every 2-3 days, thereby minimising odour in the kitchen, and is accompanied by detailed instructions as to what materials can be included.

In Italy, the use of watertight, transparent biobags in conjunction with the containers provided not only increases the "comfort" of food management, leading to higher participation rates and low organic materials remaining in the residual garbage (15%), but reduces contamination due to the ability to easily conduct visual quality control checks.

Collection Frequency

Internationally, various frequency collection models have been used, each with their own advantages and disadvantages. In the hot climate of southern Italy and Spain, collection occurs 5-6 times per week (Favoino, undated). However, in central Europe, where climates are milder, collection is once per week. In some parts of the UK, food organics are collected fortnightly.

The residual garbage collection frequency also varies. Some jurisdictions continued to offer weekly collection, while others have reduced collection to fortnightly. The risk of reducing frequency of garbage collection is that contamination in the food organics bin may rise. On the other hand, experience in Italy has shown that decreasing garbage collection is an important factor in driving participation in food organics collection schemes. This has been consistent with experience in Ottawa where retention of the weekly garbage service was found to lower participation. In the regions in the UK, objections have been raised about the move to fortnightly collections, and in some cases weekly collection was retained for "political" reasons, particularly in the summer months.

Management of Nuisance Factors

One of the major barriers to high participation, high recovery food organics collection services is managing its fermentable nature and its high moisture content (Favoino, undated). In Italy, the experience has been that if nuisance factors such as odour are avoided, participation will be enhanced and higher collection quantities and qualities will result.

In Ontario, it was found essential to line carts in summer in order to reduce the odour (Sherman, 2004). In Toronto, also, it has been found that plastic bags have been a necessary compromise to encourage participation. Overall, lining of either the kitchen caddy or the collection bin is a very common practice to reduce odour build-up and reduce cleaning frequency. Alternatively, householders are encouraged to wrap their food in paper.

Trials run in Ottawa have shown that kraft bags with a cellulose moisture-resistant liner have been very well accepted and have worked well to reduce the aversion to storing food scraps, with up to 75 percent of participants buying and using the bags. In addition, they have been found to contain odour and have increased the ease with which food organics can be collected by contractors. Using bags to contain food organics also allows it to be collected separately to garden organics, even while using a commingled organics bin, should the organics processing facility require it.

Aside from odour, the biggest concern voiced by householders has been over the increased risk of attracting animals and vermin. Complaints of this kind have been reported in Ottawa (Canada), St Edmundsbury (UK) and in suburban areas of San Francisco. However, in many cases where significant objections have been raised when collection was initiated, complaints fell away once the service became established (Eunomia, undated).

Education

While education and communication alone may not be sufficient to overcome the perception barriers to separating food organics, they are an important component in a balanced program. Experience in both the UK (St Edmunsbury) and Canada have demonstrated that community engagement on a personal basis was an essential part of increasing participation. Techniques include telephone hotlines, distributing instruction leaflets to all households, leveraging existing community groups, coverage in community newspapers, displays at local establishments, and cash prizes as incentives. In general, use of networks of community groups have been found to be very effective due to their ability to spread messages through peer-to-peer encounters, e.g., credible sources of information that "cut through the clutter" of an overcrowded media context.

In Minneapolis, implementation of a widespread public awareness campaign raised participation from 25 percent to 40 percent with peak values of 60 percent.

Enforcement

An active enforcement program is often required where residual garbage collection has been reduced from weekly to fortnightly. This is necessary to increase the barrier of incorrect behaviour and to ensure that contamination levels remain low. This has been used in several jurisdictions in the UK.

More controversial is the European trend of making food organics segregation mandatory in order to drive behavioural change. This has also been adopted in some jurisdictions in the UK, such as St Edmunsbury. It is also being considered by San Francisco, which has led the way in the US in source separating domestic food organics.

11.1.2 Benefits and Barriers – Domestic Experience

There are few examples of food organics collection in Australia. However, councils that are known to have introduced food organics collection include:

- Nillumbik, Victoria
- Camden, NSW
- Lismore, NSW
- City of Burnside, SA
- Chifley, ACT.

Characteristics of collection include:

- Garbage collection as a fortnightly system;
- Food organics co-collected with garden organics in a weekly service;
- Food organics collected limited to vegetable and fruit waste;
- Kitchen caddies offered as optional and charged to householders.

Barriers related to social acceptance and behavioural change that have been identified include:

- Uncertainty about appropriate presentations, e.g., "what should I wrap it in?";
- Elevated levels of contamination;
- Concerns about limited bin capacity, e.g., "green bin is not big enough"; and
- General community confusion about system change and, consequently, poor disposal practices.

What should I wrap it in?

Based on discussions with Councils, it has been found that the established disposal practice of wrapping food organics in plastic to contain it and keep collection bins clean (common practice when food organics was disposed of in the garbage stream) tends to be continued in relation to food organics segregation. This is despite significant effort in some education campaigns aimed at changing behaviour. Experimentation with biodegradable bags has reportedly not been successful, with organics processing contractors finding that even biodegradables are difficult to deal with.

Attempts have also been made to shift behaviour towards paper rather than plastic, leading to confusion and continuing poor practices. In addition, while newspaper and other paper products used are compostable and should therefore be compatible with processing technologies, it has been found that the quantity used to wrap the food (typically 10% by weight) is too high to be compatible with conventional windrow processes.

Contamination Levels

Confusion over how food scraps should be wrapped together with difficulties with processing technologies have led to recovery rates as low as 1-2 percent in some Councils in the initial periods of implementation. However, this was in cases where no organics collection had previously existed and, therefore, is not completely attributable to food organics collection introduction difficulties. In Nillumbik, contamination levels have now been reduced to 11 percent, and Lismore is achieving levels of 2 percent. However, in both cases, extensive community education programs have been run, and at Lismore, a strict enforcement program is in place, involving a "three strikes and out" method.

Green Bin is not big enough

Resident complaints have been experienced particularly in cases where a 120L bin is provided and in areas with large blocks and significant green space. Obviously, this is almost exclusively due to high quantities of garden organics, not food organics which has a comparatively high density (i.e. takes up a relatively small volume in the bin.)

11.2 General Comments

In light of the aspects outlined above, it is clear that for source segregated food organics collection to have any chance of "working at the community level" several aspects need to be actively managed.

In particular, the barriers to community participation in appropriate segregation/collection need to be removed or lowered as far as possible. This includes the provision of kitchen caddies, bin odour minimisation, and appropriate collection frequency. In this context, education and communication are clearly needed to explain the "how to's" of the new system, as well as its underlying environmental rationale.

The amount of effort and investment needed on the part of Council to make a source segregated food organics collection system work should not be understated. This is because one of the critical success factors for such a system is behavioural change on the part of community members. Behavioural change is difficult to achieve in the best of circumstances; it is very difficult to achieve where there are a lack of natural drivers or motivators for that change. While the sense of "doing the right thing" and force of habit may be sufficient to motivate on-going participation in kerbside recycling schemes, these may not be strong enough factors to motivate wholescale further effort in a time-poor society.

Given this dynamic, Councils and other relevant authorities would be prudent to consider targeting of their food organics recovery efforts to ensure a better return on investment. In particular, social research by a variety of agencies shows that there is a proportion of the community that is highly committed to environmental protection and that this commitment translates into that segment's household practices, including time and effort sacrifices in the name of the environment. Councils would be well advised to first generally promote the opportunity to participate in a source segregated food organics collection service and then provide it (where there is sufficient volume) on a limited basis to those households that volunteer. Given that these volunteers will need to take initiative and make a commitment, it is quite probable that the quality of their participation will be high. Conversely, providing a food organics collection service to all households in a Council area – including those that currently do not even participate in kerbside recycling or those who are unlikely to want to segregate food organics for a variety of reasons – is likely to have a lower proportionate return on investment.

In due course, Councils utilising the "volunteer approach" can leverage the good performance of its volunteers (known in marketing parlance as "early adopters") to other householders.

12 Multi-Criteria Assessment

Waste management planning and decision-making typically involves assessing a wide range of alternatives and numerous evaluation criteria. When public authorities seek a waste management solution there may be dozens of combinations of sites, collection systems and treatment technologies to choose from and a number of criteria by which to compare alternatives. When confronted with such an array of alternatives and criteria, it becomes difficult to sort, analyse, prioritise and make choices without the assistance of a tool or technique. To complicate matters, decisions on waste management issues often involve different stakeholder groups, the public, political considerations and are often controversial.

As per the previous report, Multi-Criteria Assessment (MCA) was used as a basis for conducting the final integrated assessment of the selected scenarios. MCA techniques have a strong reputation as a decision-making support tool in the environmental management arena.

MCA techniques have the advantage that they can be used to assess alternatives using criteria that have different units (e.g. $, tonne, km, etc). This is a significant advantage over traditional decision aiding methods, for example cost-benefit analysis, where all criteria need to be converted to a single unit (e.g. dollars). Some MCA techniques also have the capacity to analyse both quantitative evaluation criteria as well as qualitative evaluation criteria (e.g. yes/no, pluses and minuses, ordinal ranking).

For this project this was particularly relevant as, on the one hand, economic valuation of the financial and environmental performance of the different scenarios was determined in dollar terms while, on the other hand, an ordinal based scoring system was used to assess the technical and social performance of the different scenarios.

12.1 Methodological Background

There are numerous multi criteria assessment techniques available, each of these varying on their suitability depending on the type of data that needs to be assessed (quantitative or qualitative or both) and the outputs generated.

In accordance with the technique developed for the *Alternative Waste Treatment Technologies Handbook and Assessment Tool* (DEC, 2003), two alternative multi criteria assessment techniques are presented: Additive Weighting and Concordance Analysis. The application and basis for these techniques are discussed below.

Additive Weighting is one of the simplest multi criteria assessment techniques. It involves four principal steps as follows:

Step 1: Derive an effects matrix that scores each alternative against each criterion;

Step 2: Standardise the scores in the effects matrix to a value between 0 and 1 (standardised matrix);

Step 3: Multiply the standardised scores by the criteria weights (weighted matrix); and

Step 4: Sum the weighted criteria to obtain an overall score for the alternative.

It should be noted there is one significant shortfall of additive weighting techniques namely, it is not suitable where ordinally scaled data (i.e. ranks, good-bad etc.) is used, in particular where the ordinally scaled data provides no indication of the relative numerical difference between alternatives.

Using ***Concordance Analysis***, each alternative is compared against each other alternative on a pair-wise basis. Concordance analysis has the advantage that comparison of alternatives can be made where the set of criteria includes examples of each of the data scales listed above.

For each pair of alternatives the score for each criterion for Alternative 1 is compared against the corresponding score for each criterion for Alternative 2.

Criteria weights are assigned to the alternative that outperforms the other. Concordance indices are then calculated which represent the sum of the weights of the criteria for which the alternative scores better than the other. Finally the indices are divided by the sum of all the weights.

Care must be taken when applying concordance analysis. An alternative may be superior to another in all criteria except one (e.g. cost). Concordance assessment does not provide any indication as to *how badly* the alternative performs for that criterion however, and the poor performance against that criterion may override other considerations. Methods for addressing this can include specifying acceptable ranges that alternatives have to fall within under various criteria, e.g. cost ranges, adherence to relevant environmental emission standards, etc.

The weights that were determined through the consultative process for the NSW JRG 14 project *Assessment of Domestic Waste and Recycling Systems* (DEC, 2004) and which were then used also for the *Assessment of Garden Organics Collection Systems* (DEC, 2005) have been applied to the MCA. For subcriteria not applicable to this study (e.g. "labour relations"), the weightings of the remaining subcriteria have been adjusted so their total equals the weighting of the main criterion (e.g. "social"). Adjusted weights are presented in Table 12.1.

Only Concordance Analysis results are shown in this section for two reasons:

- The methodology is better suitable to analyse the data of this assessment; and
- To avoid confusion through presentation of too many results.

Table 12.1 Weights for Criteria Used.

Main Criteria	Subcriteria	Adopted Weight	
		Community	Local Government
Financial	System Cost	18.1%	31.8%
Environmental	Greenhouse gases	8.0%	4.0%
	Air Pollution	11.3%	6.0%
	Water Pollution	12.3%	7.2%
	Resource Conservation	10.9%	8.1%
Technical	Flexibility in feedstock quality	2.7%	3.7%
	Modularity of System	3.0%	3.1%
	Process Control	1.7%	2.1%
	Efficiency in Waste Reduction	4.0%	6.1%
	Operational Reliability	3.0%	6.3%
	Alignment with State Govt policy	1.2%	3.5%
Social	Individual & Family Impacts	9.7%	3.6%
	Residential Amenity	5.1%	5.1%
	Householder Convenience	7.0%	5.5%
	OH&S	1.9%	3.8%
	Total	***100.0%***	***100.0%***

Due to the limited amount of data from regional areas with the associated uncertainty, the MCA has not been performed for regional settings. It is recommended to consider the options performance as per Cost-Benefit Analysis (refer Section 9), and to perform an MCA only based on the situation in a specific council (or group of councils) area.

12.2 'Technical' Scores

In the consultative part of the *NSW JRG 14 project* (DEC, 2004), weightings were also elicited for technical parameters. Some of these parameters such as maturity of technology/reference facilities and staff requirements have not been built into the MCA as these are specific to individual technologies and can therefore only be considered in a tendering process and not in a study assessing generic technology categories. For the remaining parameters, scores have been assigned to the options assessed. These are provided in Table 12.2. A brief explanation is given below.

Table 12.2 Technical Scores.

Criterion		GO Fort'ly	Biowaste Weekly	Biowaste Weekly		GO Fort'ly	Biowaste Weekly	Biowaste Weekly
	LF Weekly	LF Weekly	LF Weekly	LF Fort'ly	MBT Weekly	MBT Weekly	MBT Weekly	MBT Fort'ly
Flexibility in Feedstock	5	5	5	5	3	3	3	3
Modularity	1	1	1	1	3	3	3	3
Process Control	1	1	1	1	3	3	3	3
Efficiency in Waste Reduction	1	3	4	4	3	4	4	4
Operational Reliability	5	5	4	4	3	3	3	3
Alignment with Govt Policy	1	3	3.5	3.5	4	4.5	5	5

5- Best; 1- Worst

Differences in the technical scores occur mainly between different residual waste treatment systems because collection and composting of GO and biowaste are standard techniques which does not increase or reduce the technical performance of the overall system. Only in the criterion "Alignment with Government Policy", separate organics systems have been given a higher score as source separation is seen as preferable under the *NSW Waste Avoidance and Resource Recovery Strategy* (Resource NSW, 2003).

Flexibility in Feedstock: Landfill can accept a wider range of materials than MBT and has hence been given a higher score.

Modularity: MBT facilities are fairly modular – can be established for smaller throughputs (>20,000 t/yr) – than landfills which are the least 'modular'.

Process Control: MBT facilities have higher levels of process control than landfills.

Efficiency in waste reduction: MBT facilities produce less residues than landfills which not reduce waste.

Operational reliability: Landfills cannot 'completely fail' at an operational level. It is possible that some fail to provide the necessary environmental safeguards however there is a very low risk of a major breakdown which would prevent waste disposal. For waste processing facilities, this risk is higher. MBT showing a lower score because operational reliability remains to be proven.

Alignment with Government policy: Landfill is ranked lower than MBT. Separate GO and biowaste schemes have been assigned a higher score due to the Government's preference for source separation.

12.3 Results

12.3.1 Community Preferences

Table 12.3 shows the rankings of all options assessed for the concordance analysis when the average weightings of the community are applied. The differences between the two council 'types' (high and low GO generation) lead to rankings that are not identical however, clear trends become apparent:

- Separation of organics is always preferable;
- Inclusion of food organics is preferred;
- Collections with low frequency rank higher than those with high frequency; and
- MBT options rank higher than landfill options.

Table 12.3 Scenario Rankings using Community Weightings – High GO generation

Rank	High GO Generation	Low GO Generation
1	Biowaste + MBT Fort'ly	Biowaste + MBT Fort'ly
2	GO Fort'ly + MBT Weekly	GO Fort'ly + MBT Weekly
3	Biowaste + MBT Weekly	Biowaste + MBT Weekly
4	MBT Weekly	MBT Weekly
5	Biowaste + LF Fort'ly	Biowaste + LF Fort'ly
6	Biowaste + LF Weekly	Biowaste + LF Weekly
7	GO Fort'ly + LF Weekly	GO Fort'ly + LF Weekly
8	LF Weekly	LF Weekly

12.3.2 Local Government Preferences

Table 12.4 shows the rankings when the weightings of the NSW councils participating in the survey undertaken for the *NSW JRG 14* (DEC, 2004) project are applied.

The result is comparable to that using community preferences with the exception of councils with low GO generation where the option featuring MBT processing and no organics collection wins.

Table 12.4 Local Government Options Ranking – High GO generation

Rank	High GO Generation	Low GO Generation
1	Biowaste + MBT Fort'ly	MBT Weekly
2	GO Fort'ly + MBT Weekly	Biowaste + MBT Fort'ly
3	MBT Weekly	GO Fort'ly + MBT Weekly
4	Biowaste + LF Fort'ly	LF Weekly
5	GO Fort'ly + LF Weekly	Biowaste + LF Fort'ly
6	Biowaste + MBT Weekly	Biowaste + MBT Weekly
7	Biowaste + LF Weekly	GO Fort'ly + LF Weekly
8	LF Weekly	Biowaste + LF Weekly

13 Conclusions and Recommendations

13.1 Conclusions

General

Food organics makes up between 17 and 21 percent of the total waste domestic stream, or up to 30 percent of the garbage stream (approx. 200kg per household per year).

Separate collections of food organics are provided to households on a large scale in a number of countries overseas, mostly in Europe but also in Canada and in the U.S. The majority of these systems provide a combined collection of food organics with garden organics.

For well established systems, a recovery rate of between 40 and 55 percent can be achieved. For this report, a recovery rate of 55 percent has been assumed (and a 70 percent recovery calculated as part of a sensitivity analysis).

Financial

In summary, the cost of providing a weekly combined food and garden organics collection service is estimated to be in the range $60 per household per year to $76 per household per year. This compares to a cost of providing a fortnightly garden organics only collection service of $31 per household per year – $45 per household per year.

These costs do not take into account the avoided garbage collection and disposal costs. If these are considered, and the waste disposal levy for the year 2010/11 is included[11], the following picture emerges:

Councils with a HIGH generation of garden organics

- For councils with ***high garden organics generation***,the separate collection of garden organics will be less expensive ($12 per household per year) than disposal to landfill (with garbage).
- For those councils, the co-collection of food organics (with garden organics) will cost the same as sending all organics to landfill (with garbage). A concurrent reduction of the garbage collection frequency from weekly to fortnightly would make this option $15 per household per year less expensive than no organics collection service at all.
- Processing of residual mixed waste (garbage) through MBT is less expensive than landfill for all scenarios (by $19 per household per year). The provision of a separate garden organics service would result in an additional small cost reduction. Inclusion of food organics (biowaste collection) would be slightly more expensive with a weekly garbage service and slightly less expensive with a fortnightly garbage service.

Councils with a LOW generation of garden organics

- For councils with ***low garden organics generation***, the separate collection of garden organics will be $7 per household per year more expensive than disposal to landfill (with garbage).
- For those councils, the co-collection of food organics (with garden organics) will cost $17 per household per year more than having no organics collection service at all. This would reduce to $2 per household per year in case of a fortnightly garbage collection.
- The introduction of MBT processing for garbage would reduce the overall domestic waste management costs by $15 per household per year. A separate garden organics collection service would increase these costs by $11 per household per year however, the total costs would still be $4 per household per year lower than the base case. Biowaste collection would add $22 per household per year (or $7 net over landfill) with a weekly garbage service and $7 per household per year (or $8 net over landfill) with a fortnightly garbage service.

[11] This has been done because the objective of the report is to provide councils assistance in their planning and decision making where medium term costs are more relevant than current prices.

Regional Councils

- For regional councils, a lower landfill gate fees results in the Landfill Only option being the least expensive.
- A separate (fortnightly) GO collection would add $11 per household per year, and a (weekly) biowaste collection $33 per household per year ($17 if the garbage collection frequency is reduced to fortnightly).
- The provision of MBT processing for garbage would increase costs significantly (around $40 per household per year).
- It is noted that these results are heavily dependent on the assumptions regarding landfill and MBT gate fees. It is possible that landfill fees will rise above currently assumed levels and MBT fees fall below those assumed here. This could provide results closer to those for metropolitan areas.

Sensitivity analyses

- Sensitivity analyses show relatively little impact on the results under the agreed assumptions, with one exception:

Without the announced increase in the waste disposal levy, all options considered are more expensive than the landfill only option.

In other words, what the analysis confirms is that the waste disposal levy increase will make processing of garbage ('residual waste') and most options for separating organics from the domestic waste stream 'viable' in a financial sense.

Environmental

The key outcomes of the environmental assessment are as follows:

- Separation of garden organics provides a significant improvement in environmental performance over landfilling of these materials.
- Inclusion of food organics enhances this performance;
- The provision of MBT (without biowaste separation) achieves an even higher environmental performance (22% better).
- A combination of both services (MBT and separate biowaste management) provides the best outcome (64% improvement).
- When expressed in 'ecodollar' terms, the environmental benefits are as follows:
  Eco$30-55 per household per year for biowaste collection:
  Eco$50-65 per household per year for MBT processing of garbage; and
  Eco$60-85 per household per year for MBT plus biowaste collection services.
- The use of proxy values to estimate scientifically 'unquantifiable' impacts and benefits would more than double the above environmental benefits, to up to $240 per household per year.

Cost-benefit Analysis

- Source separation of organics always achieves better result than not separating these materials.
- The higher environmental benefits of inclusion of food organics in a separate organics collection are 'equalized' by higher collection and processing costs unless garbage collection frequency is reduced to fortnightly.
- All scenarios featuring MBT achieve higher overall benefits, than scenarios with landfill (of untreated waste).
- For regional areas the net benefits are considerably lower compared to in metropolitan areas as a result of the low landfill gate fees and the relatively higher costs of biowaste collection and composting.

Social Assessment

- Food organics collection will require significant additional time and effort from the householder and therefore the collection system introduced will have to maximise the ease of participation in order to ensure high participation rates and yields;
- It is likely that an additional container (for use in the kitchen) will be required in order to increase the "comfort" factor, and to reduce odour and nuisance for the householder;
- Effective management of nuisance factors such as odour and vermin is likely to be vital to gaining community acceptance of food organics collection and to reducing residents' complaints;
- Effective education programs together with the use of existing community groups will be important to ensuring effective communication of service changes; and
- A flexible approach to garbage collection frequency may be required, especially in the initial stages of any program implementation to meet resident's concern and lower the perception barriers to participation.

MCA

The inherent differences between the two modelled council 'types', i.e. *high* and *low* GO generation, lead to slightly different rankings. However, some clear trends are apparent:

- Separation of organics (both food and garden) is generally preferable; and
- MBT options rank higher than landfill options.

The table below shows the three top ranked options for both council types, and using community and council officer weightings.

Rank	High GO Generation	Low GO Generation
Community weightings		
1	Biowaste + MBT Fort'ly	Biowaste + MBT Fort'ly
2	GO Fort'ly + MBT Weekly	GO Fort'ly + MBT Weekly
3	Biowaste + MBT Weekly	Biowaste + MBT Weekly
Local Government officer weightings		
1	Biowaste + MBT Fort'ly	MBT Weekly
2	GO Fort'ly + MBT Weekly	Biowaste + MBT Fort'ly
3	MBT Weekly	GO Fort'ly + MBT Weekly

13.2 Recommendations

Based on the outcomes of this integrated (TBL) assessment, it is recommended that:

- Councils with significant amounts of garden organics continue to be encouraged to provide regular, containerised source separated collections for these materials.
- Councils be encouraged to provide residual waste (garbage) treatment prior to landfill disposal as the assessment has confirmed that these systems achieve significant additional environmental benefits. However it is recognised that in the medium term (5 years), such technologies will be competitive on metropolitan Sydney on a purely financial basis.

In terms of including food organics – i.e. the introduction of a biowaste collection service where garden organics and food organics are co-collected – the following recommendations are provided:

- For Councils where households generate significant quantities of garden organic material (i.e. 175 kg per household per year or more), and/or where separate containerised collection services for these materials already exist, the inclusion of food organics should be considered. Councils should also evaluate the socio-demographic profile of its community when considering the introduction of this type of service.
- The introduction of a co-collected food and garden organics service will require the establishment of processing infrastructure and be supported by comprehensive community education. For councils with a low generation rate of garden organics (and where no regular, containerised collection system exists for these materials), it may wish to consider the introduction of MBT services for residual wastes (garbage) as a higher priority.
- Any barriers to community participation in the collection service, including source separation/collection, need to be removed or minimised as far as possible. This may include the provision of kitchen tidy bins. In this context, education and communication to explain the "how to's" of the new system, as well as its underlying environmental rationale, are considered vital to the success of any food and garden organics collection service.
- It should be recognised that behavioural change is often difficult to achieve and will likely take time, especially where there are a lack of natural drivers or motivators for that change. While the sense of "doing the right thing" and force of habit may be sufficient to motivate on-going participation in kerbside recycling schemes, these may not in themselves be strong enough factors to motivate further effort in a time-poor society.
- Given this dynamic, Councils and other relevant authorities may wish to consider targeting of their food organics recovery efforts to ensure a better return on investment.
- Councils need to carefully consider all the aspects associated with the introduction of a co-collected food and garden organics collection service. An option may be to first generally promote the opportunity to participate in a source segregated food organics collection service and then *provide it on a limited basis to those households that volunteer*. Given that these volunteers will need to take initiative and make a commitment, it is quite probable that the quality of their participation will be high.
- Providing a food organics collection service to all households in a Council area – including those that currently do not even participate in kerbside recycling or those who are unlikely to want to source separate food organics for a variety of reasons – is likely to have a lower success and is therefore only recommended in exceptional circumstances.

14 References

Amlinger, F., Peyr, St, & Geszti, J. (2001). Compost Management in Austria – Quantities and Qualities. Proceedings of 'Biowaste Conference'. 15-17 May 2001, Vienna.

Australia Institute. (2005). Wasteful Consumption in Australia.

Barth, Josef & Kroeger, Barbel. (1998). Composting Progress in Europe. *BioCycle*, Vol 39, Issue 4, pp. 65-68, April 1998.

Camden Council. (2006). 'Waste and Recycling Services'. URL: http://www.camden.nsw.gov.au/page/services.html#1.

City of Burnside. (2006). Burnside Bio-Organics Trial: Diverting Food organics from Landfill.

Coffs Harbour City Council. (2006). Personal Communication with Chris Foley. (28.04.2006).

Colac-Otway Shire. (2006). Personal Communication with Darren Williams. (28.04.2006).

DEC, Department of Environment and Conservation NSW. (2003a). Study on Local Government Management, Costs for Garden Organics, Final Report, December 2003, study undertaken by A Prince Consulting.

DEC, Department of Environment and Conservation NSW. (2003b). Alternative Waste Treatment Technologies Handbook and Assessment Tool.

DEC, Department of Environment and Conservation NSW. (2004). Assessment of Domestic Waste and Recycling Systems (NSW JRG-14), Final Report, for NSW Jurisdictional Recycling Group and Publishers National Environment Bureau. Prepared by Nolan-ITU.

DEC, Department of Environment and Conservation NSW. (2005). Assessment of Garden Organics Collection Systems. ISBN 1 74137 309 3. Prepared by Nolan-ITU.

DEC, Department of Environment and Conservation NSW. (2006). Fact Sheet for Landfill Operators. Details on the mechanics of levy administration.

Emerson, Dan. (2003). Source Separated Organics Pilots in the Twin Cities. *BioCycle*, Vol 44, Issue 11, pp. 22-25, November 2003.

Eunomia Research and Consulting. (undated). Current Practice in the Collection of Organics Waste. Final Report to Devon County Council. Available at URL: http://www.eunomia.co.uk.

Eunomia Research and Consulting. (undated). Maximising Recycling Rates, Tackling Residuals. Final Report to the Community Recycling Network. Available at URL: http://www.eunomia.co.uk.

Eunomia Research & Consulting. (2002). Economic Analysis of Options for Managing Biodegradable Municipal Waste. Final report to the European Commission.

European Commission, Directorate-General for the Environment. (2000). Success Stories on Composting and Separate Collection.

Farrell, Molly. (2005). 63 Percent Diversion and Rising. *BioCycle*, Vol 46, Issue 2, pp. 22-29, February 2005.

Favoino, Enzo. (2000). The Development of composting in Italy: programs for source separation, features and trends of quality composting and biological treatment of Restwaste. Proc. Jornados Sobre Compostaje, La Rioja, October 2000.

Favoino, Enzo. (2001). Success Stories of composting in Europe – Leading Experiences and developing situations: ways to success. Proceedings of 'Biowaste Conference', 15-17 May 2001, Vienna.

Favoino, Enzo. (2003). Separate Collection of Biowaste, Composting and Biological Treatment of Residual Waste: Trends and Driving Forces in European Environmental Policy. *Waste Management World*, Review Issue, July-August 2003, pp 95-106.

Favoino, Enzo, Ricci, Marco, Tornavacca, Attilio & Centemero, Massimo. (undated). Optimisation of Schemes for Source Separation of Compostable Waste Considering the Locally Most Suitable Technique. Working Group on Composting and Integrated Waste Management. URL http://www.monzaflora.it.

Favoino, Enzo, Tornavacca, Attilio & Ricci, Marco. (2004). Recent Optimisation of schemes for source separation of biowaste taking into account local conditions. Proceedings of CCN conference 'Working with Biowaste', 3 September 2004, Sheffield, UK.

Friesen, Barry & Kenney, Bob. (2001). Nova Scotia: A Leader in Recycling and Composting. *Resource Recycling*, Vol XX, No 11, November 2001, pp 26-30.

Goldstein, Nora. (2004). Residential Organics Diversion Moves Forward in Ontario. *BioCycle*, Vol 45, Issue 9, pp. 46-49, September 2004.

Goldstein, Nora. (2005a). Mixed MSW Composting Facilities in the US. *BioCycle*, Vol 46, Issue 11, pp 19-28, November 2005.

Goldstein, Nora. (2005b). Source Separated MSW Composting in the US. *BioCycle*, Vol 46, Issue 12, pp. 20-25, December 2005.

Gould, Mark, Garrison, Richard & Foster, Stephen. (1992). Source Separation and Composting of Organic Municipal Solid Waste. *Resource Recycling*, Vol XI, No 7, July 1992.

Hayes, Matthew. (1998). Curbside Collection of Compostables in England. *BioCycle*, Vol 39, Issue 4, April 1998, pp 69-71.

Herbolzheimer, Kristian & Colom, Gloria. (1999). Source Separating MSW in Spain. *BioCycle*, Vol 40, Issue 3, March 1999, pp 53-55.

IPCC, Intergovernmental Panel on Climate Change. (2001). Third Assessment Report – Climate Change 2001.

Jaimez, John . (2005). A Mandatory 50-percent diversion rate has counties looking to source-separated food scrap collection to make the grade. *Resource Recovery*, Vol XXIV, No 5, pp. 13-15, May 2005.

Jones, Timothy W. (2005). The Corner of Food Loss. *Biocycle*, Vol 46, Issue 7, July 2005, p 25.

Kass, Larry & Sherman, Steven. Expanding Participation in Food Residuals Recycling Programs. *BioCycle*, Vol 45, Issue 9, pp 43-45, September 2004.

Lehto, Tarja. (2000). Recycling in Finland: Front and Centre with BioWaste. *BioCycle*, Vol 40, Issue 2, February 2000, pp80-82.

Lismore City Council. (2006). "*Weekly Organics Bin*". URL: http://www.liscity.nsw.gov.au/view_doc.asp?id=21&cat=101. (28.04.2006).

Maslen Environmental. (2005). The Integrated Composting Programme. Final Report, September 2005.

Midwaste. (2004a). Hastings Council Domestic Organics Recovery Trial.

Midwaste. (2004b). Market Investigation & Literature Review: Organics.

Nolan-ITU. (1998). Biowaste Processing Life Cycle Assessment and Environmental Valuation (Proposed Enclosed Biowaste Processing Facility at Lucas Heights). Prepared for Waste Service NSW and the Southern Sydney Waste Board.

Nolan-ITU, (2002). Survey and Audit of Kerbside Waste and Recycling Practices and Recommended Kerbside Standards. Prepared for Environmental Protection Authority, South Australia.

Nolan-ITU. (2004). 2020 Vision for Sustainable Waste Management Discussion Paper. Prepared for City of Melbourne.

Nolan-ITU. (2004a). National Benefits of UR-3R Implementation – A Triple Bottom Line Assessment. Prepared for Global Renewables.

Nolan-ITU. (2005). Consultation Regulatory Impact Statement (RIS) on Revised National Packaging Covenant. Prepared for the Environment Protection & Heritage Council.

Nolan-ITU and Access Economics. (2002). Organic Waste Economic Values Analysis; for the Department of Industry and Trade, Environment Protection Agency.

Nolan-ITU & SKM Economics. (2001). Independent Assessment of Kerbside Recycling in Australia, Final Report, Volume 1. Prepared for National Packaging Covenant Council, January 2001.

NoWaste by 2010. (2001).Household Organic Material Collection Trial Chifley August 2000 – June 2001.

Ohr, Kristian, Pinnette, Jeffrey & Rasmussen, Oyvind. (1998). Norway: Organics Residuals Management Strategies. *BioCycle*, Vol 39, Issue 12, December 1998, pp 69-71.

Port Macquarie-Hastings Council. (2006). Personal Communication with Nicole Julian. (28.04.2006).

Plunkett, Nancy. (2001). Examining Collection of All Residential Organics. *Resource Recycling*, Vol XX, No 11, November 2001, pp.14-21.

RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste Management Options in Victoria, for EcoRecycle Victoria.

Rowan, Lesley. (2005). Kerbside Collection of Food organics in Somerset. Somerset Waste Partnership presentation, CCN Conference, September 2005.

Segall, Lori. (1993). Source Separated Organics Programs in Europe. *Resource Recycling*, Vol XII, No 7, July 1993, pp 27-35.

Sherman, Rhonda. (2004). Exploring Options for Organics Collection. *BioCycle*, Vol 45, No 2, pp. 46-47, February 2004.

Sinclair, Rob. (2002). Comparing Containers, Carts, Bags and Pails. *Resource Recycling*, Vol XXI, No 8, August 2002, pp. 10-15.

Smith, Cathy, Rathbone, Geoff & Graham, Bob. (2000). Wet-dry Recycling: Evaluating Two-Stream Processing. *Resource Recycling*, Vol XIX, No 9, September 2000, pp.26-32

Sonesson, U. (1997). The Orware Simulation Model for Compost and Transport LCA Sub-models, Swedish EPA.

Speigelman, Helen & Sheehan, Bill. (2006). The Next Frontier for MSW. BioCycle, Vol 47, Issue 2, February 2006, pp. 20-XX.

Stengler, Ella. (2005). The European Position. *Waste Management World*, November-December 2005, pp. 19-24.

Weenen, Bart van. (2000). The Netherlands: Collecting, Sorting and Composting Household Organics. *BioCycle*, Vol 41, Issue 4, April 2000, pp 77-79.

WSN, WSN Environmental Solutions. (2006). Waste Charges and Services. Issued January 2006.

Appendix A

Details of Environmental Assessment Methodology

Methodology Overview

The environmental assessment sought to identify and value the environmental impacts of organic waste recovery and open windrow composting as well as enclosed composting to enable an integrated assessment of management options for municipal waste. The assessment required application and modelling of existing LCA data, based on a detailed understanding of waste management systems in Australia. Consideration was given to the entire waste collection system and to the avoided product systems associated with technology residues.

The environmental assessment has included goal and scope definition, development and application of life cycle assessment data and environmental economic valuation of impacts.

Goal and Scope of the LCA

Goal

The goal of this LCA is to provide a transparent environmental assessment of source-separated garden organics collection and composting, within the context of treatment for municipal solid waste. The analysis is to give regard to practical collection options and average conditions within metropolitan New South Wales.

Functional Unit

The functional unit for the study is defined as the management of typical MSW per household per year. The scenarios considered include source-separated garden organics collection followed by open windrow composting and biowaste collection followed by enclosed composting. For practical purposes, the scenarios are analysed per household. For broader consideration, the data is examined on a per tonne basis.

System boundaries for the study

The system boundary for the study begins at the point of waste generation (i.e. the doorstep of the household). It includes transport impacts, sorting, processing through the selected waste management technology options and then processing or disposal of any residual material. All process energy, including energy of extraction is included.

Application of Life Cycle Assessment Data

Life Cycle Inventory data was acquired from a range of data sources. This data was reviewed and benchmarked for anomalies and the most suitable data sets were applied to the waste and recycling system. The commercial LCA software tool, SimaPro was used to apply LCA data to the systems studied.

Impact Assessment and Environmental Economic Valuation.

Once the inventory data was modelled for each of the systems under study, it was aggregated into more meaningful indicators by classification of inventory loads into the environmental impact groups and then assigned economic values. Existing environmental economic values were used from:

- Nolan-ITU and SKM Economics. (2001). *Independent Assessment of Kerbside Recycling in Australia*, for National Packaging Covenant Council.
- Nolan-ITU and Access Economics. (2002). *Organic Waste Economic Values Analysis*; for Department of Industry and Trade, Environment Protection Agency.
- DEC. (2004). *Assessment of Domestic Waste and Recycling Systems*, NSW Jurisdictional Recycling Group and Publishers National Environment Bureau

Pollutant loads within impact categories have been assigned monetary values based on environmental economic values within published government reports and the use of LCA equivalence factors. Equivalence factors are used as part of life cycle impact assessment to assign impacts based on the relationship between inventory loads within an impact category.

Environmental economic valuation is increasingly used for decision support throughout the world. The quantification of externalities using a rigorous Life Cycle approach has the support of peak bodies including the Directorate General for Research, of the European Commission. The group has spent a decade applying the same approach in valuing the externalities of energy use through the European Reseat Network as part of the ExternE project.

The Member of the European Commission, responsible for Research states, in regard to this work, has stated that:

> *"The assessment of externalities answers a social demand and this European research should help to lay down the basis for improved energy and transport policies."*
>
> Philippe Busquin, External Costs (2003) Forward, European Commission EUR20198.

Environmental economic valuation however remains a controversial methodology in some scientific communities. Reasons cited for this include the perception of certainty that a final valuation implies and monetisation of some non tangible impacts[12].

Data Sources

Table A.14.1 lists the main data sources for the environmental assessment.

System	Data Sources
Garden organics collection and processing	RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste Management Options in Victoria. Eunomia Research & Consulting. (2002). Economic Analysis of Options for Managing Biodegradable Municipal Waste, European Commission Nolan-ITU and Access Economics. (2002). Organic Waste Economic Values Analysis; Department of Industry and Trade, Environment Protection Agency Nolan-ITU. (1998). Biowaste Processing Life Cycle Assessment and Environmental Valuation (Proposed Enclosed Biowaste Processing Facility at Lucas Heights) Waste Service NSW and the Southern Sydney Waste Board.
Materials Recycling	DEC. (2004). Assessment Of Domestic Waste and Recycling Systems, NSW Jurisdictional Recycling Group and Publishers National Environment Bureau RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste Management Options in Victoria. Nolan-ITU and SKM Economics. (2001). Independent Assessment of Kerbside Recycling in Australia. Eco Recycle Victoria. (2001). Stage 1 & 2 Report for Life Cycle Assessment for Paper and Packaging Waste Management Scenarios in Victoria. Melbourne. For Eco Recycle Victoria. CRC WMPC. (1998). Life Cycle Inventories for Transport, Energy and Commodity Materials.
Collection	DEC. (2004). Assessment Of Domestic Waste and Recycling Systems, NSW Jurisdictional Recycling Group and Publishers National Environment Bureau. Nolan-ITU and SKM Economics. (2001). Independent Assessment of Kerbside Recycling in Australia. CRC WMPC (1998). Life Cycle Inventories for Transport, Energy and Commodity Materials. Eco Recycle Victoria. (2001). Stage 2 Report for Life Cycle Assessment for Paper and Packaging Waste Management Scenarios in Victoria. Melbourne.
Transport	Eco Recycle Victoria. (2001). Stage 2 Report for Life Cycle Assessment for Paper and Packaging Waste Management Scenarios in Victoria. Melbourne. Australian Greenhouse Office, Greenhouse Inventory Update.
Landfill	RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste Management Options in Victoria. Nolan-ITU (2002) Decision Support System for the Assessment of Integrated Resource Recovery System, Western Australian Municipal Association. NSW EPA (2003) Alternative Waste Treatment Technologies Assessment Methodology and Handbook

[12] International Expert Group for Life Cycle Assessment and Solid Waste Management (meeting No 5 May 2001) London.

System	Data Sources
MBT – aerobic	RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste Management Options in Victoria. Nolan-ITU. (2002). Decision Support System for the Assessment of Integrated Resource Recovery System, Western Australian Municipal Association. RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste and Resource Recovery Options (including energy from waste). Published industry data.
MBT – anaerobic	Nolan-ITU. (2002). Decision Support System for the Assessment of Integrated Resource Recovery System, Western Australian Municipal Association. RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste and Resource Recovery Options (including energy from waste) Eriksson, O. & Björklund, A. (2002). Municipal Solid Waste Model.
Thermal technologies	RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste Management Options in Victoria. Nolan-ITU. (2002). Decision Support System for the Assessment of Integrated Resource Recovery System, Western Australian Municipal Association. RMIT & Nolan-ITU. (2003). Life Cycle Assessment of Waste and Resource Recovery Options (including energy from waste). Finnveden *et al.* (2002) Energy from waste. SimaPro Inventory Data.
Paper	Finnveden *et al.* (2002). Energy from waste. Published industry data. Grant *et al.* (2001). Stage 1 & 2 Report for Life Cycle Assessment for Paper and Packaging Waste Management Scenarios in Victoria. Melbourne. For Eco Recycle Victoria.

Appendix B

Financial Sensitivity Analyses

14.1.1 Sensitivity Scenario 1 – MBT more expensive

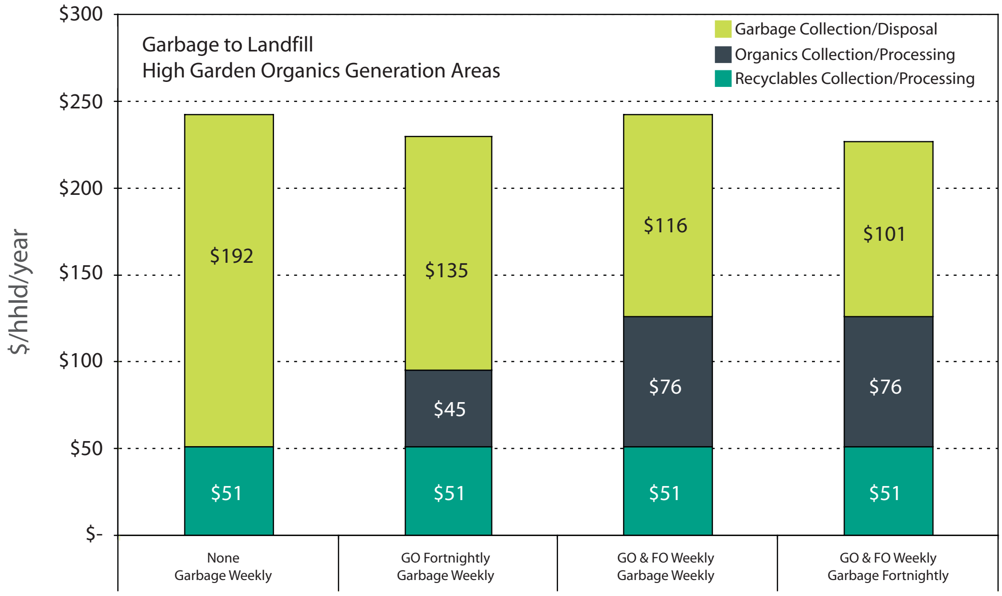
The MBT gate fee is increased from $110/t to $130/t. All other parameters are kept constant.

High GO Generating Areas – Garbage to Landfill

Table 14.2 Waste Management Costs, High GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		Weekly	Weekly	Weekly	Weekly
$ Per Household Per Year					
Garbage	Collection	$57	$50	$47	$32
	Disposal/Processing	$134	$85	$69	$69
Organics	Collection	-	$29	$43	$43
	Processing	-	$15	$32	$32
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$243***	***$231***	***$243***	***$228***
LF Only Cost		$243	$243	$243	$243
Net Cost of Organics Recycling		***$0***	***-$12***	***$0***	***-$15***
% Garbage		80%	51%	41%	41%
% Organics		0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%

Figure 14.1 Waste Management Costs, High GO Generation, Garbage to Landfill.

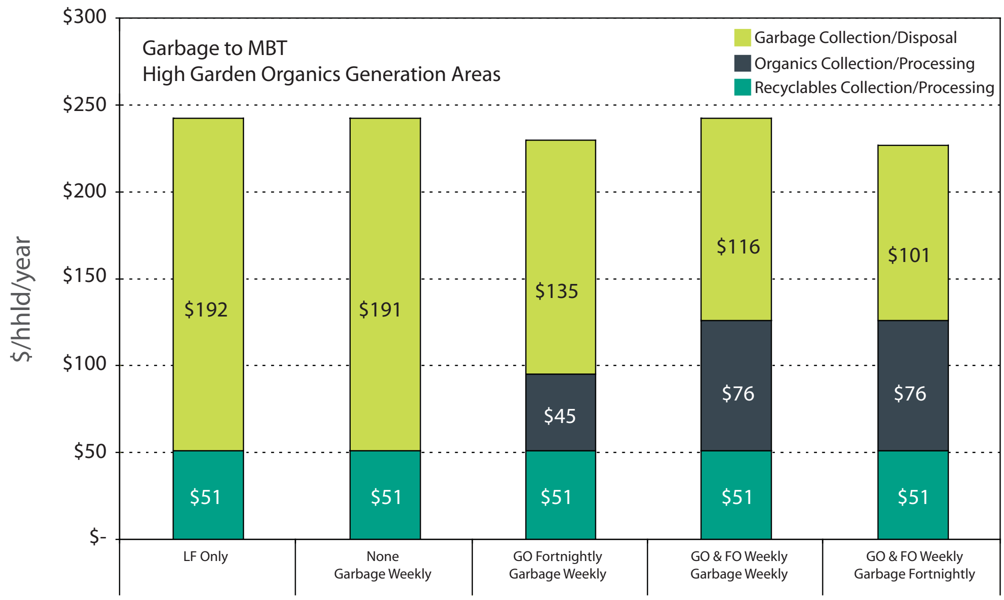


High GO Generating Areas – Garbage to MBT

Table 14.3 Waste Management Costs, High GO Generation, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		LF Weekly	MBT Weekly	Weekly	Weekly	Weekly
$ Per Household Per Year						
Garbage	Collection	$57	$57	$50	$47	$32
	Disposal/Processing	$134	$134	$85	$69	$69
Organics	Collection	-	-	$29	$43	$43
	Processing	-	-	$15	$32	$32
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$243***	***$243***	***$231***	***$243***	***$227***
MBT Weekly Cost			$243	$243	$243	$243
Net Cost of Organics Recycling			***$0***	***-$12***	***$0***	***-$15***
LF Weekly Cost		$243	$243	$243	$243	$243
Costs Change Compared to LF		***$0***	***$0***	***-$12***	***$0***	***-$16***
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 14.2 Waste Management Costs, High GO Generation, Garbage to MBT.

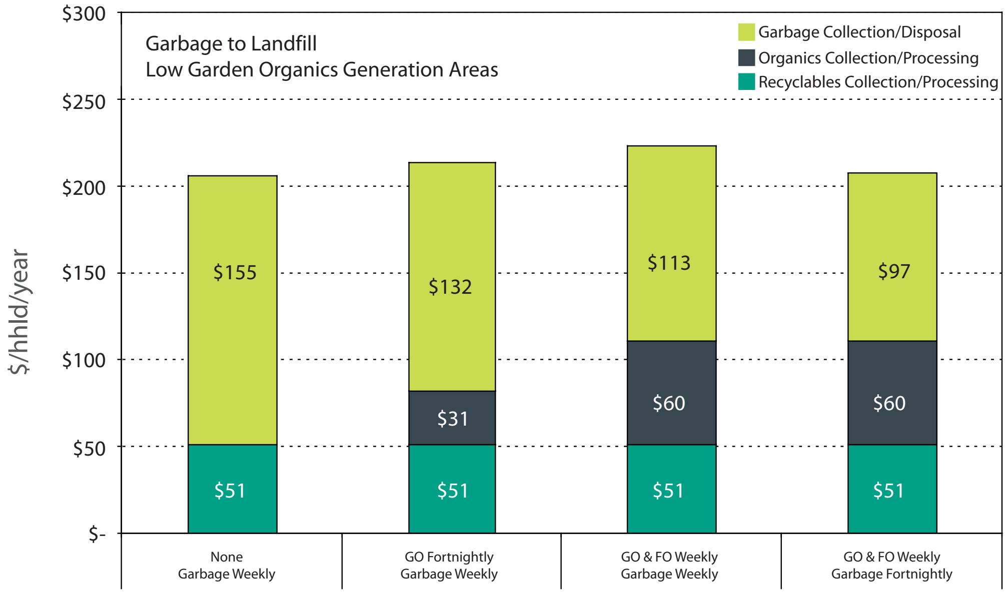


Low GO Generating Areas – Garbage to Landfill

Table 14.4 Waste Management Costs, Low GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		**Weekly**	**Weekly**	**Weekly**	**Fort'ly**
$ Per Household Per Year					
Garbage	Collection	$52	$50	$46	$31
	Disposal/Processing	$103	$82	$66	$66
Organics	Collection	-	$24	$41	$41
	Processing	-	$7	$18	$18
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$207***	***$214***	***$223***	***$208***
LF Weekly Cost		$207	$207	$207	$207
Net Cost of Organics Recycling		***$0***	***$7***	***$17***	***$2***
% Garbage		76%	60%	48%	48%
% Organics		$0	16%	27%	27%
% Recyclables (incl. contamination)		24%	24%	24%	24%

Figure 14.3 Waste Management Costs, Low GO Generation, Garbage to Landfill.



Low GO Generating Areas – Garbage to MBT

Table 14.5 Waste Management Costs, Low GO Generation, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		**LF Weekly**	**Weekly**	**Weekly**	**Weekly**	**Fort'ly**
$ Per Household Per Year						
Garbage	Collection	$52	$52	$50	$46	$31
	Disposal/Processing	$103	$103	$81	$66	$66
Organics	Collection	-	-	$24	$41	$41
	Processing	-	-	$7	$18	$18
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$207***	***$206***	***$214***	***$223***	***$208***
MBT Weekly Cost			$206	$206	$206	$206
Net Cost of Organics Recycling			***$0***	***$7***	***$17***	***$2***
LF Weekly Cost		$207	$207	$207	$207	$207
Costs Change Compared to LF		***$0***	***$0***	***$7***	***$17***	***$1***
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 14.4 Waste Management Costs, Low GO Generation, Garbage to MBT.

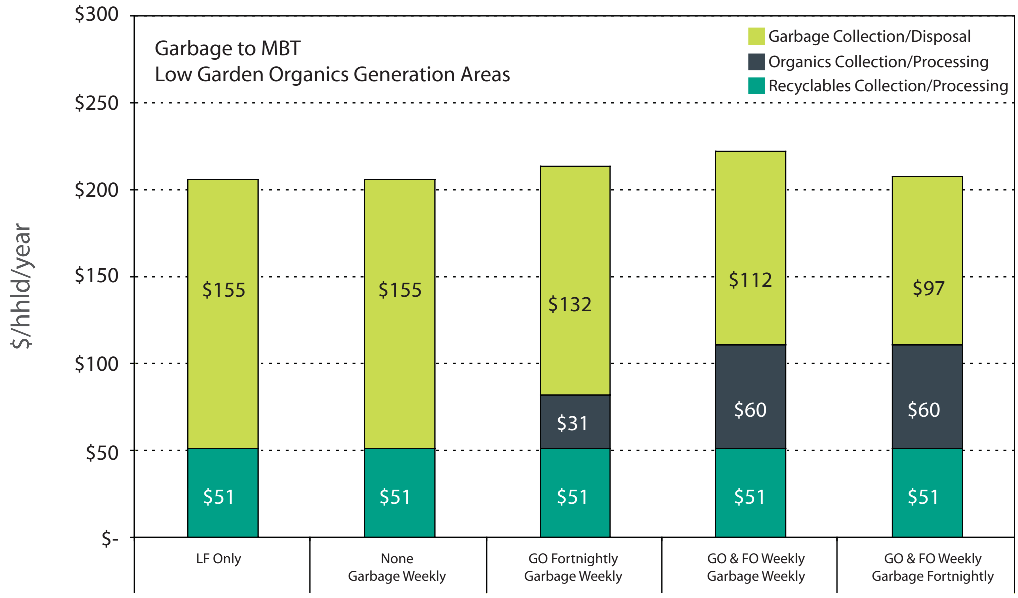
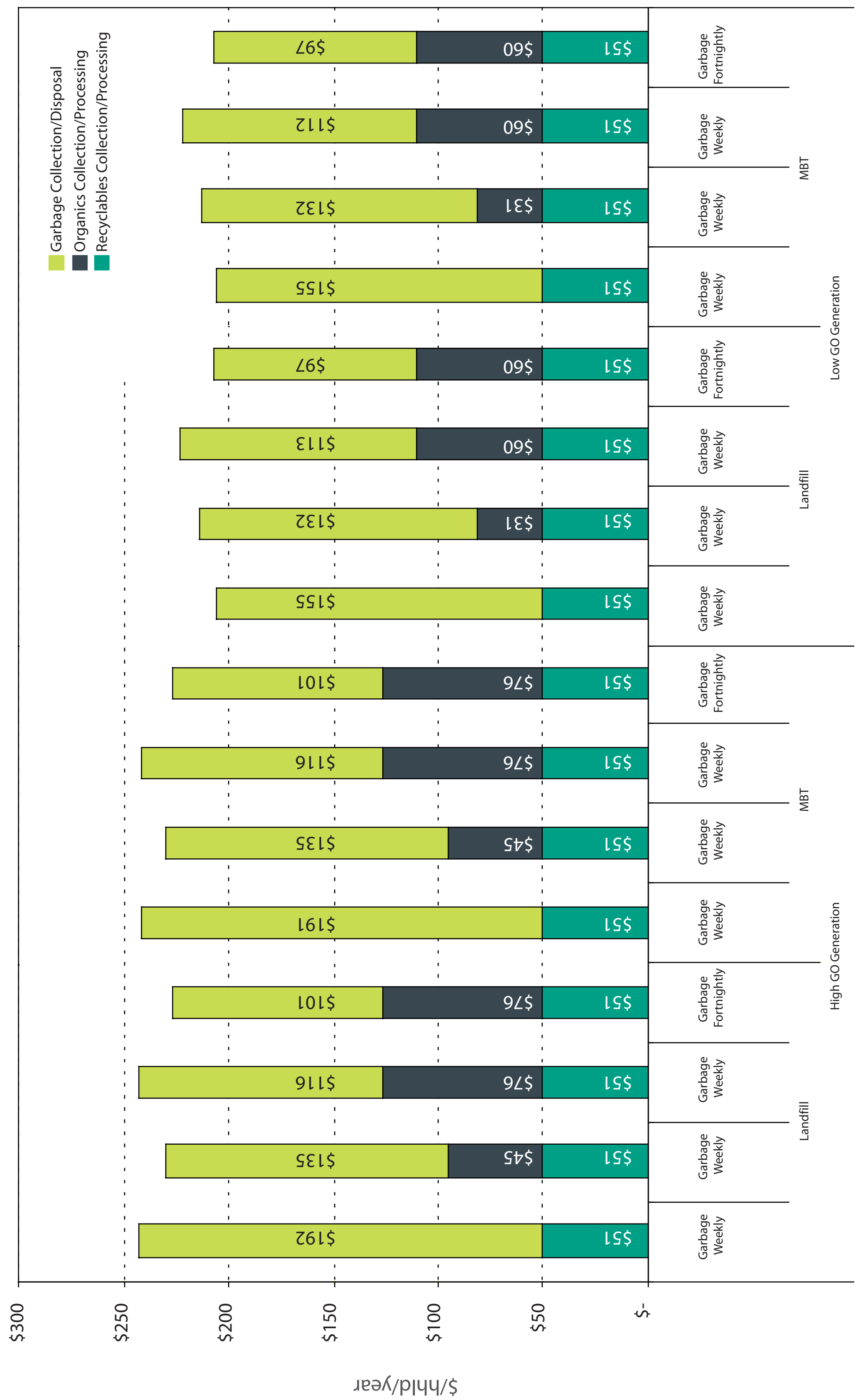


Figure 14.5 Waste Management Costs: Summary for all Systems Investigated – Sensitivity Scenario 1.



14.1.2 Sensitivity Scenario 2 – Higher open composting fees

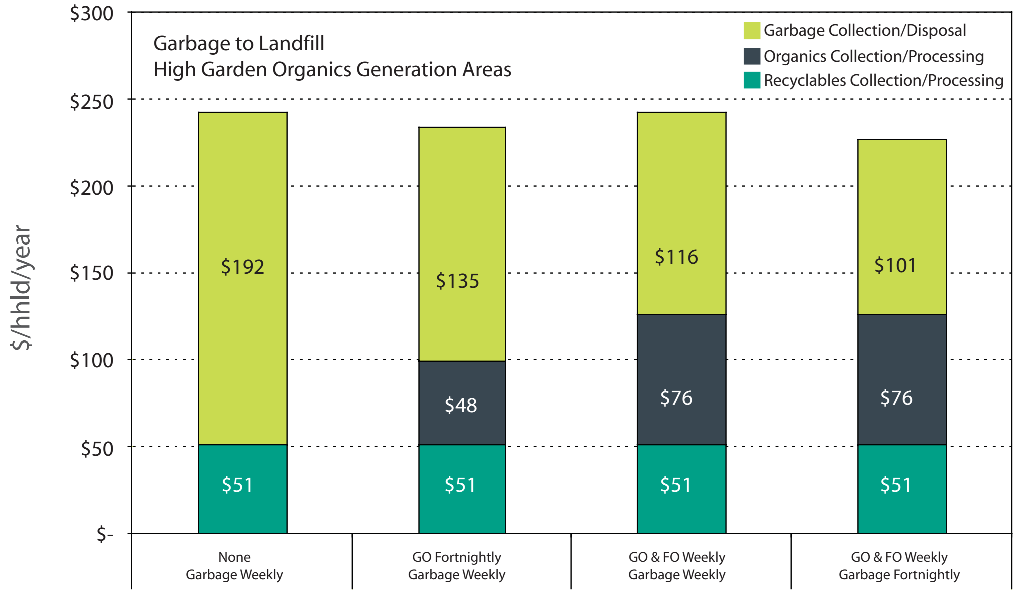
Processing costs for garden organics are increased from $44/t to $54/t.

High GO Generating Areas – Garbage to Landfill

Table 14.6 Waste Management Costs, High GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		Weekly	Weekly	Weekly	Fort'ly
$ Per Household Per Year					
Garbage	Collection	$57	$50	$47	$32
	Disposal/Processing	$134	$85	$69	$69
Organics	Collection	-	$29	$43	$43
	Processing	-	$19	$32	$32
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$243***	***$234***	***$243***	***$228***
LF Weekly Cost		$243	$243	$243	$243
Net Cost of Organics Recycling		***$0***	***-$8***	***$0***	***-$15***
% Garbage		80%	51%	41%	41%
% Organics		0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%

Figure 14.6 Waste Management Costs, High GO Generation, Garbage to Landfill.

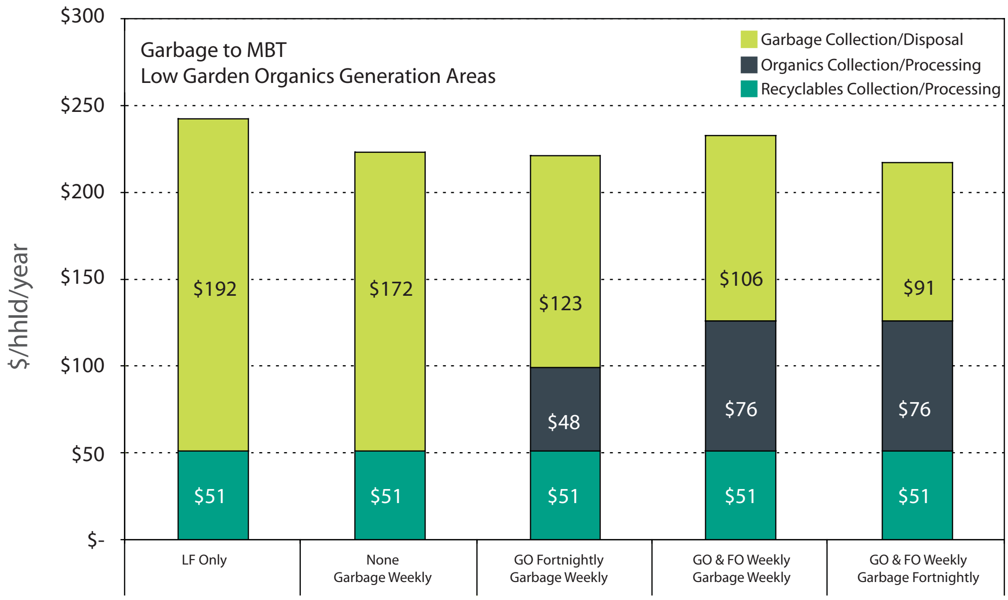


High GO Generating Areas – Garbage to MBT

Table 14.7 Waste Management Costs, High GO Generation, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		LF Weekly	Weekly	Weekly	Weekly	Fort'ly
$ Per Household Per Year						
Garbage	Collection	$57	$57	$50	$47	$32
	Disposal/Processing	$134	$115	$73	$59	$59
Organics	Collection			$29	$43	$43
	Processing			$19	$32	$32
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		*$243*	*$224*	*$222*	*$233*	*$218*
MBT Weekly Cost			$224	$224	$224	$224
Net Cost of Organics Recycling			*$0*	*-$1*	*$9*	*-$6*
LF Weekly Cost		$243	$243	$243	$243	$243
Costs Change Compared to LF		*$0*	*-$19*	*-$21*	*-$10*	*-$25*
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 14.7 Waste Management Costs, High GO Generation, Garbage to MBT.

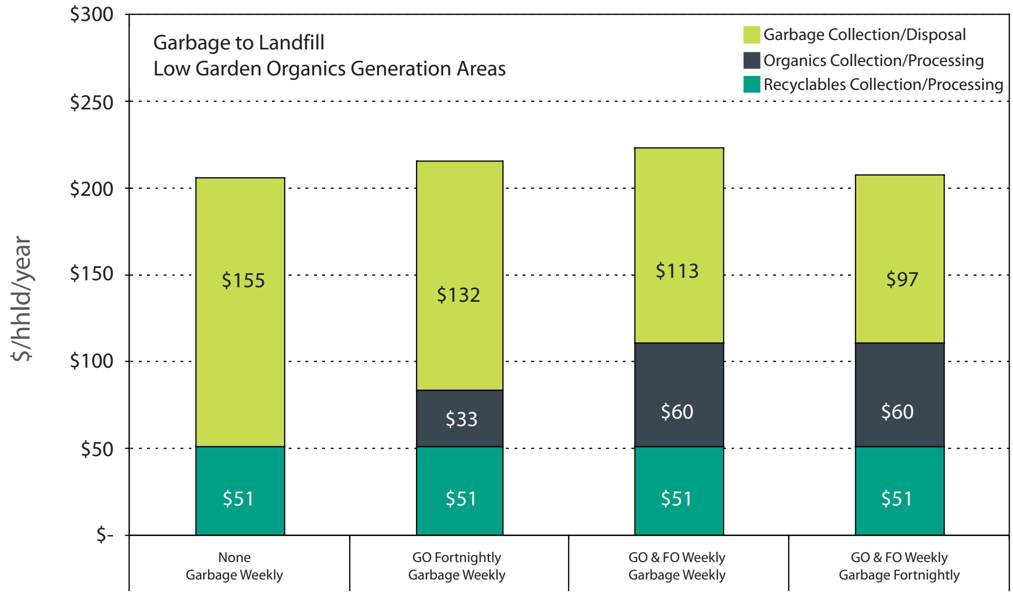


Low GO Generating Areas – Garbage to Landfill

Table 14.8 Waste Management Costs, Low GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		**Weekly**	**Weekly**	**Weekly**	**Fort'ly**
$ Per Household Per Year					
Garbage	Collection	$52	$50	$46	$31
	Disposal/Processing	$103	$82	$66	$66
Organics	Collection	-	$24	$41	$41
	Processing	-	$8	$18	$18
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$207***	***$216***	***$223***	***$208***
LF Weekly Cost		$207	$207	$207	$207
Net Cost of Organics Recycling		***$0***	***$9***	***$17***	***$2***
% Garbage		76%	60%	48%	48%
% Organics		0%	16%	27%	27%
% Recyclables (incl. contamination)		24%	24%	24%	24%

Figure 14.8 Waste Management Costs, Low GO Generation, Garbage to Landfill.



Low GO Generating Areas – Garbage to MBT

Table 14.9 Waste Management Costs, Low GO Generation, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		LF Weekly	Weekly	Weekly	Weekly	Fort'ly
$ Per Household Per Year						
Garbage	Collection	$52	$52	$50	$46	$31
	Disposal/Processing	$103	$88	$70	$57	$57
Organics	Collection	-	-	$24	$41	$41
	Processing	-	-	$8	$18	$18
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$207***	***$192***	***$204***	***$214***	***$199***
MBT Weekly Cost			$192	$192	$192	$192
Net Cost of Organics Recycling			***$0***	***$12***	***$22***	***$7***
LF Weekly Cost		$207	$207	$207	$207	$207
Costs Change Compared to LF		***$0***	***-$15***	***-$3***	***$7***	***-$8***
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 14.9 Waste Management Costs, Low GO Generation, Garbage to MBT.

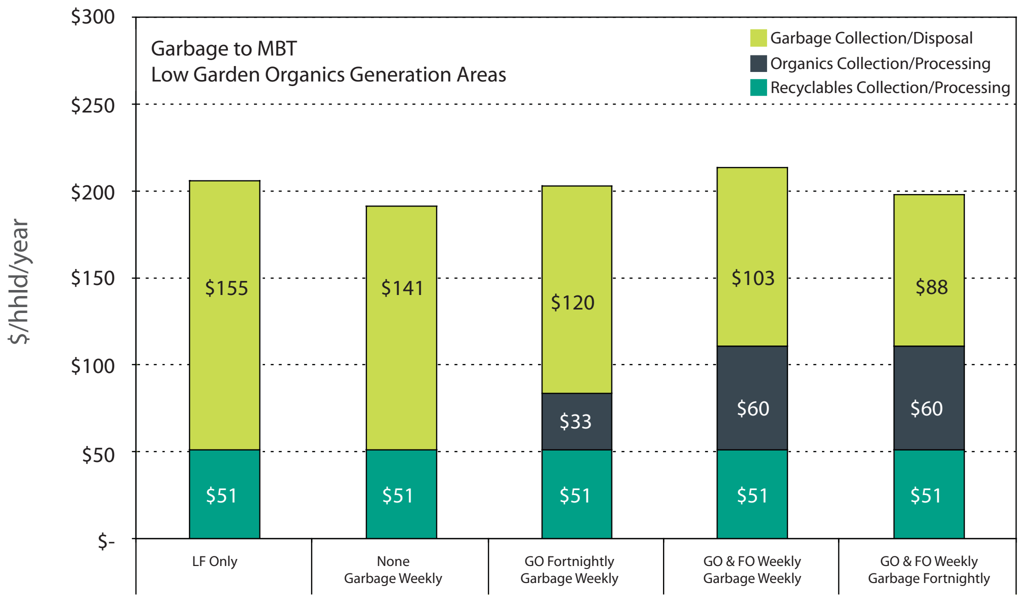
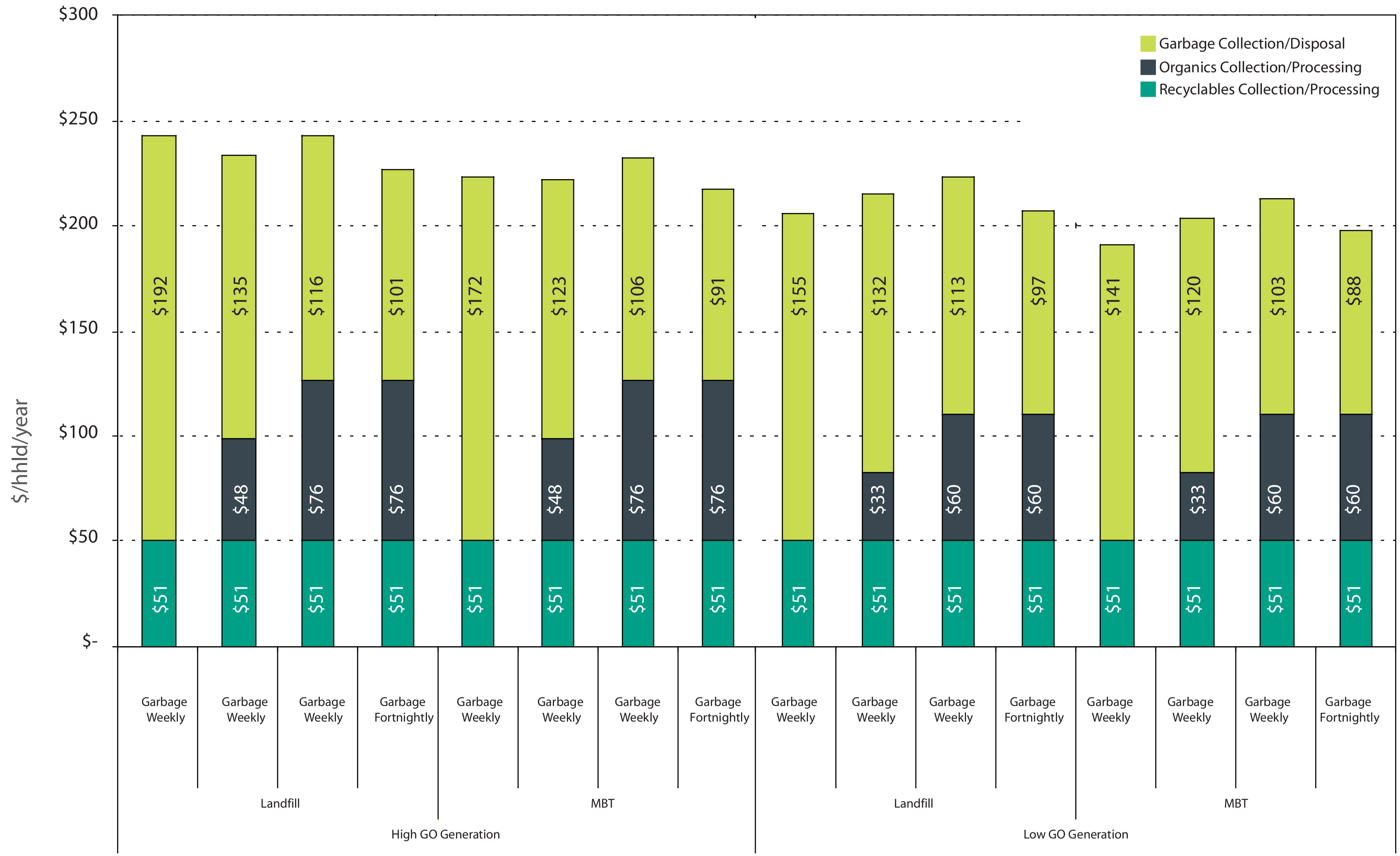


Figure 14.5 Waste Management Costs: Summary for all Systems Investigated – Sensitivity Scenario 1.



14.1.3 Sensitivity Scenario 3 – MBT, landfill fees as per previous study

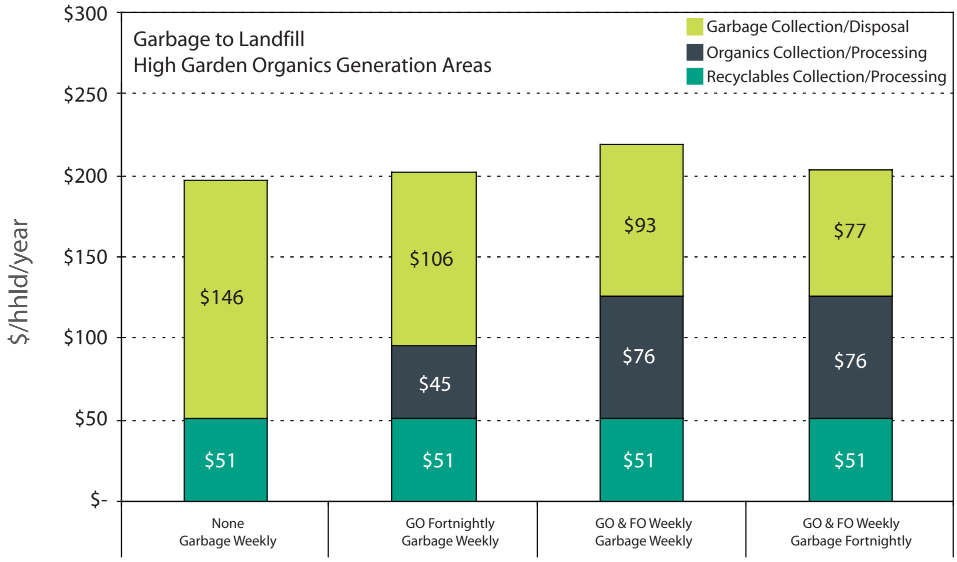
MBT and landfill fees are as per previous study (DEC 2005) to enable a direct comparison (see Table 4 1 for details).

High GO Generating Areas – Garbage to Landfill

Table 14.10 Waste Management Costs, High GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		**Weekly**	**Weekly**	**Weekly**	**Fort'ly**
$ Per Household Per Year					
Garbage	Collection	$57	$50	$47	$32
	Disposal/Processing	$89	$56	$46	$46
Organics	Collection	-	$29	$43	$43
	Processing	-	$15	$32	$32
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$197***	***$202***	***$219***	***$204***
LF Weekly Cost		$197	$197	$197	$197
Net Cost of Organics Recycling		***$0***	***$5***	***$22***	***$7***
% Garbage		80%	51%	41%	41%
% Organics		0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%

Figure 14.11 Waste Management Costs, High GO Generation, Garbage to Landfill.

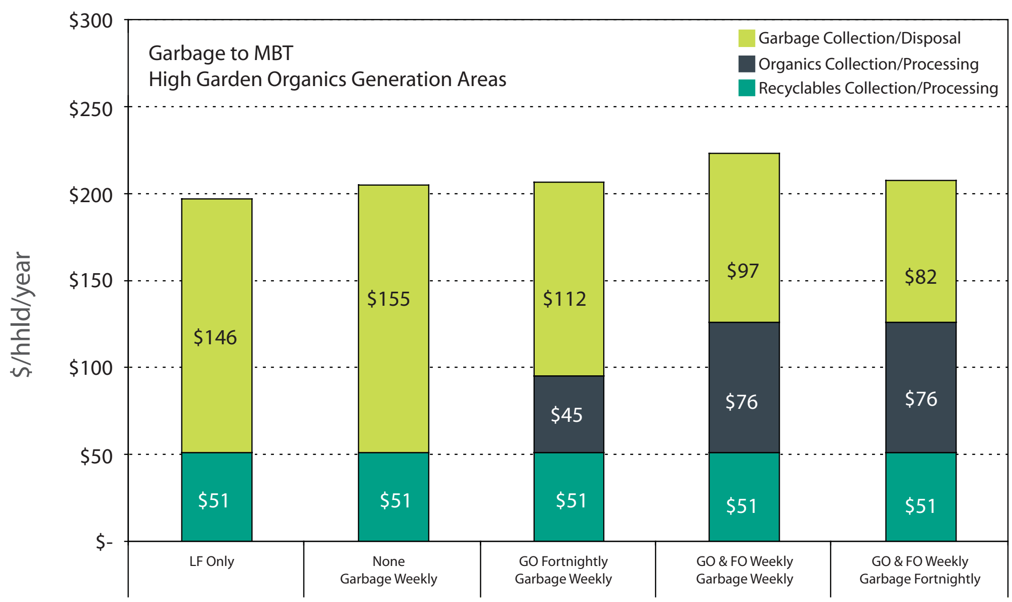


High GO Generating Areas – Garbage to MBT

Table 14.11 Waste Management Costs, High GO Generation, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		**LF Weekly**	**Weekly**	**Weekly**	**Weekly**	**Fort'ly**
$ Per Household Per Year						
Garbage	Collection	$52	$57	$50	$47	$32
	Disposal/Processing	$89	$97	$61	$50	$50
Organics	Collection			$29	$43	$43
	Processing			$15	$32	$32
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$197***	***$206***	***$207***	***$224***	***$208***
MBT Weekly Cost			$206	$206	$206	$206
Net Cost of Organics Recycling			***$0***	***$2***	***$18***	***$3***
LF Weekly Cost		$197	$197	$197	$197	$197
Costs Change Compared to LF		***$0***	***$9***	***$10***	***$27***	***$11***
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 14.12 Waste Management Costs, High GO Generation, Garbage to MBT.

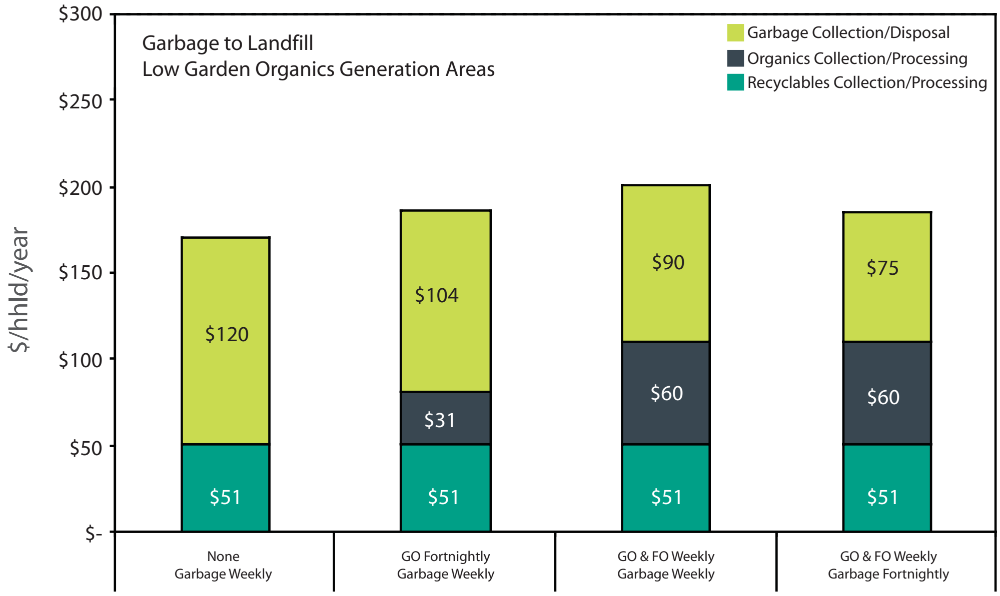


Low GO Generating Areas – Garbage to Landfill

Table 14.12 Waste Management Costs, Low GO Generation, Garbage to Landfill.

Organics Collection		None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		Weekly	Weekly	Weekly	Fort'ly
$ Per Household Per Year					
Garbage	Collection	$52	$50	$46	$31
	Disposal/Processing	$68	$54	$44	$44
Organics	Collection	-	$24	$41	$41
	Processing	-	$7	$18	$18
Recyclables	Collection	$38	$38	$38	$38
	Processing	$13	$13	$13	$13
Total System Cost		***$171***	***$186***	***$201***	***$186***
LF Weekly Cost		$171	$171	$171	$171
Net Cost of Organics Recycling		***$0***	***$15***	***$29***	***$14***
% Garbage		76%	60%	48%	48%
% Organics		0%	16%	27%	27%
% Recyclables (incl. contamination)		24%	24%	24%	24%

Figure 14.13 Waste Management Costs, Low GO Generation, Garbage to Landfill.



Low GO Generating Areas – Garbage to MBT

Table 14.13 Waste Management Costs, Low Generation Areas, Garbage to MBT.

Organics Collection		None	None	GO Fort'ly	Biowaste Weekly	Biowaste Weekly
Garbage Collection		**LF Weekly**	**Weekly**	**Weekly**	**Weekly**	**Fort'ly**
$ Per Household Per Year						
Garbage	Collection	$52	$52	$50	$46	$31
	Disposal/Processing	$68	$75	$59	$48	$48
Organics	Collection			$24	$41	$41
	Processing			$7	$18	$18
Recyclables	Collection	$38	$38	$38	$38	$38
	Processing	$13	$13	$13	$13	$13
Total System Cost		***$171***	***$178***	***$191***	***$205***	***$190***
MBT Weekly Cost			$178	$178	$178	$178
Net Cost of Organics Recycling			$0	$13	$27	$12
LF Weekly Cost		$171	$171	$171	$171	$171
Costs Change Compared to LF		***$0***	***$7***	***$20***	***$34***	***$18***
% Garbage		80%	80%	51%	41%	41%
% Organics		0%	0%	30%	39%	39%
% Recyclables (incl. contamination)		20%	20%	20%	20%	20%

Figure 14.14 Waste Management Costs, Low GO Generation Areas, Garbage to MBT.

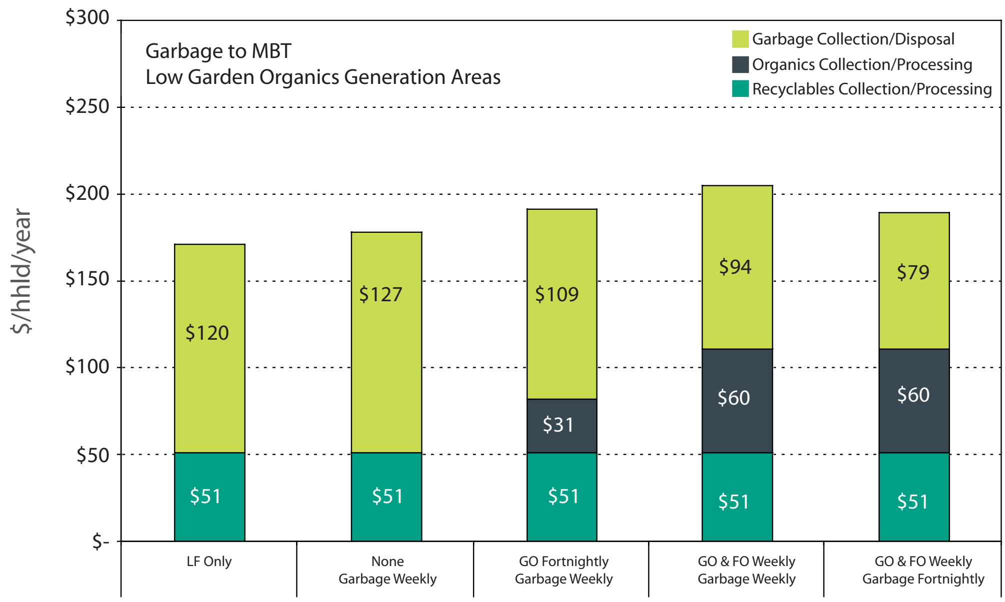


Figure 14.15 Waste Management Costs: Summary for all Systems Investigated – Sensitivity Scenario 3

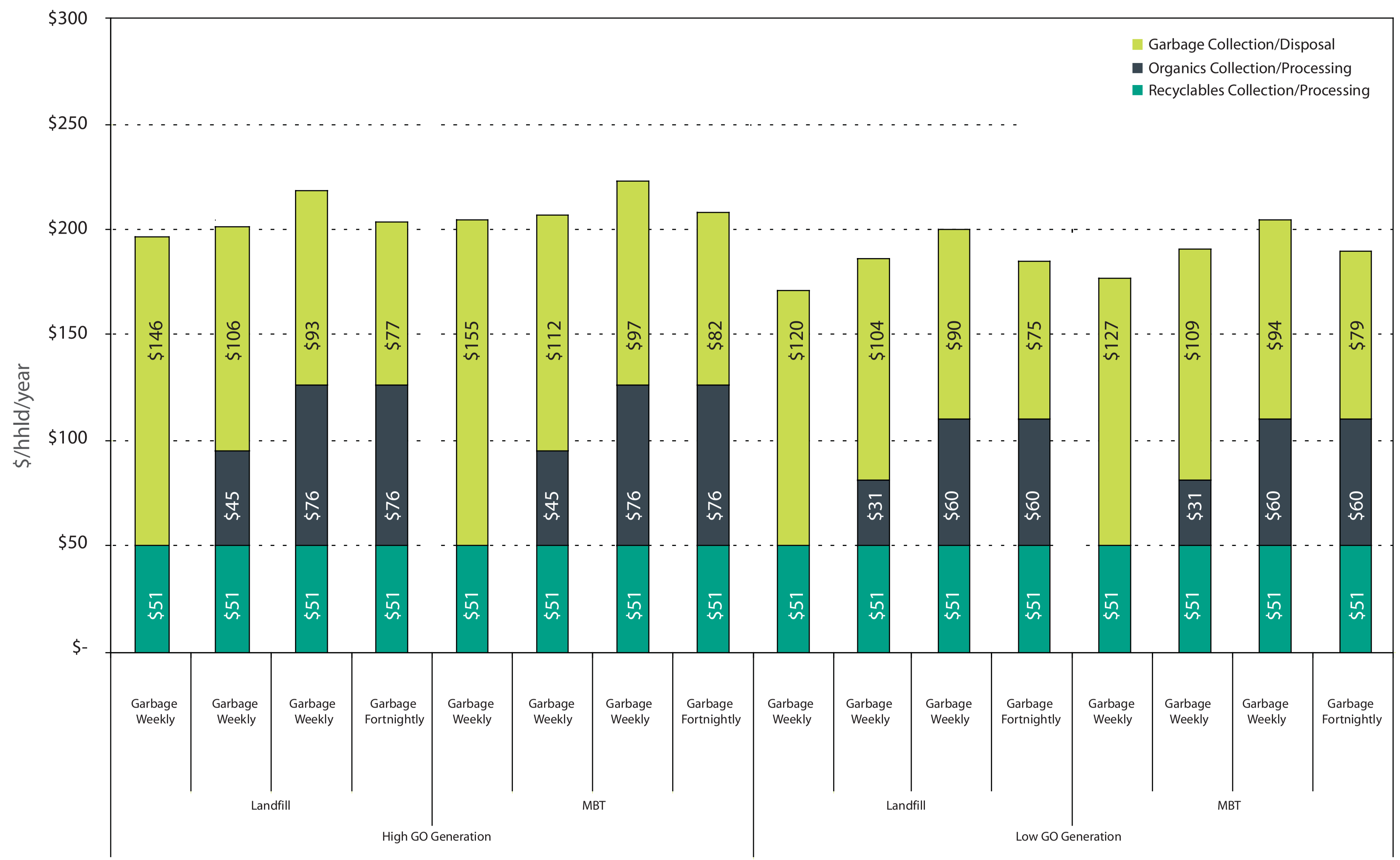


Figure 14. 15

Appendix C

Threshold Capacities for Biowaste Treatment Facilities

Introduction

DEC raised the question of minimum capacities for biowaste treatment facilities, i.e. "if it is found that source separated food organics co-collected with garden organics for processing provides a higher order use, it is conceivable that there may be a shift to smaller scale facilities, for instance in vessel composting with a resultant diminished reliance on larger scale, more capital intensive facilities in SMA than otherwise planned. (less (sic) than the 7 originally proposed by WSN)."

Discussion

All waste processing systems, other than those based on open windrow composting, are modular in nature to some extent, i.e. the number of modules determines the capacity of the system. For example, the number of tunnels will govern the capacity of a system developed around composting tunnels, while the number of percolators will govern the capacity of a system developed around percolation. The processing capacity of modules for differing technologies can vary from as low as 3,000 tpa of MSW input for a tunnel, to as high as 70,000 tpa for a recently developed system.

The other major elements that influence "minimum economic size" are the extent of pre-treatment requirements of the feedstock, maturation and final processing requirements, as well as the extent of environmental protection measures required; in particular, odour control. Hyder believes that for the SMA it would be unlikely that a biowaste processing facility smaller than 10-15,000 tpa could be economically feasible. Although there are numerous examples of biowaste processing facilities of lower capacity than 15,000 tpa operating overseas, such facilities generally service communities in regional areas.

To provide general guidance on "minimum economic capacity" for MBT facilities processing MSW as against source separated biowaste, Hyder has reviewed available information on the sizing of such facilities currently in commercial operation. A recent review conducted by Juniper (1) of operating MBT facilities for processing more than 20,000 tpa of MSW, provided by 27 different suppliers, noted that the bulk of the facilities had been constructed to process between 20,000 and 100,000 tonnes per year. Increasingly, however, facilities in the range in the range of 100,000 to 300,000 tpa are being constructed.

The following table summarises a sample of annual processing capacity for facilities currently in operation for processing MSW, by the major technology suppliers.

Technology	No Of Facilities	Minimum Capacity Tpa	Maximum Capacity Tpa	Average Capacity Tpa
Bedminster	11	25,000	247,000	81,300
Biodegma	4	37,000	200,000	98,000
BTA	5	22,000	100,000	53,400
Ecodeco	11	40,000	180,000	88,100
Haase Anlagenbau	4	50,000	200,000	121,000
Herhof	9	85,000	220,000	134,000
Horstmann	17	50,000	480,000	134,000
ISKA-GRL	4	30,000	175,000	134,000
Linde	31	22,500	300,000	110,000
OWS	6	20,000	120,000	70,000
Valorga	7	100,000	265,000	168,000
VKW	6	60,000	270,000	158,000

For the 115 MSW MBT processing facilities covered by this sample, the weighted average processing capacity is 113,000 tpa.

The Juniper review also included 72 facilities designed specifically for processing source separated biowaste, covering nine different technology suppliers. While the review did not cover all such facilities currently in operation around the world, it is considered to be a reasonable sample of currently available technology for processing biowaste. The technologies included aerobic and anaerobic systems. The annual processing capacity for the facilities identified is shown in the following table.

Technology	No Of Facilities	Minimum Capacity Tpa	Maximum Capacity Tpa	Average Capacity Tpa
Biodegma	15	6,500	40 ,000	16 ,200
BTA	20	1 ,000	150 ,000	22,600
Horstmann	11	12 ,000	75 ,000	27,200
Linde	29	3 ,000	85 ,000	N/A
OWS	8	11 ,000	40 ,000	25,750
Ros Roca	7	4 ,000	43 ,000	23,300
Sutco	6	6 ,500	50 ,000	24,400
Valorga	4	20 ,000	100 ,000	65,000
VKW	3	20 ,000	40 ,000	27,300

For the 74 biowaste MBT processing facilities covered by this sample (excluding the Linde facilities), the weighted average processing capacity is 25,000 tpa.

It is noted that there are companies/technologies which have established/operate many facilities of this kind which have not been included in the above table. The reason for this is not known.

Conclusion

Commercial facilities for processing biowaste are, on average, operating at a capacity of around 25,000 tpa. This compares with around 100,000 tpa for MBT facilities processing MSW. The main reasons for this difference is the lower quantity of biowaste (compared to residual MSW) available within a catchment area of feasible transport distances, combined with a somewhat different cost/revenue structure.

It should be noted, however, that, as for MSW processing facilities, the cost of operating biowaste processing facilities is subject to economies of scale. A study conducted by International Energy Association (2) found that the treatment cost for processing biowaste declined with increasing treatment capacity, tending to asymptotic at around 40-60,000 tpa. However, there is evidence that treatment costs for smaller units have come down over the years, and there may not be any significant economies of scale for plants greater than 40,000 tpa.

The question of "minimum economic capacity" for biowaste vs MSW processing facilities in the SMA is complex. For example, many of the small-scale facilities processing biowaste in regional areas would not be suitable for the SMA where a high standard of environmental control would be required. Issues such as site availability (with suitable buffer zones), project development costs and transaction costs are significant in the SMA and are likely to work against the economic viability of small-scale facilities.

Hyder believes that the question raised by DEC is a complex one. Whether the optimum number of facilities for the SMA could be different to the 7 suggested by WSN, would require consideration of the technology or technologies selected, and optimising facility cost and transport costs as part of an overall system.

(1) Mechanical-Biological-Treatment: A Guide for Decision Makers. Processes, Policies and Markets. Annex D, Process Reviews. Juniper Consultancy Services Ltd, March 2005.

(2) Biogas and more! IEA Bioenergy, July 2001.

Appendix D

Impact of Co-Collection of Biowaste on MBT Facilities

Introduction

DEC comments were: "Internally there is debate regarding the merits of assessing impacts on AWT. One view is that Policy should drive technology – not the other way around. The different view is that we have a government-owned facility[13] that is potentially impacted, so it may be beneficial from a 'whole of govt' sense to understand the impacts of Policy changes. There is a strong view that irrespective of co-collection by some or many councils, that predominant types of AWT may not be so starved of organics as to become unviable.

> *Can the proposal be amended to reflect a generic (only) assessment of co-collection, perhaps suggesting threshold values for generic technologies?"*

Discussion

Within the SMA, more than half of all councils provide separate collection systems for garden organics that are currently processed into a range of horticultural products. The existing Government MBT facility, nor other generic MBT technologies, do not depend on these garden organics as part of their feedstock, although the existing facility has the capacity to accept some shredded garden organics to act as bulking material in the compost hall. Such facilities would, therefore, only be impacted to the extent that introduction of co-collection of biowaste with garden organics would reduce the quantity of biowaste currently being presented as part of the MSW stream.

In terms of reduction in organics present in the garbage stream, the changes would be of a lesser magnitude than commonly expected. Even at very high recovery rates of both garden and food organics, the organic content in garbage would still be between 15 and 20%. This is also the experience in countries/municipalities where separate biowaste collections are in place since a number of years.

Other than for thermally based systems, most MBT systems designed for treating MSW involve some form of front-end sorting to concentrate an organic fraction for further processing by either aerobic or anaerobic means to manufacture various products. An MBT facility's capacity is determined by its capacity to process this organic fraction, with the front-end system generally having considerable capacity flexibility. To the extent that the front-end at the existing facility could process additional quantities of MSW, a reduction in the organic content of the MSW feedstock would actually allow the facility to increase its throughput. As the major income stream to such facilities is the MSW processing fee (the income from recycled organics is generally not a significant source of revenue), the income to the operator of the facility would increase without an appreciable increase in costs.

There is considerable flexibility in most MBT technologies to adjust to changing compositions. Even in the event that actual 'waste stabilisation' should become the predominant driver for MBT facilities (as is the case in most overseas jurisdictions), the expected changes in residual waste composition will not alter the cost/revenue structure to the extent that this would significantly influence councils' overall waste management costs, and would be entirely insignificant in terms of State waste policy (not more than several dollars per tonne of waste input).

Conclusion

While the co-collection of food organics with garden organics would reduce the organic content of MSW delivered to existing or future MBT facilities, it is unlikely that this would adversely impact the economic viability of either the existing or any future MBT facilities. Such facilities are designed around the organic load to be processed. Hence any future facilities would design their process around the resultant lower organic load associated with a co-collection policy.

In the case of the existing facility, decreasing organic content could be offset by increasing facility throughput, as far as additional quantities of MSW could likely be handled through the front-end processing system. This is likely to result in additional revenue for the operator. The actual extent possible of such adjustment would need to be assessed in conjunction with the operator.

[13] NB: It is privately owned, with a contract to a government-owned waste service provider

Appendix E

Site Specific Impacts for Biowaste Treatment Facilities

Introduction

On the draft brief, DEC commented that "More discussion of types of processing that might be suitable for co-collected materials and relative benefits has been suggested. "

It was agreed that Hyder would express our professional opinion about the life cycle environmental performance of the various processing options. This aspect has been covered in the body of the report. In addition, it was agreed that Hyder would provide a brief discussion on the site specific impacts of the various processing options, specifically odour emission potential which is by far the single most important site specific issue with facilities of this type.

Discussion

Biologically based MBT systems designed for treating MSW usually involve extensive front-end conditioning (including classification) to concentrate an organic fraction for biological treatment. In the case of biowaste processing facilities, this requirement is confined to removing contaminants from the feedstock and hence the footprint for such facilities is somewhat smaller than for facilities processing MSW.

The processing of biowaste and MSW, by either aerobic or anaerobic means, generates considerable quantities of highly odorous gases. These gases need to be contained and treated prior to discharge to the environment. Hence all unit operations involving the possible generation of odours need to be enclosed and kept at negative pressure to avoid odour release. It would be fair to say that odour management is the key challenge facing the designers and operators of such facilities, and that the willingness of a community to accept such a facility will be determined by the success or failure of the facility's operator to manage the odour issue.

In general, anaerobic decomposition produces stronger odours than aerobic decomposition. However, in these facilities the generated gas is highly concentrated and 100% captured and combusted to produce electricity. Despite a lack of adequately documented evidence the authors are of the view that – in general – anaerobic facilities have a slightly reduced potential of odour emissions compared to aerobic (enclosed) facilities.

All MBT facilities manufacturing compost products will require a considerable area for maturing the raw compost. While there would be little difference in the area required for aerobic and anaerobic systems, from a site specific consideration there is likely to be an issue as to whether the maturation area needs to be enclosed.

Conclusion

Odour control is the principal environmental issue facing processing facilities for MSW and biowaste. While there is little difference between aerobic and anaerobic systems in the generic context, very careful consideration would need to be given to odour control for any selected technology on a site specific basis.

Department of **Environment and Conservation** NSW