

# Modelling WCA Collection Systems Costs, Performance and Outputs

Hertfordshire Waste Management Partnership

May 2006



Funded through  
the Waste Implementation Programme,  
Local Authority Support Unit - Direct Consultancy Support  
Programme

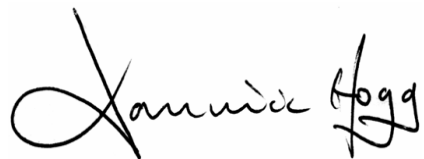


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# 1.0 Executive Summary

Eunomia is pleased to present this report considering the costs and performance of various collection systems that the districts and boroughs of Hertfordshire might chose to adopt. This study forms part of much larger piece of work, also being carried out by Eunomia, to revise the Hertfordshire Municipal Waste Management Strategy with the aim of maximising performance and minimising cost in the context of changing national policy.

Cost and performance outputs have been examined for a very wide range of different collection system configurations. These outputs have been developed through a process of scenario modelling using Eunomia's proprietary waste collection cost model. The methodology used and the model's principle inputs and data sources is described in Section 2.

*The purpose of this report is not to make specific recommendations regarding the types of system that any or all Waste Collection Authorities (WCAs) should adopt. System selections are informed by a very wide variety of parameters which cannot be properly captured through a numerical analysis such as is presented here. Political acceptability, public perceptions, local operational factors, procurement cycle considerations, contract issues and other factors all play a part in determining service selection and defy spreadsheet analysis.*

*Instead of making specific service configuration recommendations, the overarching purpose of this report is to illustrate, through transparent quantitative analysis, the likely relative cost and recycling performance of various system adjustments and to shed light, therefore, on the collection system changes that may be both productive and affordable. In so doing, it is hoped that this document can support the decision-making of responsible Council members supported by expert officers who will be able to properly weigh the various factors affecting service selection alongside cost and performance.*

The services that have been selected for modelling are based on those that are currently used and likely evolutions from these. Additionally, and so that the study reflects current best practice beyond the County boundaries, nineteen further system configurations were considered and ranked with the best of these taken forward for detailed modelling on a district-by-district basis. The methodology by which services were selected for detailed examination is described in Section 3.

The modelling work completed, indicates that whilst performance is already, generally, encouragingly high, the performance of kerbside recycling schemes could be improved still further without incurring excessive extra cost. All systems modelled assumed that:

- Where the range of materials collected is not already comprehensive, that over time it will become so.
- Education promotion and information drives to raise participation and awareness will be ongoing and will steadily and incrementally (rather

than dramatically) be successful in driving participation and performance upward.

The most successful scenarios modelled were based on:

- The Alternate Week Collection (AWC) of residual waste. This is not to say that excellent performance is unachievable with weekly residual collections, only that performance can be lifted still further and costs lowered, when this stream is collected in such a way as to incentivise participation in the recycling services that are offered.
- Collection of kitchen waste, with performance dramatically improved where the collections of this material are made weekly.

Further improvements in cost and performance beyond that which is achieved through the above adaptations, are achievable but the necessary service alterations may not be appropriate or, for a variety of reasons, desirable. The specific changes that drive maximal performance include:

- The adoption of a policy of compulsory recycling.
- The separate and weekly collection of kitchen waste.

In the case of both of these changes, it is recognised that there is a risk of public opposition and, in the case of separate kitchen waste collections, that there may be wider operational difficulties. For this reason, these service changes, whilst perhaps inappropriate in the short term, should be revisited at a later date.

Detailed analysis of modelling outputs can be found in both Sections 3 and 4.

In modelling costs, this study has taken a whole system view so that rather than splitting collection and disposal costs, the total burden on the taxpayer has been examined. Because the cost balance benefit of recycling focussed systems is predicated upon a very safe assumption of high future disposal costs, it is essential that the benefits of higher performing recycling systems (in terms of reduced disposal and treatment costs) are felt not just at the WDA level but are properly transferred to the WCA where additional collection costs will be incurred. Options for partnership working (including the development of a mechanism for sharing disposal and treatment savings) should therefore be explored as a matter of priority if whole system costs are to be optimised and council tax payers interests' best served.

## 2.0 Model Description and Methodology

### 2.1 Introduction

This study relates to the production of realistic projections of achievable recycling and composting captures by Hertfordshire's WCAs so that the quantity of material requiring treatment and disposal can be understood. In order to understand what is practically possible, it is of course essential to also consider the costs of the various waste collection options being examined.

These outputs have been developed through a process of scenario modelling and the methodology for developing these is, therefore, centrally important to the credibility of the results. The following sections describe the model, its principle inputs and the sources used for these.

### 2.2 Description of Model

Eunomia Research and Consulting's proprietary waste collection cost model is a sophisticated spreadsheet based tool that allows a wide range of variables to be accounted for and which enables the optimisation of scenarios to accurately reflect local circumstances. The scenarios selected for examination and the selection methodology are discussed in detail in Section 3.0.

The recycling performance of each collection system scenario is built up by specifying a range of performance parameters for each component of the system. Performance parameters include weight and volume of material collected by current systems, residual composition, the materials targeted by each collection service, the number of households of each type (e.g. detached, semi-detached, terrace etc) that the service is available to, the participation rate of those households and the recognition rate achieved from participating households for the materials targeted.

Costs are accumulated by the model from cost data extracted from a database within the model. The model calculates the numbers of vehicles, containers, and crew required and multiplies these by their unit costs. Disposal costs and net cost/income from material sales are also calculated and included. Finally the model adds overheads for management and administration, depot costs, and insurances and financing. Although capital requirements are shown in the model, annual costs are based on the amortised cost of capital using depreciation periods and interest rates entered by the user as appropriate.

### 2.3 Limitations of Model

It is important alongside the discussion contained within this section regarding the workings of the model, to also be explicit about the limitations of a modelling based approach.

Because this and similar models are built upon a wide range of different types of data and takes account, therefore, of all important parameters affecting

performance; and because it produces quantitative results which are presented in graphs and tables, there is a tendency to impart to the outputs of the process greater authority than may be fully justified. Indeed, for a number of reasons, the results of service modelling can be interpreted and used by the unwary (or unscrupulous) as if these were firm and reliable predictions of future outcomes.

All data and performance assumptions that are used are based on the best available information and are open to external scrutiny. However, even when using the very best information as carefully as possible, as we hope has been done here, predicting the future with a high degree of accuracy is far from straightforward. Assumptions used are based on expectations regarding a number of different types of issue including but not limited to the following areas:

- The political, legislative and regulatory environment;
- social factors relating to resident participation in services; and
- recycle and technology market conditions.

Events may lead to expectations in any of these areas to change unpredictably, thus affecting adversely the accuracy of the modelling work that is presented.

Baseline cost modelling of current services must, without detailed service survey and cost auditing, be based upon industry standard costs rather than the actual service delivery costs as they are incurred by each separate district. Also, certain cost components which are included within the model, such as those associated with Health and Safety, legal support, personnel support and even depot and facility rental values may not be included as budget line items within a given authority's calculations of service cost and may, instead, be met through other budgets. There will, inevitably therefore, be variation between what is reported by the model as representing baseline costs and what is internally reported by a given authority. Some of this discrepancy will relate to the peculiarities of specific contracting and procurement arrangements or locational constraints and some will relate to authority budgeting conventions.

This is not to say that a modelling based approach to planning is without merit; it is indeed essential to attempt, as accurately as possible, to estimate the likely performance of the various systems that are available when making long term and costly selections. In using this approach assumptions and prejudices, where they exist, cannot be hidden but are instead available to be discussed. This means that decisions can be made on the basis of the best available information rather than for reasons of any hidden bias.

Most importantly, though, all assumptions are held in common across the modelling of all systems under consideration. This means that comparisons between systems to consider the relative performance, as opposed to the absolute performance, of these systems will therefore be fairly represented by the model.

Furthermore, having examined the alternative models that are currently most widely used, Eunomia is confident that the modelling tool that we have

developed and have used for this exercise, is at least as good as (and perhaps much better than) any other available.

It would make reading (and writing) this report unnecessarily awkward were this caveat regarding the probable accuracy of a modelling approach to be included together with all results wherever they are discussed. However it is strongly recommended that that when considering the outputs of the modelling as described herein, absolute results – precise recycling rates and system costs – be read as indications of performance ranges and not absolute quantities.

## 2.4 Baseline Modelling

In order to set-up and calibrate the model for use within each specific borough or district, it is necessary to first model current collection systems. This allows for performance calculations to be tuned so that the model accurately generates current and known real-world outputs.

### 2.4.1.1 Inputting of baseline data.

For each WCA, the following data was obtained and inputted into the model:

- **Population.** Population data for the base year was based on information supplied by the ONS (Shire Districts: 1996-based England SNPP. Last update 27/01/05<sup>1</sup>). This information was then projected forward on the basis of calculations made within the Hertfordshire baseline report (+0.25% per annum).
- **Household numbers.** Household data for the base year was provided by each district. These were then projected forward on the basis of calculations made within the Hertfordshire baseline report (+0.83% per annum).
- **Numbers of houses by type of housing stock.** Housing stock types are taken from the percentage split (detached, semi-detached, terraced and other) for each WCA from the ONS census statistics. The 'other' household types are, in some cases, further subdivided based upon the number of households reported by the districts not to receive a standard residual waste collection service. It has been assumed for the purposes of modelling that such households are high rise flats, and a paladin collection round for residual waste has been assumed. This housing stock split has been assumed for both the baseline and long term models.
- **Residual tonnage data.** This was based on the latest available data for each WCA as supplied by HCC. Residual tonnage data used in the model included material collected as part of the household waste collection but did not include CA site waste, trade waste, street sweepings or clinical waste collections. Future projections of residual and recycling tonnages were calculated using information supplied by the County. For future projections, the waste growth rate was assumed

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<sup>1</sup> <http://www.statistics.gov.uk/statbase/ssdataset.asp?vlnk=4739&More=Y>

to be 1.5% per annum, as discussed in section 6.3 of the baseline report.

- **Recycling tonnage data.** This was based on the latest available data for each WCA and taken from the records showing recycling credit claims and other recycling performance as contained within the HCC 'County Collected Waste Management Statistics'. It did not include CA site recyclables and composting or, generally speaking, materials collected from bring sites (because the focus of the analysis was kerbside collection services).<sup>2</sup> Tonnages were supplied for total quantities of paper recycled. However, for the purposes of modelling, this tonnage was split between newspaper and pams and 'other paper' in a 60:40 ratio. Furthermore, no separate tonnages were provided for ferrous and aluminium tonnages captured. Therefore, based on experience elsewhere the metal tonnages collected were split such that 80% is ferrous and 20% aluminium. It is important to note here that the baselines have been modelled for services in 2004/05. Where service changes have been made since April 2005 these will not be reflected in the modelling.
- **Composition data.** The composition data can have a significant effect on the overall performance of all the recycling systems modelled, as the composition of the residual waste stream effectively represents what is available to capture. Local composition data was not available but this is not felt to undermine the modelling generally. Frequently where local data is available the analysis methodology that has been used is relatively cheap and the data that is output, therefore, is less robust. Single season, or small sample, analyses can provide a misleading picture of what is available to target within the waste stream. On the other hand, where good studies have been done these often show a good level of convergence with national data, suggesting that national consumption habits are reasonably but not entirely similar. For that reason, it is certainly preferable and adequate to use good national data than it is to use poor or uncertain quality local data. Therefore the most comprehensive national dataset was used<sup>3</sup>, which is methodologically considered to be sounder than any other large-scale study and indeed, in part, constitutes a meta-study of other major compositional studies that have been carried out.
- **Travel time by housing type.** Travel speeds between houses were estimated based on known collection times and environmental factors. The average speed with which collection vehicles are able to travel between houses is primarily a function of the housing density and traffic and road conditions. Although these are subject to large variations

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<sup>2</sup> In the case of some of the data, where bring bank material is shown as being combined with kerbside collected material then it has been necessary to make assumptions about how this material has been split. Where this has been done, and this is rare, then this is made explicit and explained.

<sup>3</sup> Analysis of household waste composition and factors driving waste increases. Julian Parfitt. WRAP December 2002.

over time it is believed that they are broadly correlated to housing type: where housing is denser it takes less time to get to each house but average speeds are lower as vehicles need to keep stopping and re-starting. Similarly housing density is generally correlated with narrower streets, more difficult access due to cars parked next to the kerbside and higher levels of traffic congestion particularly at peak times.

- **Participation and set-out rates.** The participation and set-out rates for current (baseline) configurations were not provided to the project team. Therefore it was necessary to estimate these using known tonnage figures. Dividing known tonnage outturns by the number of households to which the services are available gives an average contribution per household to total captures from which total participation rates can be estimated. The capture rate figures for paper were surprisingly high in all but three of the districts and required that the composition data be amended to reflect the fact that there appears to be greater quantities of this material in the Hertfordshire waste stream than in the national waste stream. This is not unexpected given the Hertfordshire demographic within which it is felt likely that there are more readers of broadsheet newspapers. However, even given this assumption, the tonnages provided revealed both higher than expected participation (and set-out) rates for the services currently in place *and* higher proportions of news and pams than one would normally expect to be present. Glass tonnages were also higher than the national composition data would suggest in St Albans and Three Rivers Districts and the composition data has been amended to reflect this.<sup>4</sup>

#### 2.4.1.2 Collation and inputting of background data relevant to the selected systems:

- **Vehicle specifications and performance data.** Actual cost and performance data for a range of vehicle types that are either being used in current collection systems, or that are deemed probable options for future collection systems have been obtained from manufacturers and entered into the model over time and are not specific to this project. Performance parameters include working payloads by weight and volume, required or average crew sizes, fuel

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<sup>4</sup> Whilst participation rates and the proportion of paper in the waste stream are certainly higher than Eunomia would expect to find, this is not to say that they are necessarily inaccurate. Not only do preconceptions suggest that Hertfordshire residents read more newspapers than residents of the average County, it is also entirely possible that Hertfordshire residents participate in greater numbers in using the recycling services provided to them than do the residents of other Counties, participation commonly being found to be linked to high levels of educational achievement and income. Nine of the ten WCAs in Hertfordshire are amongst the top 40% least deprived as measured by the ODPM Indices of Multiple Deprivation (with Stevenage ranking just below the 40%ile and five of the WCAs within the top 20% least deprived). For more on the relationship between educational achievement, income and participation in recycling services see, Eunomia and CRN (2003) *"Maximising Recycling Rates, Minimising Residuals"*, A Report to the CRN, May 2003, pp 12-14. See also Peter Tucker (2003) *"Understanding Recycling Behaviour"*, University of Paisley, 2003, Vol. 2, pp 61, 156.

efficiency, capital cost, and type and number of types of materials able to be separately collected.

- **Container specifications and costs.** Actual cost and performance data for a range of container types that are either currently being used in the collection systems or that are deemed probable options for future collection systems have, over time, been obtained from manufacturers and entered into the model. Performance parameters include container volume, life expectancy, and unit cost. As part of the validation exercise undertaken for this report, the cost of the containers used was checked with potential suppliers.
- **Personnel costs.** Personnel costs are based on known industry costs used in collection contracts. Costs for a range of positions have been obtained through discussions with operators and DSO management and entered into the model including management, supervisors, administrative support, HGV drivers, Non-HGV drivers, collection crew and yard crew.
- **Depot and overhead costs.** Overhead costs including insurance, performance bonds, administrative support, rent, legal and accounting costs were estimated and entered into the model. Depot costs are calculated based on estimated rental/lease costs, building maintenance, site works, machinery operation and site personnel costs. Costs for these elements were considered to be shared across all collection systems and were apportioned relative to the tonnages handled by each system.

## 2.4.2 Scenario Modelling

Having developed the baselines it was then possible to use these as a foundation for the development of various scenarios in which more comprehensive ranges of collection services are combined to derive the performance and costs of these service configurations.

### 2.4.2.1 Selection of specifications for each scenario

- **Materials to be collected by each system.** The model allows for up to five integrated collection systems to be modelled together, comprising up to four collection systems for recyclable or compostable material plus one system for the collection of residual material. Materials specified as being collected by one of the recycling or composting collections are subtracted from the residual component based on the specified capture rates.
- **Capture rates.** Capture rates for each material and housing type were specified by estimating the coverage of each system and nominating a participation rate for each system and a recognition rate for each material type in each system. In the baseline scenario, as described above, this was calculated so as to be equal to reported historic tonnages collected for the relevant materials. In those scenarios which projected forwards, these known rates were adjusted to account for system design factors that would improve the participation or

recognition rates. Factors such as increasing the frequency of a collection or container size, for example, are assumed to yield an increase in capture rate. It is also assumed that the implementation of the long term scenarios will be accompanied by an extensive education campaign, and that this will affect the overall capture rates for each system.

- **Rejection rates.** Rejection rates for materials collected from kerbside and processed through a Materials Recovery Facility were estimated based on reported current rejection rates by MRF operators.<sup>5</sup> As it was assumed reject material would not be collected in kerbside sort systems, no rejection rate factor was applied to dry recyclables collected in this way since unsuitable materials would be left at the kerbside for collection with the residual waste.<sup>6</sup>
- **Frequency of collection.** The frequency for each collection system was specified by the number of collections that would be performed each year. This was weekly, fortnightly or monthly.
- **Container type and size.** The type of container to be used for each system was selected from the model's database. The model calculates the available volume of material per household each collection day to allow optimisation of container volumes.
- **Vehicle type and number.** The type and number of vehicles to be used for each collection system was selected from the model's database. As a default, the model automatically calculates the optimum number of vehicles required based on the time available, the number of households to be collected from, and the quantity of material to be collected. This number can be adjusted manually to allow for other factors such as down-time and redundancy, or to make allowance for spare vehicles.

#### 2.4.2.2 Calculation and adjustments

As the data was inputted into the model, the potential performance of each system was calculated and a range of output data generated, which were used to evaluate each scenario. Following initial input of the above data the models were subjected to an extensive audit and review to ensure all specifications had been correctly entered and that they were an accurate reflection of what could be expected in terms of the performance of each

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<sup>5</sup> Although the Cleanaway MRF at Greenwich is reporting rejection rates of only 3%, this figure has not yet, to the best of the authors knowledge, been audited and is not representative of figures which are more normally quoted and which fall in the 5-10% range. For the purposes of this exercise, all scenarios which require the use of a MRF for the automated separation of dry recyclate into its constituent material streams have factored in a rejection rate of 10% which is felt to be realistic.

<sup>6</sup> In practice, reported rates are of the order 0.5% and below, with most of the rejects being of plastic bags used to contain materials. These 'reject' bags are useful to collectors as they improve materials quality and they make the sorting process quicker where they are used to keep materials separate.

system. Minor adjustments to performance parameters were made to the scenarios before the final results were produced.

## 2.5 Performance Assumption Guidelines

The assumptions used to calculate the performance of each scenario are critical to determining the outcomes, particularly when it comes to estimating future capture rates of materials targeted for recycling and composting. There is a high level of potential for bias towards favoured systems even with the best of intentions on the part of the modellers. In order to minimise the risks of bias the following guidelines were established regarding the assumptions used.

### 2.5.1 General Modelling Assumptions

- In all cases the long term nature of the scenarios meant that it was assumed that waste education has long been in effect and promotional campaigns are achieving positive results. The performance data was based on experience of known system performance currently achieved by similar and well operated systems in Europe.
- Convenience to the householder is a key factor affecting capture rates. It is assumed that weekly collections are most convenient to the householder and that all other factors being equal, a weekly collection yields a higher total quantity of material than a fortnightly or monthly collection.<sup>7</sup> However, if a weekly system were used for residual waste collections then this negatively impacts the recycling rates for other elements of the system.
- A wheeled bin is considered the most convenient recyclables receptacle, followed by a box, then the sack and reusable bag system<sup>8</sup>. For the purposes of this exercise a differential of approximately 10% was assumed in the relative performance of the wheeled bin compared to the box and the sack. All other factors being equal therefore a wheeled bin was assumed to yield the highest capture rates for whatever material it was used for. However, kerbside box based systems benefited from a zero rejection rate of collected material.
- At each stage, checks were conducted to gauge the available space in the container. Spare capacity was considered both for the average

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<sup>7</sup> This is especially true of 'on vehicle sort' systems. For co-mingled systems, the use of wheeled bins is more common which provide greater materials storage capacity. In commingled systems, therefore, volume becomes less of a constraint if the collection frequency is fortnightly.

<sup>8</sup> This performance hierarchy of container types is generally accepted in the industry across the world and is supported by a range of studies including the following:

Warren, M. (1998). The Role of Containers in Garbage and Recycling, paper presented at the Waste Management Institute New Zealand Incorporated Conference, Rotorua, November 1998.

Northern Sydney Waste Board (1996). An Analysis of the Kerbside Recycling Collections in the Northern Sydney Waste Board Region. Available online at <http://www.epa.nsw.gov.au/waste/wg-37.htm>

Chicago Recycling Coalition (1993). Annual Report 1993, Chicago's Blue Bag Recycling Program – Potential Problems & The Blue Bag Challenge, Chicago Recycling Coalition, Chicago.

recycling household and also higher recycling households as described by a normal distribution curve of recycling performance per individual household. Systems were optimised so that higher recycling households would not suffer a shortage of containerisation space. Similarly, restricting or making residual disposal less convenient was assumed to increase diversion through the other collection systems.

- It is assumed that sufficient processing technology infrastructure is available to enable the processing of co-mingled recyclables and in-vessel composting of kitchen waste. The performance characteristics of these recovery facilities are assumed to be similar to the best performing existing facilities. Costs of these facilities are included in the model simply through the application of a gate fee based on current quoted figures.

### 2.5.2 Cost Assumptions

- It was assumed that all performance characteristics of vehicles and containers including operating costs, interest rates on capital etc, are as for current systems. Although it is likely that the performance of equipment and systems will, in fact, improve over the period which has been modelled, the extent to which this would happen is indeterminable and has therefore not been accounted for.
- A 6.5% cost of capital (interest on vehicles) was used for all systems.
- 5% profit was included on collection and overheads. This was included in all cases, even where services are currently, and may therefore continue to be, operated by a DSO. In the case of DSO operations this figure has been retained but is to be considered as a contingency that is additionally necessary to represent the higher unit capital costs and staff overheads (particularly pensions) that these organisations can face.
- An amortisation period of seven years was assumed for all vehicles with bins and other containers amortised over different periods specific to their expected lifespan and current practices. For wheeled bins a 4% per annum replacement rate was used (10% for boxes) for loss and breakage.
- No allowance was made for inflation. Consequently, the costs should be interpreted as representing real costs (i.e. the nominal cost in the actual year modelled would be higher in that year as a consequence of inflationary pressures).

Details of the commodity prices (and gate fees) used in each scenario are detailed in Appendix 2.<sup>9</sup> However, a few points are worth noting here:

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<sup>9</sup> Commodity prices were taken from published price listings at <http://www.letsrecycle.com/prices/index.jsp> on the 2nd November 2005. Where a range was given a mid-point price was used. Gate fees are taken from discussions with operators and other Authorities.

- The cost of windrow composting of garden waste was set at £19/tonne;
- Kitchen waste, when mixed with garden waste prior to collection, attracts a gate fee at an in-vessel compost facility of £50/tonne. Where kitchen waste is collected separately for in-vessel composting it was assumed that 50% additional garden waste would be added as structural material and to balance nutrient content; the gate fee was calculated as the £50 fee for kitchen plus a £25 fee for half a tonne of in-vessel composted garden waste minus the cost saving from the avoided half tonne of garden waste windrow composting (£19/2). The total cost therefore calculates to £65.50 per tonne; although this appears more expensive than the mixed kitchen and garden systems, in practice this comes out slightly cheaper due to the savings achieved through windrow composting the remaining garden waste.<sup>10</sup> It is important to note here that where kitchen waste is sent to IVC separately, the additional garden waste required is assumed to be taken from a secondary source – e.g. from Civic Amenity Sites and NOT from the kerbside collection of garden waste;
- Newspaper and magazines generate revenue of £35/tonne. However, when co-mingled with card with a monthly collection, the material could be of lower quality than when collected more frequently since there is greater potential for contamination and for the material to get wet. In this case the price of paper is dropped to £25/tonne;
- Other recyclable paper is assumed to command a value of £10/tonne, unless its quality falls (as in the case of the monthly collection of paper and card), in which case a zero value is assigned;
- Cardboard collected on its own commands a value of £19/tonne. When co-collected with paper the value drops to £5/tonne. However where card is collected with garden and/or kitchen waste, the material will require in-vessel or windrow composting depending upon the material it is collected with. Where card is collected with garden waste the cost will be £19/tonne, and where it is collected with kitchen or kitchen and garden waste the cost rises to £50/tonne;
- It is assumed that all commodity prices remain unchanged between the base case and optimised scenario modelling. This assumption does not account for the possibility that recycle values will increase (possible as the market into which these commodities can be sold becomes more diverse and mature) or decrease (if markets weaken as a result

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<sup>10</sup> Gate fees for windrow and IV composting are felt not only to reflect current market realities but also to be safe projections of likely future costs. Windrow composting at £19/tonne is sufficiently highly priced so that the compost produced can be freely provided to farmers (see “Research Analysis of the Market Potential for Lower Grade Composted Materials in the UK”, WRAP, 2003, for a discussion of the enormous size of this potential market). IVC at £50/tonne is priced at a rate which it is felt, following discussions with technology suppliers and industry experts, is sufficient to cover the costs of state-of-the-art odour and particulate abatement technologies that may be useful in ensuring compliance with any future regulatory regimes and which, in the Surrey context, will certainly be particularly valuable in securing planning permissions.

of renewed investment in primary production in response to strengthening demand). The reason for this assumption (which is arguably conservative in the current context) is that it is not possible to credibly estimate the extent to which this may happen, certainly within the scope of this project.<sup>11</sup>

- Revenues from material sales are realised and included to be offset against total gross service costs where a box/reusable sack system is used for the collection of dry recyclables. Where co-mingled collections are used, the materials are passed on to a Materials Recycling Facility (MRF) which is assumed to keep the revenues obtained from the sale of the collected materials.
- Once again, all costs are expressed in 2005/6 pounds sterling without allowance being made for inflation.

## 2.6 Notes on Interpretation of Cost & Performance Data

- **Recycling Rate.** The recycling rate percentages quoted represent only a percentage of the material handled by the collection systems modelled. They are not equivalent to the BVPI recycling rate, which would also include material from bring sites, street cleansing etc.
- **Bring Systems.** Only kerbside collection systems are included in the model. There is an interrelationship between the amounts of material collected through kerbside and bring systems which has not been modelled. Generally speaking kerbside systems are considered to be more convenient for householders and therefore they will normally divert material away from existing bring systems. However, where bring systems are available alongside existing kerbside systems they will collect some extra material not captured by the kerbside system. This may be partly due to bring systems providing a facility to recycle a) larger loads of material than are able to be placed in the kerbside system – such as may result from parties or cleanups etc. and b) materials which households may wish to have out of their house at a specific time (for example, if they are going on holiday).
- **System Costs.** System costs projected by the model include the estimated costs of collection and treatment / disposal for household waste and recycling collection services. Special, clinical, and commercial collection services are not included in the modelling data, nor are any of the street cleansing, bring site or CA site operations included. Additionally, it should be borne in mind that system costs as represented by declared BVPI 86 performance often under-represent the full cost of service delivery: if costs, such as insurance, legal support, human resources support or depot rental value are not present

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<sup>11</sup> This reverse position is felt to be unlikely: The value of Packaging Recovery Notes, particularly for glass, where the country is currently falling well short of its packaging recovery targets, are expected to rise fairly sharply and support the market value of this material. Global demand for metals and paper is felt likely to remain high and that these markets will therefore remain buoyant.

as line items on the service manager's budget then they will not be usually be reported as constituting part of the collection costs. These are captured, albeit in some cases approximately, by the model.

The costs represented by the modelled data will therefore not be equivalent to either the likely contract costs for any waste management contacts or the total cost of waste service provision. The projected cost data presented here should therefore be used for indicative and comparative purposes only. The cost of disposal has been included because it is important, when considering *system* costs, to consider cost avoided as well as cost incurred and income generated.

System costs **do not** include the costs of LATS purchases, sales revenues or fines. This is thought sensible in the absence of certainty regarding the level at which permits will trade and the true likely impact. However, this factor should be borne in mind when considering the relative performance of the various systems discussed throughout the rest of the document because, if market rates tend towards the levels of the fines (£150/tonne), as is entirely possible, particularly in target years, then the performance of schemes which recycle large quantities of waste and particularly those which capture considerable quantities of biodegradable materials, will deliver major additional cost advantages relative to other options (either through avoided purchases, or revenue generations) not captured herein.

## 2.7 Service Configuration Codes

Throughout the rest of this document a large number of service configurations are discussed each of which involves the separate kerbside collection of several waste streams either for disposal or recycling. For the sake of brevity and to avoid breaking up the discursive flow regarding the relative benefits of these systems, a coding system was developed to identify these systems briefly without needing full sentence explanations each time a new system is introduced. For example, by using this coding system it is possible to refer to a system which collects dry recyclables in a variety of boxes and bags on a single fortnightly pass together with the fortnightly co-collection of cardboard, kitchen and garden waste, simply as MB&B14, KGC14.

In order to be able to read and understand the document it is necessary to understand this fairly simple coding system. The codes are in two parts with the first part identifying the collection system used for dry materials, separated by a comma from the second part which refers to the system(s) for organic material. Both sections contain numbers which describe the frequency of the service described by the letters before it: if a code contains three numbers then the service configuration comprises three systems on separate passes. The letter codes are defined as follows:

- B&B:- Dry recyclables, box and bag supplied, kerbside sort.
- MB&B:- Dry recyclables, multiple containers, kerbside sort.
- Co:- Co-mingled, where weekly from a bag, where fortnightly from a bin.
- PC:- Paper and card.

V:- Vessels; bottles and cans – normally “Containers” but ‘C’ is reserved.  
KG:- Kitchen and garden waste mixed, collected from wheeled bin.  
KGC:- Kitchen, garden and card, collected from wheeled bin.  
K:- Kitchen, kitchen container with liners and outside bin.  
Gs:- Garden, re-usable sack.  
KC:- Kitchen, as with “K”, with card separately bundled alongside.  
G:- Garden, wheeled bin.  
£:- Garden waste service on a £20 annual charge using wheeled bins.

A full list and description of each of those service combinations which were examined most closely and upon which all further discussion focuses are included in Appendix 3 which can be used as a key to understanding the codes used throughout the rest of the document.

## 3.0 Appraisal of System Configurations for Long Term Modelling and Option Selection

### 3.1 Introduction

As described in the previous section, using information supplied by Hertfordshire County Council and the district and borough councils, it was possible to model the current systems that are currently operating within each WCA. This modelling was based on inputting the current service configurations for each district alongside the current tonnages of residual, dry recycling and organic materials collected at the kerbside. The baseline modelling is important in that it enables the model to be calibrated and provides a benchmark against which the optimised and interim scenarios can be compared.

Because the principle aim of this work is to reveal the potential impacts of changes that might be made to the services offered for the collection of household waste, the selection of which services to examine through modelling was a key consideration and one which is discussed in some detail over the following pages.

### 3.2 Modelling of Long Term Residual Waste Collection Systems

Fundamental to all collection systems configurations are the systems used for the collection of residual waste. It is increasingly recognised that the alternate weekly collection (AWC) of residual waste reduces total system costs whilst increasing recycling performance. Concerns about the unpopularity of this service change are starting to recede now that around 100 English and Welsh Local Authorities collect fortnightly and with eleven of the top twenty authorities in terms of recycling performance collecting in this way.<sup>12</sup> All long-term options that were modelled were based upon the AWC of residual waste using a 240l wheeled bin so that the impact of this method of collection could be understood against all other system contexts. It is felt that this allows all authorities, regardless of the systems envisaged for collection of recyclables and compostables, to understand how these might perform in the best possible context; that's to say when refuse collections are relatively less convenient.

However, it is recognised that for some authorities the prospect of reducing the frequency of residual waste collections does not, at the current time, seem realistic, or even, in some cases, desirable. Furthermore, good performance is clearly being achieved already by authorities who collect on a weekly basis and if, as noted above, nationally eleven of the top twenty performing

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<sup>12</sup> Entec (2005) *Alternate Week Collections*, Report for WRAP, June 2005. Authorities might, as with most service changes, expect some early protests. However, experience suggests that these can be reduced through thorough preparation prior to service delivery, and that they may die away over time as the system beds in.

authorities collect refuse on an AWC basis, this still leaves nine of the country's best performers collecting residual waste weekly.

To assess, therefore, the impact of weekly residual waste collection on cost and performance, a separate sensitivity analysis was carried out which amended the best performing system to investigate the impact of collecting residual waste weekly against an otherwise fully optimised collection service background. This analysis revealed that weekly rather than fortnightly collection of residual waste led to a 15% increase in costs and a 14% fall in recycling performance, discussed in more detail in Section 6.

### 3.3 Hertfordshire Specific Systems for Detailed Examination

It was clear from considering current practice that certain systems would need to be examined on a detailed district-by-district basis. These were:

- B&B14,KGC14;
- B&B7,KGC14;
- Co14,KGC14;
- MB&B14,KGC14;
- MB&B14,G14K7;
- MB&B7,KGC7;
- PC14V14,KGC14; and
- B&B14, KGC14(Compulsory Recycling)

These systems are either currently operated in Hertfordshire or are natural and simple evolutions from those which are currently used and which officers have expressed an interest in considering in more detail. Because of the immediate relevance of these systems and the known requirement, therefore, that their relative benefits be examined on a district-by-district basis these were immediately added to the service configuration short-list that was taken forward and is discussed in the next Section.

### 3.4 Development of Additional Long List of Fully Optimised, Longer Term Scenarios

In order to open up the scope of the project so that systems not currently in use in Hertfordshire could also be brought forward for consideration, and to avoid an overly insular appraisal of collection options, a separate process was designed for the selection of a small number of additional systems that might offer a good cost / benefit balance. The methodology developed started by considering a variety of systems for the collection of both the dry and organic recyclable and compostable fractions.

#### 3.4.1 Dry Recyclables

A number of different systems might be used to maximise the collection of dry recyclables. The following systems are all envisaged as having the capacity to collect all grades of recyclable paper, glass bottles and jars, aluminium and

steel cans, textiles and plastic bottles. They are also capable of collecting card and in modelling were adjusted to do so where card was not collected together with the organic materials. The systems considered were:

- A. Kerbside sort of materials collected in two containers (44 litre box and reusable HDPE sack); collected weekly in a single pass.
- B. Kerbside sort of materials collected in multiple boxes/bags (2 × 44 litre boxes plus a disposable thick coloured sack); collected weekly in a single pass.
- C. Weekly collection of co-mingled materials in a bag. This system collects mixed recyclables enabling quicker pick-ups and more efficient collection. However, the materials have to be sorted at a materials recycling facility (MRF), a gate fee has to be paid and the material sales revenues are lost.
- D. Co-mingled fortnightly collection using a wheelie bin. With similar considerations to the previous system, this approach further requires residents to have sufficient space for bin storage and is considered less appropriate in urban high density housing. When compared to the previous system, it may be expected that the advantage of lower collection costs due to the fortnightly collection rounds will be to an extent offset by inferior performance due to the decreased convenience.
- E. Paper, card and textiles collected in a sack with containers collected in a box. Both are collected fortnightly, but on alternating weeks.
- F. Containers are collected weekly from a box with paper and card collected monthly from a 180l wheeled bin.

All systems which require kerbside segregation were modelled to use 'Kerbsider' vehicles to reflect long term concerns regarding the Health and Safety Executive's (HSE's) view of the manual handling risks associated with stillage vehicles. This is discussed in more detail in Section 6

### 3.4.2 Organic material

A greater number of systems were considered for the collection of organic waste than for dry recyclables. This allowed for the possibility that garden waste and kitchen waste might be collected and treated together or that treatment costs might justify the separate collection of kitchen waste so that garden waste does not require expensive in-vessel composting. The following systems are based on experience of the more successful systems used on the continent, and were modelled to include the supply of a caddy and bio-bags so that kitchen waste can be conveniently and hygienically stored separately in the kitchen before being ferried to the bin from where it is collected. The following organic collection systems were considered:

1. Kitchen and garden waste collected together in a wheeled bin on a fortnightly basis;
2. Kitchen and garden waste collected together in a wheeled bin on a weekly basis;
3. Kitchen collected separately in a 35 litre bucket weekly with a kitchen caddy and biodegradable bags supplied, garden waste collected separately in wheeled bin on a fortnightly basis;

4. Kitchen collected in a 35 litre bucket weekly with kitchen caddy and biodegradable bags supplied, garden collected in wheeled bin fortnightly on a pay per use basis – all charges for residents wishing to use garden waste collections were modelled as being set at £20/annum;
5. Kitchen, garden and cardboard collected in wheeled bin weekly;
6. Kitchen and cardboard in a kerbside bucket weekly with kitchen caddy and biodegradable bags supplied, garden waste collected from a wheeled bin fortnightly (excess card bundled alongside);
7. Kitchen collected in a bucket weekly with kitchen caddy and biodegradable bags supplied, garden collected in a reusable sack fortnightly;
8. As system 1 (kitchen and garden in wheelie bin fortnightly) with the additional supply of a kitchen caddy and biodegradable bags for the kitchen waste;
9. As system 2 (kitchen and garden in wheelie bin weekly) with the additional supply of a kitchen caddy and biodegradable bags for the kitchen waste.

#### 3.4.3 Service Combinations and Early Stage Short-Listing

The full list of possible service combinations based on the services described above is shown in Table 1 below. As discussed above, all long term configurations included the fortnightly collection of residual waste from wheeled bins.

Table 1:- Collection Service Configurations for First Stage Long Term Modelling with Option Codes

<b>Dry</b>	<b>A</b> <b>Kerbside sort,</b> <b>weekly, 1 pass,</b> <b>two containers</b>	<b>B</b> <b>Kerbside sort,</b> <b>weekly, 1 pass,</b> <b>multiple</b> <b>containers</b>	<b>C</b> <b>Co-mingled,</b> <b>weekly,</b> <b>sack</b>	<b>D</b> <b>Co-mingled,</b> <b>fortnightly,</b> <b>wheeled bin</b>	<b>E</b> <b>Kerbside sort,</b> <b>two containers,</b> <b>alternating</b> <b>weeks, 2 pass</b>	<b>F</b> <b>Containers</b> <b>weekly. Fibres</b> <b>monthly using</b> <b>box and bin</b>
<b>Organic</b>						
<b>1: Kitchen + garden,</b> <b>wheeled bin – fortnightly</b>	B&B7, KG14					
<b>2: Kitchen + garden,</b> <b>wheeled bin – weekly</b>	B&B7, KG7			Co14, KG7		
<b>3: Garden fortnightly.</b> <b>Kitchen weekly</b>	B&B7, G14 K7	MB&B7, G14 K7	Co7, G14K7	Co14, G14K7	PC14V14, G14K7	PC31V7, G14K7
<b>4: Same as 3 but with</b> <b>garden on a pay-per-use</b> <b>basis</b>	B&B7, £G14K7					
<b>5: Same as 2 with addition</b> <b>of card</b>	B&B7, KGC7		Co7, KGC7	Co14, KGC7		
<b>6: Same as 4 with addition</b> <b>of card with kitchen</b>	B&B7, £G14KC7	MB&B7, £G14KC7				
<b>7: Garden fortnightly -</b> <b>reusable sack. Kitchen</b> <b>weekly</b>	B&B7, Gs14K7			Co14, Gs14K7		
<b>8: System 1 plus kitchen</b> <b>caddy/bags</b>	B&B7, KG14+					
<b>9: System 2 plus kitchen</b> <b>caddy/bags</b>	B&B7, KG7+					

## 3.5 Shortening the Long List of Options

It would clearly not have been practical, desirable or a sensible use of resources to model all possible combinations for all authorities within Hertfordshire (which would have led to the production of over 500 models). It was necessary, therefore, to design a short-listing process to identify a small number of additional scenarios for detailed consideration at the WCA level above and beyond those that were automatically progressed for reasons of immediate and direct relevance.

### 3.5.1 Qualitative Appraisal of All Possible Service Combinations – Internal Eunomia Workshop

The first stage in producing a short list of options for modelling involved a qualitative appraisal carried out at an internal workshop using Eunomia's full senior staff team. This half-day workshop involved the detailed consideration of all the collection services for individual material streams and combinations of services presented in Table 1 above. Those service configurations that were considered most likely to perform well in terms of cost efficiency and/or recycling and composting performance or to be particularly interesting for other reasons, were identified. This process led to the selection of nineteen combinations for more detailed consideration. These are highlighted in Table 1 where cells in the table have been shaded.

## 3.6 Producing a Final Short List – Scenario Modelling for a Generic Authority

To be able to practically model scenarios on a district-by-district basis, it was necessary to focus on a more limited short list of additional systems to include alongside those that were automatically taken forward. To determine which of the options favoured at the workshop event should be taken forward to the final and most detailed level of modelling, each of the preferred nineteen scenarios were modelled for an example ('generic') authority. This was done in line with the methodology discussed in Section 2. The aim of this was to provide performance comparisons between these favoured system configurations so that the best performing systems could be quantitatively identified.

### 3.6.1 Results from Generic Authority Modelling

The headline results for all nineteen scenarios are presented in Table 2.

In order to understand why certain of the systems modelled performed better than others, it is necessary to consider the individual systems in terms of the modelling input parameters. Assumptions and more detail regarding the impact of selected parameters for the specific scenarios under examination are as follows.

Table 2:- Modelling Results of the Generic Authority Additional Nineteen Long Term Scenarios

<b>System Combination</b>	<b>Total system cost per household</b>	<b>Recycling rate</b>	<b>Arisings growth</b>	<b>Biowaste diversion</b>
<b>B&amp;B7,KG14</b>	£ 110.69	43%	11%	51%
<b>B&amp;B7,KG7</b>	£ 126.40	49%	12%	60%
<b>B&amp;B7,G14K7</b>	£ 116.05	50%	11%	60%
<b>B&amp;B7,£G14K7</b>	£ 102.39	43%	6%	51%
<b>B&amp;B7,KGC7</b>	£ 126.71	49%	12%	60%
<b>B&amp;B7,£G14KC7</b>	£ 104.03	43%	6%	51%
<b>B&amp;B7,Gs14K7</b>	£ 108.67	45%	5%	55%
<b>MB&amp;B7,£G14KC7</b>	£ 112.37	40%	6%	49%
<b>MB&amp;B7,G14K7</b>	£ 124.45	47%	11%	58%
<b>Co7,G14K7</b>	£ 129.43	49%	11%	60%
<b>Co7,KGC7</b>	£ 138.75	49%	12%	61%
<b>Co14,KG7</b>	£ 135.16	45%	12%	57%
<b>Co14,G14K7</b>	£ 124.81	45%	11%	58%
<b>Co14,KGC7</b>	£ 135.46	45%	12%	57%
<b>Co14,Gs14K7</b>	£ 117.44	41%	5%	52%
<b>PC14V14,G14K7</b>	£ 122.52	45%	11%	56%
<b>PC31V7,G14K7</b>	£ 118.46	52%	11%	63%
<b>B&amp;B7,KG14+cdy</b>	£ 115.86	46%	11%	55%
<b>B&amp;B7,KG7+cdy</b>	£ 132.20	53%	12%	64%

### 3.6.2 Recycling System Performance Comparisons

Because the scenarios are designed as optimised long term options against a background of good communication and campaign work (both locally and at a national level) good participation and recognition rates have been modelled.

Weekly systems against a backdrop of AWC for refuse, whether they are kerbside sort or commingled, achieve the highest recycling participation with rates reaching 80% by 2012. Recognition rates for these systems are also higher than for other service types with rates of, for example, 88% for newspapers, 60% for card and 85% for glass bottles being estimated for participants.

Weekly co-mingled systems are generally modelled to achieve similar or better capture rates as those systems which use kerbside sort and a box and/or bag. Despite potential performance gains that may be associated with a particular co-mingled recycling system, revenues from the sale of recovered material are lost as collection authorities will typically use a commercial contractor to operate the required sorting facility (or alternatively incur the cost of running one themselves). Furthermore, sorting operations will sustain losses in recovery either through imperfect sorting or through contamination of the mixed materials. A rejection rate of 10% has been modelled in all such instances based upon current industry standards. As such, savings made on collection costs (deriving from the simpler vehicles that can be used and faster pickup times) are offset by the loss of material revenues, the gate fees incurred and the potentially lower recycling rates once rejected materials have been factored in.

A further, very important reason for the relative suppression of participation rates for co-mingled services is the very high participation rates that were revealed by baseline modelling. Participation rates in co-mingled services are generally higher than for source-separated services because they are relatively easier for residents to use. However, where residents are already willingly participating at a high rate, as appears to be the case in many Hertfordshire Districts, then the potential performance gains offered by a switch to co-mingled systems is eroded.

The complexity of the multi box system (MB&B7) and the requirement for extra container space both inside and outside the resident's house means that participation rates are slightly lower than the simple box and bag system. Moving from a B&B7 to a MB&B7 system lowers participation rates by around 5% (to 70%), set-out rates fall 4% (to 53%) and recognition rates for newspaper and junk mail (as a randomly selected example material) fall by 8% (to 80%)

### 3.6.3 Organic System Performance Comparisons

As with all services, more frequent collections of garden and kitchen waste have been modelled to achieve better capture rates. However, the improvement in capture of garden waste when moving to weekly services is much less dramatic than that experienced for kitchen waste when this material is collected weekly instead of fortnightly (because garden waste arises intermittently anyway).

The improvements and the difference in level of improvement between the two services is best illustrated by comparing B&B7, KG7 with B&B7, KG14. In the scenario where organic collections are fortnightly, participation rates are 75% increasing to 80% where collections are weekly. Set-out rates are also lower where collections are fortnightly (around 77% for weekly, 65% for fortnightly). It is only when moving to recognition rates, however, that one starts to see the considerable variance in performance change between the two material types. Moving from fortnightly to weekly collections for garden waste leads to no increase in recognition rates with these stable at around 90% overall whereas for kitchen waste there is a very considerable rise of 36% (30% to 66%).

The reason for this variation in level of performance is driven by a number of factors. Garden waste is easily stored outside and people do not find this either difficult or unpleasant. If the collection needs to wait an extra week a small

number of people will be motivated by this delay to take their waste to the HWRC themselves, but the vast majority will be happy either to delay their activity in the garden, or for the material to be stored in the bin, or to leave any overflow on the ground for later transfer to the bin and collection on their next collection day.

With kitchen waste, however, the picture is quite different. Residents have the very well established habit of disposing of this material together with residual refuse. They also tend towards a 'squeamishness' when considering this waste. These two things lead to an initial resistance to the idea of disposing of this waste in any other way.<sup>13</sup>

Where refuse collections are offered at the same frequency as kitchen waste collections and on the same day, then there is no incentive for residents to overcome this initial resistance to the service and participation rates remain low.<sup>14</sup> When kitchen waste and residual collections are at the same frequency and on alternate weeks then residents are tempted to play the system by putting out their kitchen waste in the receptacle which is due to be collected soonest. It is only when the kitchen waste service is more frequent than the residual waste service that the easiest and quickest way for residents to dispose of this waste is by using the service provided so that good habits become established and participation rates rise.<sup>15</sup>

Another key factor influencing system performance is the container supplied to residents. The more convenient and easy the container is to use, the higher participation will be. Whilst 240l bins can be easily wheeled around the garden, to and from wherever the mower is being emptied or the tree pruned, sacks need to be dragged or lifted. Also, because a sack can be folded up and stored out of sight, used for storage for another purpose or lost, whilst a bin will always be visible to residents within their property boundary (except perhaps to those who

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<sup>13</sup> Whilst discussing kitchen waste collections with residents in focus group sessions, Eunomia has been struck by the frequency with which this irrational prejudice has been expressed. Residents appear, when considering kitchen waste stored in a separate bin, to be pre-disposed to think of this as either new or smellier waste than when it is stored together with their refuse. This prejudice evaporates fairly quickly when they are asked to think about the lack of any practical differences in the waste when stored in either two systems. Although, therefore, it would appear that this widespread prejudice is weakly held, it is necessary that it be challenged either by communications or practically by providing differential service levels if this impediment to good participation rates is to be overcome.

<sup>14</sup> Evidence for this can be found in the OWL trial which was operated in sample areas across four West London boroughs by ECT and supported by a publicity campaign run by Waste Watch. Against a backdrop of weekly residual waste collections this service only achieved 17% participation rates. Recently, since the end of October 2005, this service has started to be rolled out much more widely and participation rates in the best performing wards have reached and exceeded 35% already. This suggests conservatism on the part of the modelling although, having been operational for less than three months, these levels of participation cannot yet be relied on.

<sup>15</sup> Indeed it is arguable that once these services are well established participation rates will rise much higher than has been modelled, simply because they represent the quickest and most reliable way to get rid of potentially smelly waste. Services in Turin in Northern Italy report participation rates in excess of 90%. However, because no such evidence base exists in this country a conservative approach has been taken to modelling this service.

have the very largest residences!), residents are slightly more likely to use a bin than a sack for this reason also. When comparing B&B7,G14K7, to B&B7,Gs14K7, it can be seen that participation rates in the sack based system are 10% lower at 65%. The differential in set-out rates (55% for the sack based system against 65% for the bin system) exacerbate the total difference in captures still further.

On the other hand, sack-based systems are cheaper. Although sacks get lost, stolen and torn and very high replacement rates (50%) have been modelled to ensure that this effect is properly captured, the container costs for wheeled bin systems remain more than double that for sack-based systems. If maximising captures is not a priority, therefore, and the service operator (or DSO) is able to take the necessary measures to satisfy the HSE that the manual handling risks are manageable, then perhaps sack-based systems will be appropriate in some cases.

When considering containment for kitchen waste systems it is similarly obvious that more convenient systems will lead to higher participation rates. Wherever a system has been modelled that collects kitchen waste separately, then this has been designed to use two containers, one for storage in the kitchen (and which is well ventilated) and the other for outside storage and emptying by collection services. Starch liners have also been modelled as being used. This system allows waste to be stored in the kitchen so that it is well aerated and becomes dry. This prevents it, even in hotter weather from becoming smelly or starting to breakdown anaerobically and giving off unpleasant odours.<sup>16</sup>

Although, to date, no good comparative studies have been conducted in the UK proving the participation impact of systems using good containerisation, there is academic consensus amongst those that have most experience of the design and operation of these systems that significantly better participation and recognition rates are inevitable where container selection is optimised.<sup>17 18 19</sup> The relationship between the supply of a kitchen container for kitchen waste and service participation levels has been modelled in scenario B&B7,KG7+cdy where although participation and set-out levels are the same as in B&B7,KG7,

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<sup>17</sup> This is supported by extensive communications with Enzo Favoino and Marco Ricci of the Scuola Agraria del Parco Di Monza, who are Europe's most widely published and cited authorities in this area.

<sup>18</sup> Preston officers report very high levels of resident (and operative) satisfaction in the 7,500 h/holds where they are trialling kitchen waste collections using a 20l bin, a 7l kitchen caddy and are supplying liners. Starch liners, allow for the use of a basket type kitchen caddy with slots and holes for good aeration of the waste. Well aerated material dries more quickly than that which is wet and this slows the rotting process, thus making the waste less obnoxious to residents. A well aired system, clearly cannot become anaerobic and is therefore less smelly for that reason also.

<sup>19</sup> In order to test the impact of various container combinations on participation and captures Eunomia will be carrying out the first such research within the UK during the first half of 2006. This research will, once complete be available to the authorities of Hertfordshire. Very early findings tend to confirm the trend that has been identified here.

recognition rates rise from 66% to 85% as householders become less reluctant to put the smelliest kitchen scraps into the container which is supplied to them.

The final key component in understanding the relative performance of the various organic waste collection systems is the use in some systems of a charge for the collection of green waste, whilst in other systems collections are made free of charge. This has been captured in, for example, the change between B&B7,G14K7 and B&B7,EG14K7 by decreasing participation from 75% to 40% which, as can be seen from Table 2 brings about a fall in the rate of recycling household collected waste of 7%. The size of this change is exacerbated by the fact that free garden waste collection services have been shown by a wide number of research projects to attract up to 100% new garden waste into the household collected stream.<sup>20</sup> Some of which would otherwise be disposed of at HWRCs but much of which is entirely new to the municipal waste stream, having previously been home composted or left, in the case of leaf-fall, to rot *in-situ*.

Whilst introducing a charge for the collection of garden waste clearly impacts recycling performance at the kerbside it does so at the cost, therefore, of recycling performance at HWRCs where collections and segregation are carried out at lower total cost to the taxpayer. It also reduces the attraction of new waste into the municipal waste stream. Although, therefore, free garden waste collections deliver performance gains, these are lower than appears from looking only at doorstep performance. Furthermore, no other service innovation so directly undermines waste prevention activities (notably in respect of home composting).

Charging for the collection of garden waste has, of course, the added benefit of raising significant revenues to offset against the costs of the scheme. In fact, it would appear that charging a subscription at a rate of £20 / participating hhold / annum (as has been modelled in all scenarios for which garden waste is charged) with participation rates set at around 40% across all households within the district, creates revenues that are almost (but not quite) equivalent to the service delivery costs.

It is, of course, not possible to charge for the collection of garden waste when it is co-collected with kitchen waste.<sup>21</sup> This means that services which collect garden

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<sup>20</sup> One study in Hampshire suggests that garden waste arisings in areas with wheeled bins collections for this material, are more than four times higher than in areas where garden waste is not accepted with refuse (MEL Research Ltd (2000) *Project Integra: Kerbside and Household Waste Recycling Centre Waste Analysis and Questionnaire Survey Results*). A new report based on extensive study and case history and to which Eunomia has contributed is shortly due to be published by WRAP which discusses this subject in some detail. See also David Mansell (2001) *Study of Kerbside Collections Options for Organic Waste*, First Phase Report; Avon Friends of the Earth; Eunomia (2004) *Current Practice in the Collection of Organic Wastes*, Final Report to Devon County Council.

<sup>21</sup> Section 45 (3) of the EPA requires that “[...]No charge shall be made for the collection of household waste except in cases prescribed in regulations made by the Secretary of State[...]” whilst the relevant regulations, “The Controlled Waste Regulations 1992”, specify in Schedule 2, point 3 that collections of garden waste may be charged for. Therefore, it is a legal obligation to

waste separately from kitchen waste are, when the garden waste is charged for, cheaper than those which collect the materials together. This is notwithstanding the fact that a separate fleet and containers are required.

### 3.7 Ranking System Methodology

In order to *assist* in determining which options should be taken forward together with those automatically selected, a scoring system was devised so that the nineteen additional systems could be ranked. Scores were awarded to each system configuration in each of four categories: cost; recycling / composting performance; the extent to which they attracted new arisings growth; and how good they were at diverting bio-waste.

The top performing system in each category was given a score of one for that category. Other systems received a score that was less than one in the same proportion as their performance was less than the best in that category.

For instance, a system with a recycling rate only half as high as the best system, would have scored 0.5 for recycling. Likewise, whilst the cheapest system scored 1 for cost, a system that cost 33% more would have been given a score of 0.66. Arisings growth returns a maximum score of 1 at zero increase, and a zero score at 30% growth (a cap conceived as a sensible maximum limit to place upon waste growth).

It was further necessary to weight the criteria to reflect the fact that, for instance, cost may be a more important consideration in comparing one system configuration against another.

The assessment criteria together with their calculation technique and weighting scores are shown in Table 3 below.

Table 3:- Evaluation Criteria & Weighting

Criteria	Scoring Calculation	Weighting
Cost per household	$1 - (\text{Cost} - \text{min cost}) / \text{min cost}$	3
Recycling/composting rate	Performance / max performance	2
Arisings growth	$(30\% - \text{growth}) / 30\%$	1
Biowaste diversion	Performance / max performance	2

### 3.8 Ranking the Nineteen Additional Long Term Models

Once the scores for each criteria and for each scenario were generated, these were multiplied by the respective weighting and totalled in order to produce a

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collect kitchen waste free of charge and any system which mixes it with another material, whatever that material may be, must also be provided free of charge.

ranking of the scenarios (the higher the score the better the overall performance). The results of this analysis are shown in Table 4.

**Table 4:- Scoring and Ranking the Nineteen Long Term Scenarios**

	<b>Cost (£)</b>	<b>Recycling rate</b>	<b>Growth</b>	<b>Biowaste diversion</b>	<b>Total score</b>	<b>Rank</b>
<b>B&amp;B7,KG14</b>	£ 110.69	43%	11%	51%	7.42	14
<b>B&amp;B7,KG7</b>	£ 126.40	49%	12%	60%	7.62	7
<b>B&amp;B7,G14K7</b>	£ 116.05	50%	11%	60%	8.00	2
<b>B&amp;B7,£G14K7</b>	£ 102.39	43%	6%	51%	7.84	4
<b>B&amp;B7,KGC7</b>	£ 126.71	49%	12%	60%	7.62	8
<b>B&amp;B7,£G14KC7</b>	£ 104.03	43%	6%	51%	7.79	5
<b>B&amp;B7,Gs14K7</b>	£ 108.67	45%	5%	55%	8.00	3
<b>MB&amp;B7,£G14KC7</b>	£ 112.37	40%	6%	49%	7.37	16
<b>MB&amp;B7,G14K7</b>	£ 124.45	47%	11%	58%	7.56	11
<b>Co7,G14K7</b>	£ 129.43	49%	11%	60%	7.56	10
<b>Co7,KGC7</b>	£ 138.75	49%	12%	61%	7.31	17
<b>Co14,KG7</b>	£ 135.16	45%	12%	57%	7.07	18
<b>Co14,G14K7</b>	£ 124.81	45%	11%	58%	7.45	13
<b>Co14,KGC7</b>	£ 135.46	45%	12%	57%	7.06	19
<b>Co14,Gs14K7</b>	£ 117.44	41%	5%	52%	7.42	15
<b>PC14V14,G14K7</b>	£ 122.52	45%	11%	56%	7.45	12
<b>PC31V7,G14K7</b>	£ 118.46	52%	11%	63%	8.14	1
<b>B&amp;B7,KG14+cdy</b>	£ 115.86	46%	11%	55%	7.57	9
<b>B&amp;B7,KG7+cdy</b>	£ 132.20	53%	12%	64%	7.78	6

### 3.9 Ranking System Sensitivity Analysis

A sensitivity analysis was carried out on the ranking system, to determine the impact of changing the relative weightings of the criteria. Instead of ranking 'Cost' as the most important criteria carrying a weighting multiplier of 3, this criteria was, in the sensitivity analysis, downgraded to carry only a weighting of 2 – the same weighting given to scores awarded for recycling performance.

The weighting scores were therefore changed and the scoring and ranking methodology repeated. The outcome of the sensitivity analysis as it affected the

top seven performing systems using the main weighting methodology, is shown in Table 5 below.

Table 5:- Sensitivity on Criteria Weightings

System	With Cost Criteria Weighted 3		With Cost Criteria Weighted 2	
	Score	Rank	Score	Rank
PC31V7,G14K7	8.14	1	7.28	1
B&B7,G14K7	8.00	2	7.12	2
B&B7,Gs14K7	8.00	3	7.05	4
B&B7,£G14K7	7.84	4	6.82	7
B&B7,£G14KC7	7.79	5	6.79	9
B&B7,KG7+cdy	7.78	6	7.06	3
B&B7, KG7	7.62	7	6.84	5

This analysis showed that the ranking system had not been unduly biased by cost considerations with five of the original top seven scenarios remaining within the top seven, and the top two retaining their previous ranking.

### 3.10 Selecting which Additional Long-Term Options to Model Using the Ranking System and Other Practical Considerations

With eight systems already pre-selected for detailed district level modelling by virtue of their immediate or expected imminent relevance, it was only possible to select a relatively small subset of the additional systems that had been modelled for the 'generic' authority as described above. Because of the similarity in the fourth and fifth highest ranking systems it seemed unnecessary to take both of these forward and this therefore indicated a sensible cut-off point. The top four ranking additional systems were therefore progressed together with the eight that more closely match current practice. The full list of systems modelled on a district-by-district basis is presented in Table 6 at the start of the next Section.

## 4.0 Detailed Modelling Outputs

Following the methodology discussed in Section 3.0, twelve long term options were modelled for each local authority. These twelve are based on both planned future iterations of current services for each of the districts, and likely scenarios that could practically be taken forward given the current services, investment and political outlook.

The summarised results of the modelling exercise for Hertfordshire are displayed in the tables and chart below. The recycling rate and biowaste diversion rate shown is **not** the same as BVPI recycling / composting rates and relates only to the percentage of material collected at the doorstep through regular collections. These figures also account for the increase in arisings resulting from system effects, where free collections of green waste are offered and are assumed to lead to more waste being collected overall. The figures listed alongside the heading for revenue / treatment costs relate to the revenue gained from the sale of the recyclables collected and the gate fees for treating compostable waste. The total system cost row in the table includes all costs, not just WCA incurred collection costs.

While the overall summary results are presented here, the detailed results of the initial modelling exercise for each WCA are presented in the Appendices to this document.

Given that the same long term scenarios were applied to each district, with the same participation and set-out rates, the general pattern of results is very similar for each district. The lessons of the modelling are therefore common to all districts, and are set out below.

As a reminder and key to the long-term service configurations which have been modelled for each district, Table 6, below, summarises the systems key features. More detailed configuration information is contained for all scenarios in Appendix 3.

Table 6:- Modelled Optimised Scenarios

Scenario Code	Dry Collection	Organic Collection
B&B7, £G14K7	Kerbside sort, weekly, 1 pass in two containers.	Charged garden service collected fortnightly in wheeled bin. Kitchen collected weekly with bucket, kitchen caddy and sacks.
PC31V7, G14K7	Containers collection weekly in a box. Fibres collected monthly in a bin.	Garden collected fortnightly in wheeled bin. Kitchen collected weekly with bucket, kitchen caddy and sacks.
B&B7, Gs14K7	Kerbside sort, weekly, 1 pass in two containers.	Garden fortnightly reusable sack. Kitchen collected weekly with bucket, kitchen caddy and sacks.
Co14, KGC14	Co-mingled collection in a wheeled bin, fortnightly.	Kitchen + garden + card collected fortnightly in a wheeled bin.
B&B14, KGC14	Kerbside sort, fortnightly, 1 pass in two containers.	Kitchen + garden + card collected fortnightly in a wheeled bin.
B&B7, KGC14	Kerbside sort, weekly, 1 pass in two containers.	Kitchen + garden + card collected fortnightly in a wheeled bin.
MB&B14, KGC14	Kerbside sort, fortnightly, 1 pass in three containers.	Kitchen + garden + card collected fortnightly in a wheeled bin.
MB&B14, G14K7	Kerbside sort, fortnightly, 1 pass in three containers.	Garden collected fortnightly in wheeled bin. Kitchen collected weekly with bucket, kitchen caddy and sacks.
MB&B7, KGC7	Kerbside sort, weekly, 1 pass in three containers.	Kitchen + garden + card collected weekly in a wheeled bin.
PC14V14, KGC14	Kerbside sort, fortnightly, 2 pass in two containers.	Kitchen + garden + card collected fortnightly in a wheeled bin.
B&B14, KGC14 (CR)	Kerbside sort, fortnightly, 1 pass in two containers, with compulsory recycling.	Kitchen + garden + card collected fortnightly in a wheeled bin.
B&B7, G14K7	Kerbside sort, weekly, 1 pass in two containers.	Garden fortnightly wheeled bin. Kitchen collected weekly with bucket, kitchen caddy and sacks.

## 4.1 Modelling Summary Outputs

Table 7:- Hertfordshire Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	40,517	49,447	54,358	46,391	46,696	49,469	52,950	50,712	53,655	61,583	53,154	46,549	52,278
<b>Total Collection Cost (£,000)</b>	27,729	33,995	38,848	30,354	26,915	30,821	27,880	30,420	35,997	41,569	32,176	27,900	36,930
<b>Net Revenue/ Treatment Cost (£,000)</b>	-86	-2,149	-3,270	-1,865	-4,216	-3,743	-9,225	-4,441	-3,692	-6,176	-4,667	-3,743	-2,391
<b>Net Cost/ HH (£)</b>	92	105	115	99	99	105	112	108	114	131	113	99	111
<b>Recycling tonnage</b>	74,237	208,246	251,908	197,720	196,441	207,797	184,757	191,492	222,160	229,207	183,559	207,797	217,200
<b>Recycling rate</b>	19.4%	47.7%	54.5%	44.8%	42.3%	44.7%	39.7%	41.2%	48.0%	49.0%	39.5%	44.7%	49.4%
<b>Biowaste diversion rate</b>	23.3%	56.4%	64.1%	52.2%	49.6%	51.5%	48.1%	48.5%	58.1%	58.6%	47.0%	51.5%	58.7%

Figure 1: Graph showing comparison of different system inputs and outputs (HCC).

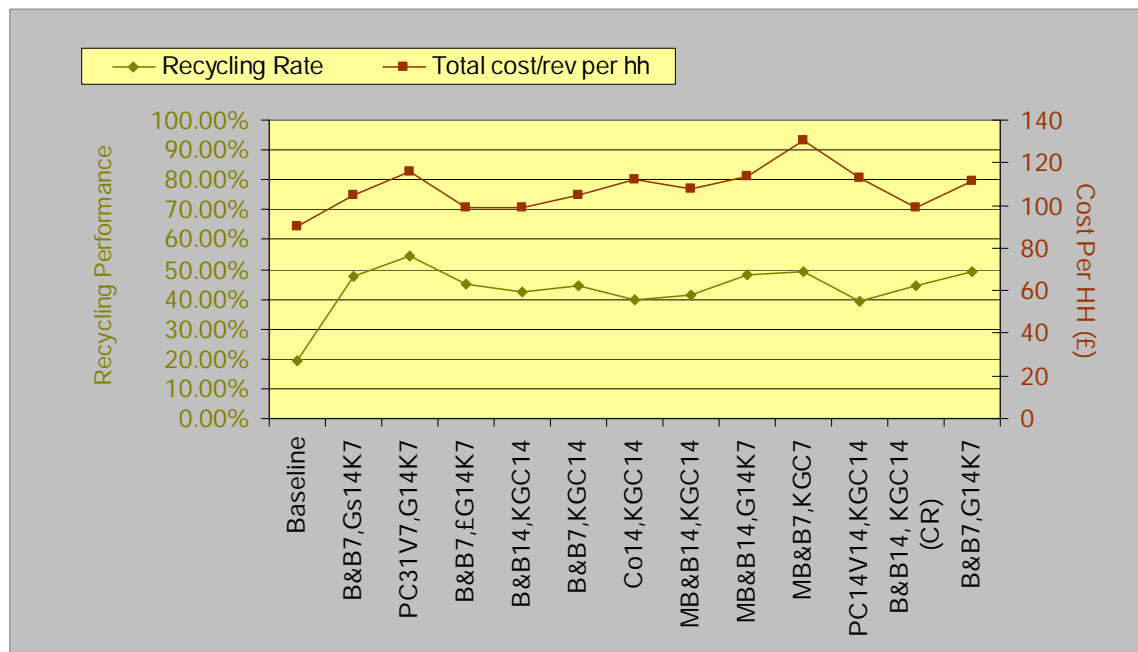


Figure 1 and Table 7 above show the results for the combined baselines and for the long term modelled scenarios assuming that all WCA's adopt the same collection system. It is not intended to reflect reality, but is shown so that comparisons between the different systems can be made. As stated, more detailed analysis for each district is presented in the appendices, with general discussion of lessons learned below.

## 4.2 Results Analysis

What is clear from the chart above is that in the long term, as services are optimised, there are significant gains that can be made in the overall kerbside recycling rate in the optimised long term scenarios. While these gains will result in additional costs to the WCA, the proportional cost increase appears to be justified by the recycling gains that can be made. Indeed the lowest cost long term scenarios, a position shared jointly by B&B14,KGC14; and B&B7,£G14K7 and B&B14, KGC14 with compulsory recycling, could lead to increases in recycling performance of 22.9%, 25.4% and 25.3% respectively, for an average additional investment of only £7 per household.

### 4.2.1 Key System Changes Required

For each of these scenarios the modelled improvements in recycling performance in the long term scenarios were achieved by adopting (or maintaining where the factors have already been implemented) a four-fold approach:

- expanding the range of dry recyclables collected;
- adding a kitchen waste collection either together with or separately from the garden waste collection (and preferably on a weekly basis);

- adopting Alternate Weekly Collections (AWC) for residual waste; and
- ongoing education, promotion and information drives to raise awareness and participation.<sup>22</sup>

Without any one of these factors evidence and modelling suggests that such high recycling rates at the kerbside cannot be achieved. While the rates projected by the model for Hertfordshire may seem high, they are not unrealistic, and indeed, the performance of the very best authorities suggests that certain of the assumptions may in fact be pessimistic. Figures reported for 2004/05 show that a small handful of authorities nationally are starting to report recycling rates approaching 50%, with one Council, St Edmundsbury, in West Suffolk topping the 50% threshold.<sup>23</sup> Furthermore when assuming that a residual waste AWC policy is adopted, recycling and kitchen waste services become, by implication, relatively more efficient at removing kitchen and food packaging waste from the householder's property so that participation is stimulated simply for reasons of convenience. This is not to say that good performance is impossible alongside the weekly collection of residual refuse; only that costs when collecting residual refuse more frequently will be higher and that recycling performance will, to some extent, be depressed.

However it may be worth re-iterating that the recycling rates quoted do not represent BVPI 82a+b figures, but the recycling rate for waste that is collected through regular doorstep services alone.

#### 4.2.2 The Top Performing Scenario (PC31V7, G14K7)

The modelling shows that in the long term, recycling rates topping 50% are achievable, with the PC31V7,G14K7 scenario providing potential for a recycling rate of 54.5%. This rate is achievable with an additional spend of an average of £23 per household. The project team does, however, have concerns regarding the acceptability of this scenario to WCA officers. Because it is based on a total of five separate collection systems (including refuse) it is felt that there may be some resistance to seriously considering it as an ideal long-term option. Whilst the system requires that householder use a large number of containers it optimises the collection logistics for paper – the heaviest of all dry recyclables. Similar systems, such as that used by Blaby DC in Leicestershire, perform well and with little resistance from residents.

#### 4.2.3 Cost and Recycling Performance

The relationship between cost and recycling performance is fairly similar in all long term scenarios, with the notable exceptions of the co-mingled scenario and the B&B14, KGC14 with compulsory recycling (see section 4.2.8 for a discussion

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<sup>22</sup> It has been assumed that the scenarios modelled for 2012 are optimised, and follow several years of sustained national, regional and local promotion activities. The costs, nationally, of failing to meet our Landfill Directive, Article 5 obligations for the diversion of bio-waste are such that it seems very safe to assume that resource will be found to continue either with the current WRAP communications campaign or something that serves the same purpose.

<sup>23</sup> <http://www.letsrecycle.com/info/localauth/news.jsp?story=5173>

of compulsory recycling). Co-mingled collection is more expensive per tonne of recyclable material collected, as can be seen by the divergence of the recycling and cost curves in the graph. This is to be expected, since the materials collected will be sent to a MRF for treatment (for which a gate fee is paid) and the MRF will retain all material commodity values.

What is surprising with the co-mingled scenario modelled here is that it underperforms when compared to many of the other long term models. In many authorities nationwide, it would be expected that co-mingled collection services would out-perform box and bag systems given the fact that wheeled bins are considered more convenient than box and bag systems. In Hertfordshire, this can be explained, at least in part, by the fact that the districts have already achieved high participation rates, and so the expected performance differential between co-mingled and kerbside sort systems is not apparent. Furthermore, the co-mingled scenario has an assumed rejection rate of 10%<sup>24</sup> which significantly affects the captures for recycling of the material collected.

It can also be seen that the box and bag scenarios are generally the cheapest to implement, yet still yield good material captures. This is explained by the fact that the dry materials are collected on a single pass, with the revenues from the materials being passed back to the WCA as an income. There is also no rejection rate with the kerbside sort systems as any reject material is assumed to be left at the kerbside for collection with the residual waste.

#### 4.2.4 Treatment Costs

As the WCA's move from the baseline to the long term scenarios, the modelling shows that the net revenue will decrease dramatically, leading to a significant cost to the WCA/WDA. The cause of this shift is the move to the collection of kitchen waste which must be composted in more expensive in-vessel facilities as opposed to the cheaper windrow facilities that can be used where garden waste is separately collected.<sup>25</sup> Such costs offset all of the revenues gained from the sale of dry recyclables. This effect is exacerbated when garden and kitchen (and card) waste are co-collected, since all material must be sent to an in-vessel treatment facility.

#### 4.2.5 Collection Frequency

The collection frequency of dry and organic materials for recycling/composting is an important factor when looking at both cost and performance output. In the long term models a direct comparison to test the performance of weekly against fortnightly collections is the MB&B14,KGC14 and MB&B7,KGC7. As can be seen, the total system cost with a weekly collection costs around £23 per household more, adding just under 8% to the recycling rate.

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<sup>24</sup> Based on known industry standards.

<sup>25</sup> The Animal by-Product Regulations requires that all waste which may contain meat products must be composted via more thorough and expensive processes before it is deemed safe to be applied to land.

All the top performing scenarios in terms of recycling output have weekly collections of kitchen waste, with the top three performers also having some form of weekly collection of dry recyclables. This is unsurprising, given that weekly collections of materials provide residents with greater capacity for the storage of recyclable and compostable materials and also incentivise the set out of more materials, being relatively more frequent than the AWC services for refuse that are modelled.

#### 4.2.6 Charged Garden Waste Collection

An important feature of the graph, is the low relative cost of B&B7,£G14K7, when compared with the other weekly dry collection scenarios (e.g. B&B7,£G14K7 has a cost of £99 per household compared with £111 per household for B&B7,G14K7). Quite clearly, revenues generated by charging for garden waste are a significant factor in controlling costs. Furthermore, the charge deters kerbside presentation of garden waste and therefore further reduces collection costs.<sup>26</sup>

However a significant quantity of this material is likely to be captured instead and more cheaply at HWRCs. The fact that the material arises in County rather than district controlled streams does not lead to a collapse in recycling performance and whilst the service will recycle less kerbside collected waste than alternative systems which collect garden waste free of charge, recycling performance in this combined stream is still over 44%.

The whole system costs of garden waste collections can only be understood with reference to LATS trading prices and Hertfordshire CC's likely LATS balance which. It may be that the LATS position is such that maximising garden waste captures becomes imperative although this is not indicated by the analysis done to this point.

However, the current position across most of the county is that districts are collecting this material free of charge. The idea of moving a popular service onto a chargeable footing is likely to cause significant public and, therefore, political opposition. This opposition might be to the extent that other collection system objectives are hindered.

#### 4.2.7 Kitchen Waste Collection Options

Although some of the districts have already rolled out a kitchen waste collection service (and all which have done have implemented a combined kitchen, garden and card system), others have not and it is worth considering the range of options available in the longer term.

Looking in more detail at the tonnage outputs of the various long term organic collections, in all cases the separate collection of kitchen waste on a weekly

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<sup>26</sup> There is a significant body of evidence to support the common-sense assumption that where garden waste collections are presented free of charge, garden waste arisings increase. Whilst this is reflected in the recycling rate, the WCA is forced to pay for the collection of waste that would not otherwise have been part of the waste stream.

basis, as in for example the G14K7 scenarios, yields the most kitchen waste per annum for composting of any system. This compares very favourably with tonnages collected when kitchen waste is mixed with garden waste and card on a fortnightly basis, or even when it is collected with garden and card on a weekly basis. Collecting kitchen waste on its own on a fortnightly basis is not considered to be optimal. Capture rates will be low with many residents preferring to use the residual bin for kitchen waste rather than the separate collection service.

Given this, the balance of cost and recycling performance means that there may be value in providing separate collections for kitchen and garden waste. This is especially true when a charge for the collection of garden waste is introduced, if such a change is considered possible.

As stated, all WCA's within Hertfordshire collecting kitchen waste in 2004/05, co-collect it with garden waste and card. This type of system is more convenient to the householder but requires that the whole stream be in-vessel composted. The extra waste and the high treatment costs combine to make such systems the most expensive to operate when looking at whole system (as opposed to only collection) costs. Collection costs taken on their own are also, perhaps initially surprisingly, lower than where kitchen waste is co-collected with garden waste and card on a weekly basis using RCVs. The types of vehicle that are required to carry out separate kitchen waste collections are much smaller, more fuel efficient, do not have bin-lifts and make pick ups more quickly. The larger, heavier and slower RCVs are only therefore required on alternate weeks to pick up the garden waste which is anyway more voluminous and therefore better suited to compaction based vehicles.

The cost advantages of collecting organic streams separately, however, are offset by considerations regarding the need to maintain an additional fleet of vehicles, to manage and promote an entirely separate service and to have an additional vehicle pass once each fortnight. It is by factoring in treatment costs are that the full extent of the advantage of separate collections can be appreciated. However, recent and expected increases to the cost of windrow composting reduce the treatment cost differential and may, to some extent undermine the financial logic of separate collections. Furthermore, it is acknowledged that the operational and, potentially, the public perception related issues associated with the creation of an entirely separate system for the collection of kitchen waste make the introduction of such a system, in the short term, unrealistic. However, the performance and potential cost benefit that have been modelled in the long-term suggests that this is an issue that should be reconsidered at a later date.

#### 4.2.8 Compulsory Recycling

The impact of implementing a policy of compulsory recycling on householders has been modelled. Although there is limited experience of this within the UK, the London Borough of Barnet has introduced the scheme and believes it to be a very considerable success, increasing the amount of recycling collected at the kerbside by almost 30% and with participation rates ranging from 60% to 90%. In 2005, the scheme won the best local authority initiative award in the Awards for Excellence in Recycling and Waste Management.

Based on experience in Barnet, and taking into account the fact that participation rates are already high within Hertfordshire as a whole, it was conservatively estimated that the move towards compulsory recycling (for dry recycling only) would increase participation from 65% to 75% in the B&B14 stream. No increase was assumed in the organic waste stream. This has the impact of raising the recycling rate by 2%, with a negligible change in costs<sup>27</sup>.

Clearly, should compulsory recycling be enforced on the organic waste stream as well, then recycling rates would increase further. However the extent to which this could be achieved would depend to a great extent on what organic service was operational. For example, it would be untenable, and likely subject to legal challenge, to enforce compulsory organic waste recycling on a charged garden waste service. However, it may be feasible where a separate kitchen waste collection service is provided.

#### 4.2.9 Consideration of Long Term Disposal Costs

Whilst at first glance, the move to the longer term scenarios may seem expensive, increased expenditure must be put into context. It is important to recognise that by 2012, the cost of disposal of residual waste will have dramatically increased, with the landfill tax increasing to £35 per tonne. If this is added to a £23 per tonne landfill gate fee, each tonne of waste disposed of in this way will attract minimum total gate fees and taxes of £58 per tonne. Collection costs will, of course, be additional as will the costs of any LATS penalties, or costs of buying allowances that may be required if recycling services were not enhanced.

Furthermore, as kerbside recycling schemes become more comprehensive and effective in the long term, the cost per tonne of collection decreases as vehicles and crew are used more efficiently.

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<sup>27</sup> It can in fact be seen that there is a slight decrease in costs with the move to compulsory recycling. This is because the extra materials collected are cost little extra to collect as vehicles are used more effectively and the revenues are generated from the sale of the materials. However, it must be pointed out that this cost decrease does not take into account any cost of additional monitoring/ promotional material and enforcement that may be required.

## 5.0 Selecting Service Configurations for Environmental Appraisal

In order to carry out a proper Strategic Environmental Appraisal (as is required by the Environmental Assessment of Plans and Programmes Regulations 2004 when producing or revising an MWMS: the wider process that this options appraisal is produced in support of) it is necessary to consider the impacts of the collection systems that might be operated by each of the WCAs to calculate the cumulative environmental impacts that these will generate. Because the LATS position is relatively favourable until close to the second target year of 2012/13, it has been decided to base projections upon the collection systems that might be operational at this time.

It is important to note that these systems are not those which are expected to be adopted by the WCAs through the strategy which this document supports, but are those which appear to us likely to offer a good or optimal cost / performance balance. Political, financial, and operational factors will lead WCA officers, in reality to develop systems which are different from these. Additionally, differences regarding the underlying assumptions upon which the modelling is based will lead officers to make differing conclusions regarding certain service elements. Specifically, Eunomia believes that separate collections of kitchen waste, supported by AWC for refuse is likely to maximise the diversion from landfill of this material and to be affordable whilst WCA officers tend to believe that co-collection with garden waste may well perform to the necessary standard, and that separate services may not at any stage be necessary.

The actual systems which the WCAs intend to roll-out in the early years of the Strategy are summarised in the Action Plan which supports the Strategy document. It would seem likely that the systems that are offered for waste collection will continue to develop beyond only that which is currently firmly planned and modelling suggests that further developments will be necessary to meet the performance targets that are set. It is, therefore, necessary to understand what the impact of further reaching developments will be if the Strategic Environmental Assessment is complete and it is for this reason that it has been felt necessary to consider they types of system development that may be adopted above and beyond only that which is firmly committed.

To determine the types of systems that might be in place, the following decision rules have been used:

1. Systems selected are, as a default, fundamentally similar to those that are currently in place in terms of the collection systems for recycling and composting.
2. Where a limited range of recyclable materials are collected at kerbside then the existing service is modelled as being enhanced to collect a comprehensive range of dry recyclables.
3. All residual waste services are modelled as being operated on an AWC basis. The national momentum in its adoption means that it is becoming increasingly easy for authorities to make this cost saving, performance

enhancing service change without undue political difficulty. It seems likely, therefore, that this change will be made, if not by all, then at least by the large majority of authorities in Hertfordshire.

4. Where authorities have indicated a *possible* interest in certain types of service or policy change and the modelling shows this to have a favourable impact, then this has been included within the option selected.
5. Where a single simple additional change seems likely to deliver either significant cost or performance benefit then these have also been included within the option selected.

The result, therefore, is a range of systems based upon current services and aspirations with some slight further evolutions that for reason of price or performance may, between now and 2013, become attractive to the officers and members involved. It is, of course, entirely possible, indeed likely, that different systems will be in place. Service selection is unlikely to be made using the same logic as has been applied here and action planning indicates that in some cases the direction and speed of change will be different. *The point of this exercise, however, is not to accurately anticipate what systems will be operated but to provide a comparative framework for evaluation of those systems that are indicated by the action planning.*

Applying the decision rules described above yields the services configurations for each district and borough described in the following Sections.

In most cases, further incremental service developments would yield further affordable improvement. A note of whether this would be the case and what system would deliver these improvements has been made in each of the following sections and these are separately taken forward to test the outputs generated by an 'ideal' service configuration selection. The purpose of this is to illustrate the scope of performance improvement that could be delivered if more ambitious service selections are made and to examine the cost of these.

## 5.1 Broxbourne BC

### 5.1.1 Current Service

At the end of 2004/05, the last full year for which data is held BBC was collecting paper, cans and glass from a kerbside box on a fortnightly basis and garden waste, also fortnightly from either sacks or 240l bins.

This approximates to the service code B&B14, G14, with residual collected weekly.

### 5.1.2 Anticipated Service and Selection Rationale

It was not possible to interview BBC officers in preparation of this report because of the departure and new appointment of key personnel. However, it is felt likely that officers would be inclined towards selecting to include kitchen and card waste together with current garden waste collections in light of the HCC offer that all disposal costs would be met by the WDA (as this has been the case with most of the other authorities). This would give a service configuration of B&B14, KGC14.

It would be possible to improve upon the performance of this service configuration by increasing the frequency of either the dry or organic material collections. Increasing the frequency of dry collections is shown as increasing whole system costs by £224k (a net cost / hh increase of £6) and improving performance by 2.4%. Because it is very unusual to have organic compostable waste collected more frequently than dry recyclables no such system has been modelled.

*The simple evolution service configuration that is taken forward, therefore, is B&B7, KGC14.*

Building upon a box based service and looking at whole system costs it would seem that an ideal ultimate service configuration might be B&B7, G14K7. Although this is modelled as being £490,000 more expensive than B&B14, KGC14, it achieves a recycling rate 7.3% higher and leads to the additional diversion of 9.5% more BMW in the kerbside collected stream.

*The ideal service configuration that is taken forward, therefore, is B&B7, G14K7.*

## 5.2 Dacorum BC

### 5.2.1 Current Service

At the end of 2004/05, the last full year for which data is held DBC was collecting paper cans and plastic on a weekly basis from two kerbside boxes with garden, kitchen and card collected fortnightly, predominantly from 240l bins.

This approximates to the service code B&B7, KGC14.

### 5.2.2 Anticipated Service and Selection Rationale

When interviewed DBC officers expressed a longer term interest in co-mingled collections.<sup>28</sup> Although an exact comparison can't be made, B&B14, KGC14 can be directly compared with Co14, KGC14 and appears to perform favourably costing £756,000 less and achieving a higher recycling rate (40.1% against 37.9%). These calculations, of course, are not based upon a small depot-based MRF but upon an external facility where a gate fee is paid and material values forfeit because it is felt that it is only this type of facility that could properly separate a full range of co-mingled materials including glass, plastics, cans and paper. This assumption suggests, therefore, that the current system for the collection of dry materials is already reasonably optimised.

With the dry system already optimised and because DBC officers also expressed an interest in considering the impacts that the separate collection of kitchen waste might bring, it makes sense for performance and cost reasons to consider the separate collection of kitchen and garden waste.

*The simple evolution service configuration that is taken forward, therefore, is B&B7, G14K7.*

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<sup>28</sup> All references to interviews relate to meetings held between Eunomia project staff and key waste management officers at each of the WCAs during the week commencing Monday 26<sup>th</sup> September 2005.

Although this is £383,000 / annum more expensive, it also achieves a recycling rate which is nearly 4% higher and leads to the additional separate capture of 6% more kerbside collected BMW.

Because this system is shown by the modelling applied to the generic authority (as described in Section 3) to be close to optimal (achieving the second highest score under both weighting methodologies) then no further ideal long term scenario needs to be taken forward and the same system will be modelled in both the simple evolutionary scenarios and for the long-term ideal scenarios.

*The ideal service configuration that is taken forward, therefore, is B&B7, G14K7.*

## 5.3 East Hertfordshire DC

### 5.3.1 Current Service

At the end of 2004/05, the last full year for which data is held, paper was collected fortnightly from a kerbside box with garden waste also collected fortnightly from 240l bins. It is firmly planned, however, that this system should be expanded so that the dry system collects paper, glass and cans and the organic system includes kitchen waste.

This is equivalent to B&B14, KGC14, with residual collected weekly.

### 5.3.2 Anticipated Service and Selection Rationale

This current system is similar to that used by Broxbourne BC and the same logic is applied therefore in determining which systems to take forward for the purpose of projecting waste treatment and disposal capacity requirements.

*The simple evolution service configuration that is taken forward, therefore, is B&B7, KGC14.*

Similarly, looking at long-term ideal solutions, it may be decided that the additional logistical difficulties of organising separate collections of kitchen and garden waste are justified by the possible performance gains. B&B7, G14K7 although more expensive than B&B7, KGC14 (costing £379,000 more) but delivers a kerbside recycling rate which is 4.9% higher and leads to the diversion of an additional 7.8% BMW. Depending on how LATS costs savings are distributed between the two tiers of Hertfordshire local government whole system costs for the separate collection of kitchen waste may prove to be better value as well as better performing.

*The ideal service configuration that is taken forward, therefore, is B&B7, G14K.*

The extremely rural nature of East Hertfordshire may affect collection logistics to a greater degree than is captured by the model and it may be certainly need to be considered in more detail that the separate collection of kitchen waste may not perform as well as shown in the modelling and this would certainly need to be considered in detail

## 5.4 Hertsmere BC

### 5.4.1 Current Service

At the end of 2004/05, the last full year for which data is held paper was collected fortnightly from the kerbside from a kerbside box with cardboard, kitchen and garden waste also collected fortnightly from 240l bins. It is firmly planned, however, to move to a twin bin, twin box approach with boxes collecting fibres and containers (excluding glass) on alternate weeks and with bins collecting residual and organic on alternate weeks.

This approximates to PC14V14, KG14.

### 5.4.2 Anticipated Service and Selection Rationale

Because this service configuration is not commonly found amongst the other districts of Hertfordshire and reflecting the fact that there is a firm commitment to make the fairly major changes that are necessary to roll out the service described above it seems sensible to base waste arisings projections on this service without any further changes made.

*The main service configuration that is taken forward, therefore, is PC14V14, KG14. It is assumed that by 2013 this service will also collect glass at kerbside.*

Although PC14V14, KG14 is not amongst the higher performing systems that has been modelled it is relatively cheap. It is also fairly closely related to the very best performing system that has been modelled which also operates on a twin bin, twin box system but attempts to optimise the collection frequencies for the materials collected with containers and kitchen waste being collected weekly (and a new collection service required for the kitchen material) residual remaining on an AWC basis and paper and card being collected from larger bins on a monthly basis.<sup>29</sup>

*The ideal service configuration that is taken forward, therefore, is PC31V7, G14K7.*

## 5.5 North Hertfordshire DC

### 5.5.1 Current Service

At the end of 2004/05, the last full year for which data is held glass and paper were collected fortnightly from kerbside boxes with garden waste collected fortnightly from 240l bins.

This approximates to B&B14, G14, with residual collected weekly.

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<sup>29</sup> Higher volume or potentially smelly recyclable materials are removed frequently whilst denser paper, which therefore takes up less space in the household, is removed less frequently. In this way householder engagement with the scheme is maintained and collection services are matched to the materials that are collected.

### 5.5.2 Anticipated Service and Selection Rationale

It is firmly planned that an additional bag be distributed to residents for the collection of plastics and cans and that kitchen waste and cardboard are co-collected with the garden waste giving a service code of MB&B14, KGC14. With plans for service expansion only recently agreed and because officers have tentatively expressed an interest in considering the impact of AWC it makes sense that the current planned services, supported by AWC, form the basis upon which waste treatment projections are built.

*The simple evolution service configuration that is taken forward, therefore, is MB&B14, KGC14.*

If financial considerations strongly support the separate collection of kitchen and garden waste, as it appears from the modelling that they may, then by 2013 it is possible that officers will have shifted the collection of organic waste onto this basis. Without considering the impact of any LATS saving distribution arrangement, it would appear that such a service would be £334,000 more expensive but that this extra expenditure would achieve a 5.3% increase in the recycling rate and a 7.6% increase in the amount of kerbside collected bio-waste that is separately captured.

*The ideal service configuration that is taken forward, therefore, is MB&B14, G14K7.*

## 5.6 St. Albans DC

### 5.6.1 Current Service

At the end of 2004/05, the last full year for which data is held St. Albans DC was collecting paper, plastic bottles and cans from all residents and glass from others using a fortnightly box based scheme. Garden waste was also being collected on a fortnightly basis.

This approximates to the service code B&B14, G14, with residual collected weekly.

### 5.6.2 Anticipated Service and Selection Rationale

It is firmly planned to expand the scope of the service offered so that glass is collected from all households and with kitchen waste and cardboard co-collected with garden waste with all services remaining on a fortnightly basis. This equates to B&B14, KGC14. The simplest evolution of this service would be to increase the frequency of collections for dry materials which is relatively more important in more urban areas where householder space is at a premium. This adaptation would increase costs an additional £371,000 (excluding LATS considerations) and add 2.8% to the recycling rate.

*The simple evolution service configuration that is taken forward, therefore, is B&B7, KGC14.*

Once such a change has been made it may be attractive for reasons of cost and certainly of performance to introduce a further separate scheme for the collection

of kitchen waste. This would add a further £288,000 to costs but would also, according to modelling, lead to a further increase in the recycling rate of 4.3% and the capture of 6.3% more of the BMW in the kerbside stream.

*The ideal service configuration that is taken forward, therefore, is B&B7, G14K7.*

## 5.7 Stevenage BC

### 5.7.1 Current Service

At the end of 2004/05, the last full year for which data is held, paper, glass and cans were collected weekly from two boxes and garden waste was collected fortnightly.

This approximates to the service code B&B7, G14, with residual waste collected weekly.

### 5.7.2 Anticipated Service and Selection Rationale

Officers have indicated that they intend to expand organic waste services so that kitchen waste and card are collected together with green waste and recognise that the adoption of AWC using wheeled bins would allow for the re-balancing of service costs. Modelling indicates that the best next step beyond the B&B7, KGC14 that is planned is to move kitchen waste collections onto a weekly basis. Costs are best managed by leaving garden waste collections on a fortnightly basis and by separately treating the waste. Performance is also shown by modelling to be massively improved by this adjustment so that the recycling rate would increase by 5.1% with an additional 8.1% of BMW diverted from the kerbside collected stream.

*The simple evolution service configuration that is taken forward, therefore, is B&B7, G14K7.*

As with Dacorum BC, the simple evolution service configuration that is taken forward for the purpose of whole County waste projection purposes appears from the modelling to be already optimised and no further 'ideal' configuration need be considered.

*The ideal service configuration that is taken forward, therefore, is B&B7, G14K7.*

## 5.8 Three Rivers DC

### 5.8.1 Current Service

At the end of 2004/05, the last full year for which data is held, paper, glass, cans and plastic were collected fortnightly from 3 boxes with garden kitchen and cardboard also collected fortnightly from a 240l bin.

This is represented by the service code MB&B14, KGC14, with residual collected weekly but constrained by bin size and policies regarding the refusal of side waste.

## 5.8.2 Anticipated Service and Selection Rationale

Officers have indicated that they would like to see the collection of dry recyclables moved onto a weekly basis but that depot capacity constraints currently prevent this. It would be of further benefit in performance terms if organic waste collections could be moved onto a weekly basis so that the relative convenience of the service compared well with the alternative residual waste service.

Modelling suggests that weekly collections of both dry materials and also kitchen, garden and card would be relatively expensive costing an additional £880,000. If funds could be found to support this change and if an agreement can be reached between the Hertfordshire WCAs and WDA to redistribute LATS savings (or earnings from the sales of permits) then it may be that this service development might be considered to be worthwhile, not least because it would deliver an additional boost to recycling rates of 7.9% and lead to the capture of 10.2% more kerbside collected BMW than current services.

*The simple evolution service configuration that is taken forward, therefore, is MB&B7, KGC7.*

Although no similar service has been modelled which tests the separate collection of kitchen waste, the results of the modelling tend to indicate that although making garden waste collections separately and less frequently may make sense from a financial perspective, the recycling performance gain will be relatively insignificant. Because the purpose of this part of the exercise is to project waste treatment and disposal capacity requirements, it is therefore not necessary to examine any change to the simple service evolution to understand the impacts of an 'ideal' long terms service selection: from the point of view of captures, but not price, MB&B7, KGC7 is already ideal.

*The ideal service configuration that is taken forward, therefore, is MB&B7, KGC7.*

## 5.9 Watford BC

### 5.9.1 Current Service

At the end of 2004/05, the last full year for which data is held, glass, paper cans and plastic boxes were collected fortnightly from three kerbside boxes and garden kitchen and cardboard were also collected fortnightly from a 240l wheeled bin

This is represented by the service code MB&B14, KGC14, with residual collected weekly but constrained by bin size and policies regarding side waste.

### 5.9.2 Anticipated Service and Selection Rationale

Although Watford officers have expressed reservations regarding the complications that might be involved in moving to AWC, it is also recognised that there would be significant advantages in such a move. Whilst there is no great appetite, therefore, it would appear that there is an acceptance that this change may well happen and that it would likely also involve a shift in the frequency with which dry recyclables are collected.

*The simple evolution service configuration that is taken forward, therefore, is MB&B7, KGC7.*

Although no similar service has been modelled which tests the separate collection of kitchen waste, the results of the modelling tend to indicate that although making garden waste collections separately and less frequently may make sense from a financial perspective, the recycling performance gain will be relatively insignificant. Because the purpose of this part of the exercise is to project waste treatment and disposal capacity requirements, it is therefore not necessary to examine any change to the simple service evolution to understand the impacts of an 'ideal' long terms service selection: from the point of view of captures, but not price, MB&B7, KGC7 is already ideal.

*The ideal service configuration that is taken forward, therefore, is MB&B7, KGC.*

## 5.10 Welwyn Hatfield DC

### 5.10.1 Current Service

At the end of 2004/05, the last full year for which data is held paper and glass, were collected fortnightly from 2 boxes with garden waste also collected fortnightly from a 240l bin.

This is represented by the service code B&B14, G14, with residual collected weekly with residents supplying their own black sacks.

### 5.10.2 Anticipated Service and Selection Rationale

It is intended that kitchen waste and card should be co-collected together with garden waste once the Mill Green facility is equipped with IVC facilities. Additionally, it seems likely that the collection of dry recyclables might be moved to a weekly basis before 2012 and that a more comprehensive range of materials be included within the service. This service configuration would equate to B&B7, KGC14 which, modelling suggests would, once supported by AWC for residual waste, would outperform the baseline recycling rate by 25%.

*The simple evolution service configuration that is taken forward, therefore, is B&B7, KGC14.*

Moving kitchen waste collections onto a weekly basis whilst leaving collections of garden waste on a fortnightly basis would increase costs by £260,000 but would also boost the recycling rate by another 5% as residents find it increasingly easy to dispose of their kitchen waste using the service that is specifically provided for this purpose.

*The ideal service configuration that is taken forward, therefore, is B&B7, G14K7.*

## 5.11 Summary of Collection Options Used for Treatment and Disposal Projection Purposes

The systems that are taken forward and which are discussed in the previous sections are summarised in

Table 8:- Collection Systems Used for Waste Treatment and Disposal Capacity Requirements Projections

Authority	Conservative Option Selection	'Ideal' Option Selection
Broxbourne BC	B&B7, KGC14	B&B7, G14K7
Dacorum BC	B&B7, G14K7	B&B7, G14K7
East Hertfordshire DC	B&B7, KGC14	B&B7, G14K7
Hertsmere BC	PC14V14, KG14	PC31V7, G14K7
North Hertfordshire DC	MB&B14, KGC14	MB&B14, G14K7
St. Albans DC	B&B7, KGC14	B&B7, G14K7
Stevenage BC	B&B7, G14K7	B&B7, G14K7
Three Rivers DC	MB&B7, KGC7	MB&B7, KGC7
Watford BC	MB&B7, KGC7	MB&B7, KGC7
Welwyn Hatfield DC	B&B7, KGC14	B&B7, G14K7

## 5.12 County-wide Treatment Requirements under 'Conservative' and 'Ideal' Collection Option Selection Scenarios

Having identified the types of system that may be rolled out at the WCA level, it is possible to look at what this would mean in terms of WDA level responsibilities.

### 5.12.1 Treatment and Disposal Capacity Requirements under 'Conservative' Collection Options Selection Scenario

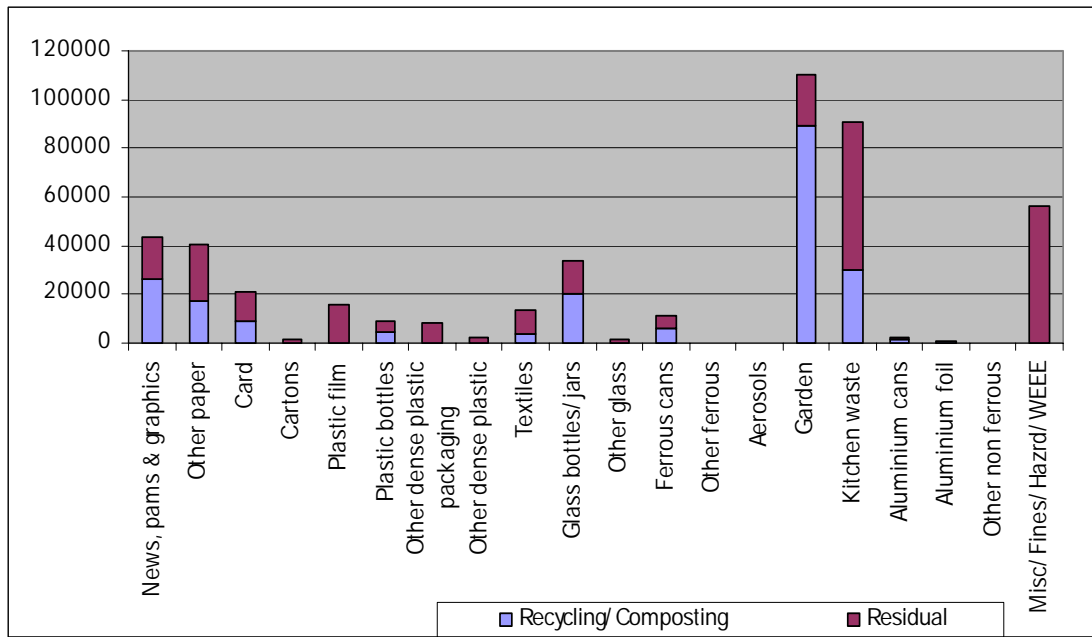
Whole system waste costs for doorstep collected waste, including collection and haulage costs, sorting, treatment and disposal gate fees and landfill taxes but excluding LATS will, if all districts make the smaller incremental changes described above, be £52.5M per annum. This will yield 208K tonnes of material for recycling with 45.5% of this waste stream being recycled. Additionally, 53.5% of kerbside collected bio-waste will be diverted from residual disposal reducing LATS exposure.

252,314 tonnes of the kerbside collected waste will still require treatment / disposal under this collection system selection scenario. This will break down as described in Table 9. The split between residual and recycled waste on a material by material basis is illustrated in

Table 9:- Waste Outputs by Material under Conservative Assumptions Regarding Collection System Evolutions

<b>Residual Waste (inc rejects)</b>	<b>Tonnage</b>
News, pams & graphics	16810
Other paper	23770
Card	11502
Cartons	1474
Plastic film	15604
Plastic bottles	3892
Other dense plastic packaging	8135
Other dense plastic	2140
Textiles	9635
Glass bottles/jars	13476
Other glass	1721
Ferrous cans	5395
Garden	20768
Kitchen waste	60243
Aluminium cans	756
Aluminium foil	427
Misc/Fines/Hazrd/WEEE	56567
<b>Total</b>	<b>252314</b>

Figure 2:- Material Split Between Recycled and Residual Stream under Conservative Assumptions regarding Collection System Developments



## 6.0 Long Term Option Sensitivity Analyses

The combination of different service configurations within the 19 modelled generic authority scenarios identifies the key relativities between cost and performance for potential long term collection systems. However, legitimate questions remain concerning the impact of certain key differences in the operational practice of these systems. As such, four additional scenarios were run by modifying the B&B7,Gs14K7 scenario<sup>30</sup> to account for the following potential variations:

1. Weekly rather than fortnightly collection of residual waste;
2. The use of stillage vehicles used instead of Kerbsiders for dry recyclables;
3. Kitchen waste sent for anaerobic digestion (AD) rather than in-vessel composting (IVC);
4. A single pass of a Kerbsider vehicle to collect both the recyclables and kitchen waste.

These systems, as run through the model under the generic authority configuration, generate the results as below in Table 10.

Table 10: Sensitivity Analysis Results

	B&B7,Gs14K7	Weekly Residual Sensitivity	Stillage Sensitivity	AD Sensitivity	Single Pass Sensitivity
Cost / hhold	£109.18	£126.93	£105.21	£107.70	£110.00
Recycling rate	45%	39%	45%	45%	45%
Growth	5%	5%	5%	5%	5%
Biowaste diversion	55%	48%	55%	55%	55%
Score	8.01	6.92	8.12	8.05	7.98
Rank	3	5	1	2	4

### 6.1 Weekly Residual Waste

Increasing the frequency of residual waste collections both reduces time householders are forced to *live with* their waste and also provides greater

<sup>30</sup> Although this was not the best performing scenario under the ranking methodology described in Chapter 3, it had a better spread of score against all criteria and was seen as a sensible compromise option, not for implementation, but against which sensitivity analysis could most usefully be carried out.

capacity for their waste. As such, the residual waste stream becomes the predominant waste pathway. Participation in recycling services reduces due to the relative greater ease of disposal as waste and associated recognition rates fall since using recycling services properly becomes less habitual and less critical.

Results from the modelling show very large sensitivity to this collection parameter. Although there is minor saving made from reduction in the number of recycling vehicles (a 16% saving in Kerbsider vehicles and 17% in garden waste collection vehicles), in order to effectively double the number of residual waste collections there is a 109% increase requirement for residual vehicles (which is also affected by the increase in disposal through this system). This pushes the net cost/revenue per household up from £109 to £127 per household.

This fact alone identifies the failure inherent in this system, without the restriction on residual waste capacity, optimisation of the other systems cannot be achieved. It is unsurprising that ranking of this system shows it performs worst of all the sensitivities. Coincidentally it would also appear at the bottom of the pile of all of the 19 standard long term scenarios. This merely underlines the fact that seeking to achieve high recycling rates whilst making residual waste collection equally convenient is likely to be a) more expensive and b) less successful in terms of performance parameters.

## 6.2 Substitution for Stillage Recyclable Vehicles

Stillage vehicle characteristics are subtly different from the Kerbsider vehicles. Although they are both kerbside sort systems the stillage vehicles are both smaller and cheaper. They are also commonly operated with smaller operating crews. As such the model identifies that greater numbers of vehicles (7% additional) are required, and that they have to return to base to empty materials more frequently. However, the lower capital cost of these vehicles and lower staffing rates realise a cost saving over the base case. Consequently this system scores well and ranks highest of all options.

However, stillage vehicles involve higher health and safety risk to operatives (due to issues of manual handling) and may not be suitable in all local authority situations. Detailing the exact choice of fleet is not intended to be a significant part of this work. It is more important to optimise the overall system and indeed, real situations will often involve a mixed fleet anyway. What this does identify is the scope of potential cost differences that may be achieved if this particular choice of vehicle were deemed suitable. What has not been tested in this project and may be worth examining at a future point is the impact of co-collecting kitchen waste with dry recyclables using a stillage vehicle.<sup>31</sup> We anticipate that this could deliver further cost reductions.

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<sup>31</sup> This system is currently operated by ECT in North Somerset County Council, The London Borough of Ealing and is due to be rolled out by Bristol City Council.

### 6.3 Anaerobic Digestion (AD) Treatment of Kitchen Waste

Many AD technology providers offer systems capable of digesting 100% food waste. There are many suppliers in the market. No preference is implied for Greenfinch Ltd, but this is just one such supplier of a system with the claimed ability to digest separately collected kitchen waste. It claims a possible gate fee of £50/tonne although this may be an idealised cost and has not been substantiated in commercial tenders. A more sensible gate fee was considered to be £60/tonne and this was used in the modelling.

IVC on the other hand requires bulking up of the kitchen waste with more fibrous material (e.g. green waste sourced potentially from HWRCs). Interestingly, from a system perspective makes it possible that AD may be slightly cheaper than IVC (because all garden waste can still be composted at open-air windrows).

The AD product would likely benefit from the addition of structural material prior to land application. There is no reason why material from windrow composting could not fill this role. The final maturation phase could be conducted by mixing windrowed material with the output from the AD facility to produce a better structural and higher quality product.

Composted digestate produced from food waste (as opposed to that which is produced from mixed waste) can, and is currently in many parts of mainland Europe, being applied to land without restrictions. Indeed, wet processes make it possible to precipitate off salts, making the material more suitable for high grade applications than aerobically composted material containing food waste.

Digestate produced from food waste can, and is currently in many parts of mainland Europe, be applied directly to the land unlike that which is produced from mixed waste. This is not felt, therefore, to undermine this sensitivity analysis. On the other hand, the analysis is totally dependent on gate fees which may, in practice, be higher than was modelled. In this respect, therefore, this analysis must be treated with caution.

### 6.4 Single Pass for Recyclables and Kitchen Waste

Adding kitchen waste as an additional material to be collected on the recyclables Kerbsider removes the need for an additional fleet of specific kitchen waste collection vehicles. It does, however, transfer burden to the kerbsiders by way of adding an additional collection time per property where an extra bin has to be collected and also by limiting the capacity for recyclable collection as compared to the base case. The question is, therefore; are the effective cost savings in kitchen vehicles greater than the additional cost involving Kerbsider vehicles? Due to the relative high expense of Kerbsiders and high staffing for sorting on these vehicles, the single pass option entails significant extra cost over the base case. The simplicity and low cost of the single operative kitchen waste collection vehicles means that their use will improve overall collection efficiency.

## Appendix 1: Waste Composition Data Used

District	BBC	DBC	EHDC	HBC	NHDC	SADC	SBC	TRDC	WBC	WHDC
News, pams & graphics	11.00%	10.30%	8.10%	9.80%	8.10%	13.10%	8.10%	13.00%	11.90%	11.50%
Other paper	9.70%	9.00%	9.30%	9.30%	9.30%	11.10%	9.30%	11.00%	10.00%	10.00%
Card	4.90%	4.90%	4.90%	4.90%	4.90%	6.00%	4.90%	4.00%	4.90%	4.50%
Cartons	0.40%	0.40%	0.40%	0.40%	0.40%	0.20%	0.40%	0.30%	0.40%	0.20%
Plastic film	3.50%	4.00%	4.00%	4.00%	4.00%	2.80%	4.00%	4.00%	3.50%	3.50%
Plastic bottles	2.10%	2.10%	2.10%	2.10%	2.10%	2.00%	2.10%	2.10%	2.10%	2.10%
Other dense plastic packaging	2.10%	2.10%	2.10%	2.10%	2.10%	1.10%	2.10%	2.10%	2.10%	1.70%
Other dense plastic	0.30%	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%	0.60%	0.20%	0.20%
Textiles	3.20%	3.20%	3.20%	3.00%	3.20%	3.20%	3.20%	3.20%	3.00%	3.00%
Glass bottles/jars	6.00%	7.90%	7.90%	7.90%	7.90%	10.00%	7.90%	9.50%	7.90%	7.90%
Other glass	0.50%	0.50%	0.50%	0.50%	0.50%	0.10%	0.50%	0.50%	0.20%	0.30%
Ferrous cans	2.70%	2.70%	2.70%	2.70%	2.70%	2.70%	2.70%	2.50%	2.70%	2.70%
Garden	16.20%	16.00%	16.40%	16.40%	16.40%	16.40%	16.40%	15.00%	16.00%	16.00%
Kitchen waste	22.20%	21.00%	22.20%	22.00%	22.20%	20.00%	22.20%	21.00%	22.00%	21.90%
Aluminium cans	0.49%	0.49%	0.49%	0.49%	0.49%	0.49%	0.49%	0.49%	0.49%	0.49%
Aluminium foil	0.21%	0.21%	0.21%	0.21%	0.21%	0.21%	0.21%	0.10%	0.10%	0.21%
Misc/Fines/Hazrd/WEEE	14.50%	14.60%	14.90%	13.60%	14.90%	10.00%	14.90%	10.61%	12.51%	13.80%

## Appendix 2: Commodity Prices Used

Table 11 shows the commodity prices that were used in the model for the base cases, mid and long term scenarios. It has been assumed that for the intermediate years, the commodity prices have remained the same. This is with the exception of residual waste, where the landfill tax escalator has been included.

For the commingled options, the commodity prices are not included, since it is assumed that the MRF will keep the revenue from these materials and so is of no financial benefit to the council.

The treatment of garden and kitchen wastes incurs a cost to each council. Where garden and kitchen waste (or garden, kitchen and card) are collected together, all materials must go to in-vessel composting for recovery, and the price for both materials is the same (assumed to be £50 per tonne). Where kitchen and garden waste are collected separately, the garden waste can be treated in cheaper, open air windrow composting facilities, assumed to be £19 per tonne. However the in vessel composting of kitchen waste alone does not give a sufficiently good mix of material to enable a useable product to be formed and some form of garden material is needed. Therefore, where kitchen waste is collected separately to compost, some garden waste will need to be identified from elsewhere, thus increasing the overall cost of treatment.

Newspaper and magazines generate revenue of £35/tonne. However, when commingled with card with a monthly collection, the material could be of lower quality than when collected more frequently since there is greater potential for contamination and for the material to get wet. In this case the price of paper is dropped to £25/tonne.

Other recyclable paper is assumed to command a value of £10/tonne, unless its quality falls (as in the case of the monthly collection of paper and card), in which case no value is attached.

Cardboard collected on its own commands a value of £19/tonne. When co-collected with paper the value drops to £5/tonne. However where card is collected with garden and/or kitchen waste, the material will require in-vessel or windrow composting depending. Where card is collected with garden waste the cost will be £19/tonne, and where it is collected with kitchen and garden waste the cost will rise to £50/tonne.

Where glass is separated into colours the revenue increases from £10/tonne to £20/tonne.

Table 11 below shows the commodity prices used for each of the long term models taken forward for each district.

Table 11: Commodity Prices for Base Long Term Scenarios (£)

Commodity	B&B7 KGC14	B&B14 KGC14	B&B7 £G14K7	MB&B1 4 KGC14	B&B7 Gs14K7	PC31V7 G14K7	MB&B1 4 G14k7	MB&B7 KGC7	PC14V1 4 KGC14	B&B14 KGC14 (CR)
News, pams & graphics	35	35	35	35	35	25	35	35	35	35
Other paper	10	10	10	10	10	-	10	10	10	10
Card	-50	-50	15	- 50	15	5	15	- 50	-50	-50
Plastic film	50	50	50	50	50	50	50	50	50	50
Plastic bottles	150	150	150	150	150	150	150	150	150	150
Other dense plastic packaging	30	30	30	30	30	30	30	30	30	30
Textiles	150	150	150	150	150	150	150	150	150	150
Glass bottles/jars	20	20	20	20	20	20	20	20	20	20
Ferrous cans	60	60	60	60	60	60	60	60	60	60
Garden	- 50	- 50	- 19	- 50	-19	-19	-19	- 50	- 50	- 50
Kitchen waste	- 50	- 50	- 65.50	- 50	-65.50	-65.50	-65.50	- 50	- 50	- 50
Aluminium cans	700	700	700	700	700	700	700	700	700	700
Aluminium foil	700	700	700	700	700	700	700	700	700	700
Other non ferrous	-500	-500	-500	-500	-500	-500	-500	-500	-500	-500

## Appendix 3: Description of the Nineteen Scenarios Modelled for a 'Generic' Authority & Additional Long Term Models Taken Forward for Each District

<b>System Configuration Code</b>	<b>B&amp;B7,KG14</b>		
System Description	Box & bag	Kitchen & garden	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden, Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	240L wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,KG7</b>		
System Description	Box & bag	Kitchen & garden	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden, Kitchen waste,	Residual
Frequency	Weekly	Weekly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,G14K7</b>			
System Description	Box & bag	Garden	Kitchen	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden	Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Weekly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,£G14K7</b>			
System Description	Box & bag	Garden (with annual charge of £20)	Kitchen	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden	Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Weekly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,KGC7</b>		
System Description	Box & bag	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aerosols (ferrous & non ferrous), Aluminium cans, Aluminium foil	Card, Garden, Kitchen waste	Residual
Frequency	Weekly	Weekly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,EG14KC7</b>			
System Description	Box & bag	Garden (with annual charge of £20)	Kitchen & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aerosols (ferrous & non ferrous), Aluminium cans, Aluminium foil	Garden	Card, Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Weekly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,Gs14K7</b>			
System Description	Box & bag	Garden	Kitchen	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil	Garden	Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Weekly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	Re-usable PP sack (woven with handles)	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV no binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,KG14+cdy</b>		
System Description	Box & bag	Kitchen & garden w. extra caddy	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden, Kitchen waste,	Residual
Frequency	Weekly	Fortnightly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	240L wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,KG7+cdy</b>		
System Description	Box & bag	Kitchen & garden w. extra caddy	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil	Garden, Kitchen waste,	Residual
Frequency	Weekly	Weekly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>MB&amp;B7,EG14KC7</b>			
System Description	Multiple box/bag	Garden (with annual charge of £20)	Kitchen & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aerosols (ferrous & non ferrous), Aluminium cans, Aluminium foil	Garden	Card, Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Weekly	Fortnightly
Container	2 * RR44 Kerbside Boxes & Co-mingled printed coloured sack	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>MB&amp;B7,G14K7</b>			
System Description	Multiple box/bag	Garden	Kitchen	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden	Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Weekly	Fortnightly
Container	2 * RR44 Kerbside Boxes & Co-mingled printed coloured sack	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>Co7,EG14K7</b>			
System Description	Co-mingled dry	Garden	Kitchen	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden,	Kitchen waste,	Residual
Frequency	Weekly	Fortnightly	Weekly	Fortnightly
Container	Co-mingled printed coloured sack 55micron	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Standard RCV no binlifts	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>Co7,KGC7</b>		
System Description	Co-mingled dry	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aerosols (ferrous & non ferrous), Aluminium cans, Aluminium foil,	Card, Garden, Kitchen waste,	Residual
Frequency	Weekly	Weekly	Fortnightly
Container	Co-mingled printed coloured sack 55micron	140l wheelie	240L wheelie
Vehicle	Standard RCV no binlifts	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>Co14,KG7</b>		
System Description	Co-mingled	Kitchen & garden	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil,	Garden, Kitchen waste	Residual
Frequency	Fortnightly	Weekly	Fortnightly
Container	240L wheelie	140l wheelie	240L wheelie
Vehicle	Standard RCV w. binlifts	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>Co14,G14K7</b>			
System Description	Co-mingled	Garden	Kitchen	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil	Garden	Kitchen waste	Residual
Frequency	Fortnightly	Fortnightly	Weekly	Fortnightly
Container	240L wheelie	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Standard RCV w. binlifts	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>Co14,KGC7</b>		
System Description	Co-mingled	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aerosols (ferrous & non ferrous), Aluminium cans, Aluminium foil,	Card, Garden, Kitchen waste,	Residual
Frequency	Fortnightly	Weekly	Fortnightly
Container	240L wheelie	140l wheelie	240L wheelie
Vehicle	Standard RCV w. binlifts	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>Co14,Gs14K7</b>			
System Description	Co-mingled	Garden	Kitchen	Residual
Materials Collected	News, pams & graphics, other paper, card, plastic bottles, textiles, glass bottles/jars, ferrous cans, aerosols (ferrous & non ferrous), aluminium cans, aluminium foil	Garden	Kitchen waste	Residual
Frequency	Fortnightly	Fortnightly	Weekly	Fortnightly
Container	240L wheelie	Re-usable PP sack (woven with handles)	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Standard RCV w. binlifts	Standard RCV no binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>PC14V14,G14K7</b>				
System Description	Containers	Garden	Kitchen	Paper & Card	Residual
Materials Collected	Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aerosols (ferrous & non ferrous), Aluminium cans, Aluminium foil	Garden	Kitchen waste	News, pams, graphics, other paper & card	Residual
Frequency	Fortnightly	Fortnightly	Weekly	Fortnightly	Fortnightly
Container	RR44 Kerbside Box	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	Co-mingled printed coloured sack 55micron	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV no binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>PC31V7,G14K7</b>				
System Description	Containers	Garden	Kitchen	Paper & Card	Residual
Materials Collected	Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aerosols (ferrous & non ferrous), Aluminium cans, Aluminium foil,	Garden	Kitchen waste	News, pams, graphics, other paper & card	Residual
Frequency	Weekly	Fortnightly	Weekly	Monthly	Fortnightly
Container	RR44 Kerbside Box	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	180L wheelie	240L wheelie
Vehicle	Terberg Kerbsider quick w/o paper	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts no MRF	Standard RCV w. binlifts

ADDITIONAL MODELS TAKEN FORWARD FOR EACH DISTRICT:

<b>System Configuration Code</b>	<b>Co14,KGC7</b>		
System Description	Co-mingled dry	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil,	Card, Garden, Kitchen waste,	Residual
Frequency	Fortnightly	Weekly	Fortnightly
Container	240l wheelie	140l wheelie	240L wheelie
Vehicle	Standard RCV w. binlifts	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B14,KGC14</b>		
System Description	Box & bag	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil	Card, Garden, Kitchen waste	Residual
Frequency	Fortnightly	Fortnightly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B7,KGC14</b>		
System Description	Box & bag	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil	Card, Garden, Kitchen waste	Residual
Frequency	Weekly	Fortnightly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>MB&amp;B14,KGC14</b>		
System Description	Multiple box/bag	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil	Card, Garden, Kitchen waste	Residual
Frequency	Fortnightly	Fortnightly	Fortnightly
Container	2*RR44 Kerbside Box & Co-mingled printed coloured sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>MB&amp;B7,KGC7</b>		
System Description	Multiple box/bag	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil	Card, Garden, Kitchen waste	Residual
Frequency	Weekly	Weekly	Fortnightly
Container	2*RR44 Kerbside Box & Co-mingled printed coloured sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>MB&amp;B14,G14K7</b>			
System Description	Multiple box/bag	Garden	Kitchen	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil	Garden	Kitchen waste	Residual
Frequency	Fortnightly	Fortnightly	Weekly	Fortnightly
Container	2*RR44 Kerbside Box & Co-mingled printed coloured sack	240L wheelie	10l & 35l +bags w. extra caddy +bin (104 bags/hh/yr)	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Double or Single-operative food waste vehicle	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>PC14V14,KGC14</b>			
System Description	Containers	Kitchen, garden & card	Paper & Card	Residual
Materials Collected	Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil	Card, Garden, Kitchen waste	News, pams, graphics, other paper & card	Residual
Frequency	Fortnightly	Fortnightly	Fortnightly	Fortnightly
Container	RR44 Kerbside Box	140l wheelie	Co-mingled printed coloured sack 55micron	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV no binlifts	Standard RCV w. binlifts

<b>System Configuration Code</b>	<b>B&amp;B14,KGC14 (Compulsory Recycling)</b>		
System Description	Box & bag	Kitchen, garden & card	Residual
Materials Collected	News, pams & graphics, Other paper, Plastic bottles, Textiles, Glass bottles/jars, Ferrous cans, Aluminium cans, Aluminium foil	Card, Garden, Kitchen waste	Residual
Frequency	Fortnightly	Fortnightly	Fortnightly
Container	RR44 Kerbside Box & Re-usable HDPE sack	140l wheelie	240L wheelie
Vehicle	Terberg Matec Kerbsider	Standard RCV w. binlifts	Standard RCV w. binlifts

## Appendix 4: Modelling Outputs on a District by District Basis

Collection options reports for each district have been supplied to the responsible officers. Although these do not form a central part of the strategy being, as they are, discussion documents which outline the possible advantages and disadvantages of various system configurations, it is still felt to be of value to present the central modelling outputs upon which each is based.

Table 12:- BBC Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	3,199	4,253	4,640	4,020	3,984	4,208	4,513	4,331	4,630	5,244	4,534	3,988	4,474
<b>Total Collection Cost (£,000)</b>	2,074	2,924	3,305	2,641	2,292	2,611	2,371	2,595	3,074	3,531	2,742	2,391	3,153
<b>Net Revenue/ Treatment Cost (£,000)</b>	0	-195	-290	-168	-360	-319	-788	-380	-328	-534	-400	-319	-216
<b>Net Cost/ HH (£)</b>	87	108	118	102	101	107	114	110	117	133	115	101	113
<b>Recycling tonnage</b>	5,136	17,638	21,348	16,638	16,541	17,471	15,580	16,112	18,156	19,439	15,491	17,471	18,398
<b>Recycling rate</b>	15.8%	47.4%	54.3%	44.3%	41.9%	44.2%	39.4%	40.8%	46.1%	48.9%	39.2%	44.2%	49.1%
<b>Biowaste diversion rate</b>	20.2%	56.7%	64.4%	52.2%	49.5%	51.5%	48.0%	48.4%	55.8%	58.9%	47.1%	51.5%	59.0%

Figure 3: Comparison of different system inputs and outputs (BBC).

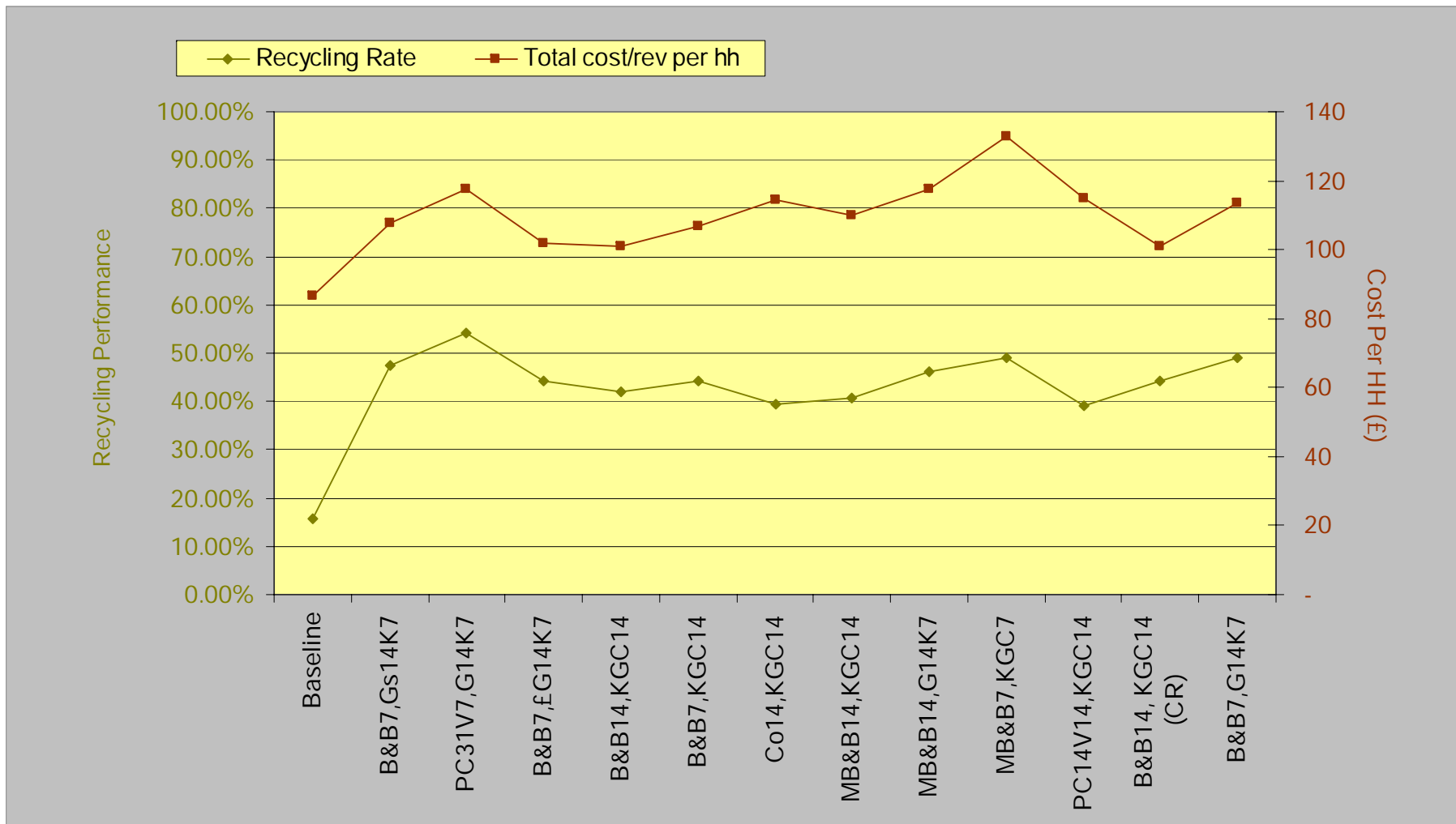


Table 13:- Dacorum Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	5,362	6,195	6,838	5,782	5,856	6,199	6,612	6,325	6,759	7,620	6,661	5,833	6,582
<b>Total Collection Cost (£,000)</b>	3,533	4,140	4,781	3,653	3,250	3,733	3,389	3,663	4,381	4,989	3,914	3,368	4,541
<b>Net Revenue/ Treatment Cost (£,000)</b>	-235	-227	-364	-191	-518	-459	-1,107	-544	-418	-743	-568	-459	-258
<b>Net Cost/ HH (£)</b>	92	100	110	93	94	100	106	102	109	122	107	94	106
<b>Recycling tonnage</b>	12,837	25,163	30,686	23,822	24,048	25,451	22,762	23,526	26,092	27,876	22,475	25,451	26,311
<b>Recycling rate</b>	24.8%	44.4%	51.2%	41.6%	40.1%	42.4%	37.9%	39.2%	43.6%	46.1%	37.4%	42.4%	46.1%
<b>Biowaste diversion rate</b>	33.6%	53.3%	61.2%	49.2%	47.9%	49.8%	46.6%	47.0%	53.2%	56.1%	45.0%	49.8%	55.8%

Figure 4: Comparison of different system inputs and outputs (DBC).

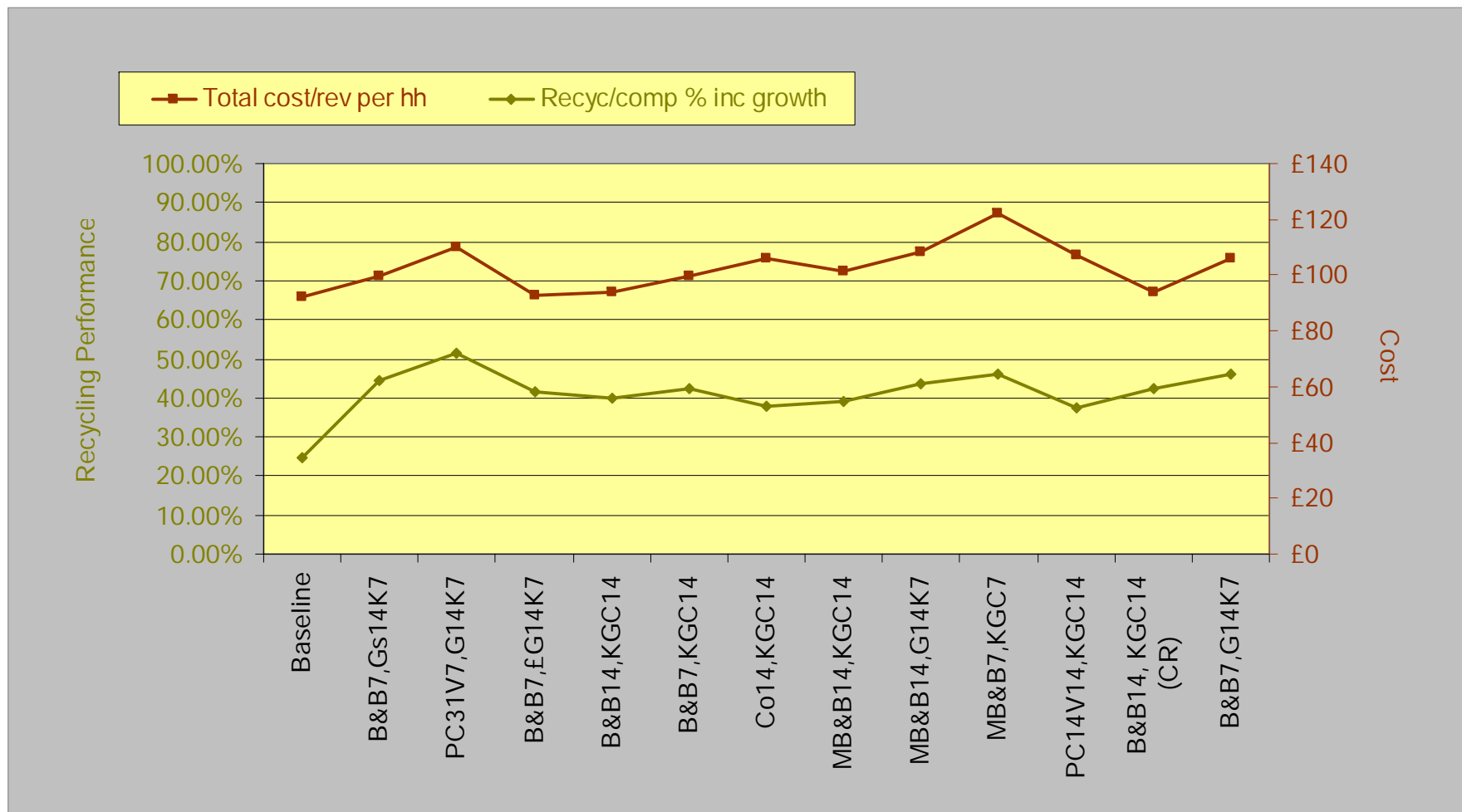


Table 14:- EHDC Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	5,112	6,295	6,937	5,897	5,949	6,296	6,751	6,463	6,851	7,846	6,781	5,926	6,675
<b>Total Collection Cost (£,000)</b>	3,279	4,197	4,826	3,720	3,279	3,768	3,393	3,725	4,465	5,141	3,959	3,399	4,591
<b>Net Revenue/ Treatment Cost (£,000)</b>	-44	-324	-470	-286	-589	-528	-1,238	-620	-531	-863	-650	-528	-357
<b>Net Cost/ HH (£)</b>	93	107	118	100	101	107	115	110	116	133	115	101	113
<b>Recycling tonnage</b>	7,323	27,439	33,148	26,044	25,856	27,240	24,326	25,207	29,479	30,354	24,269	27,240	28,646
<b>Recycling rate</b>	14.4%	47.3%	53.9%	44.4%	41.9%	44.1%	39.4%	40.8%	48.0%	48.9%	39.3%	44.1%	49.0%
<b>Biowaste diversion rate</b>	21.2%	56.9%	64.6%	52.6%	49.9%	51.6%	48.4%	48.8%	59.1%	59.5%	47.7%	51.6%	59.4%

Figure 5: Comparison of different system inputs and outputs (EHDC).

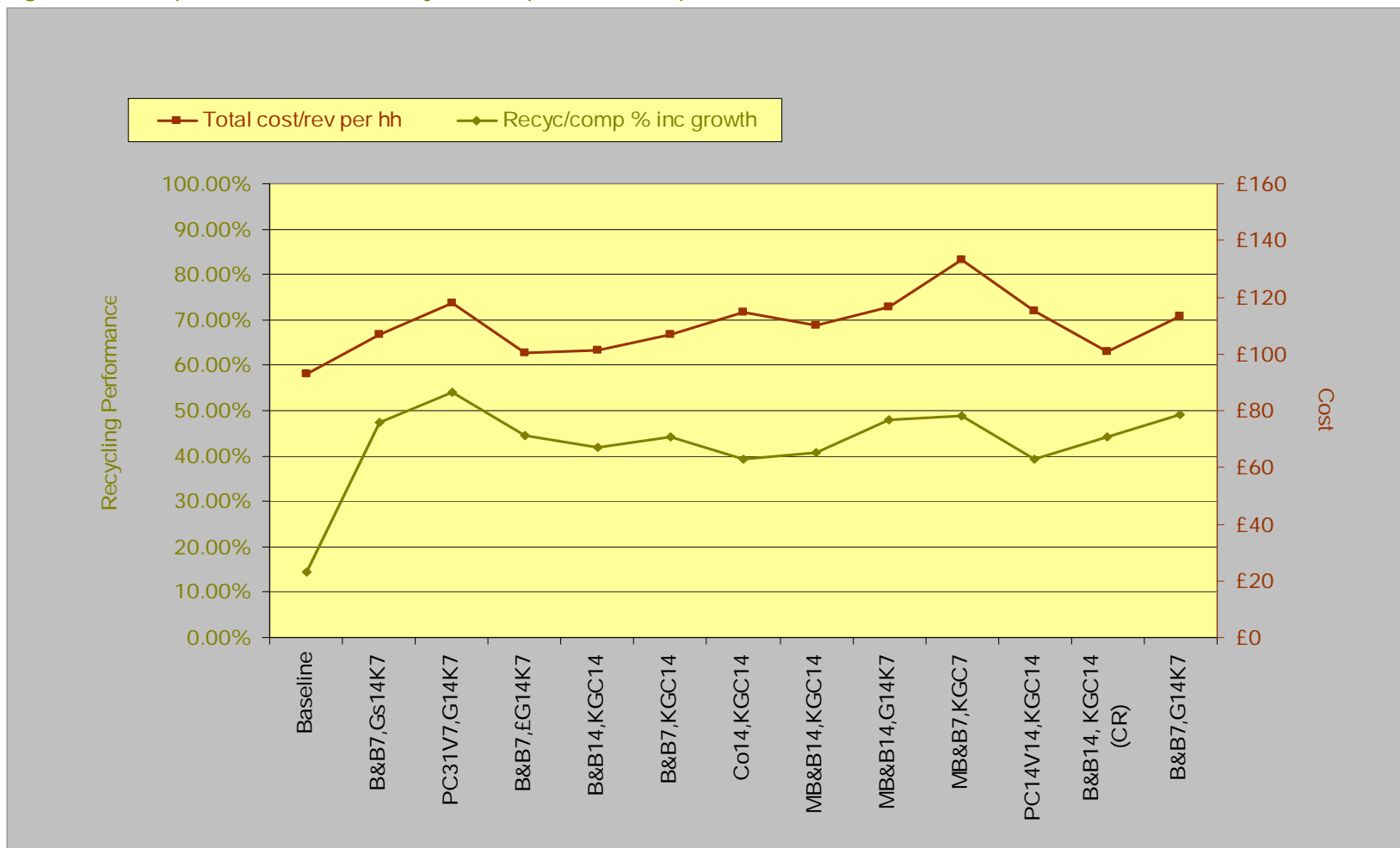


Table 15:- Hertsmere Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	3,954	4,536	4,948	4,278	4,251	4,496	4,819	4,620	4,888	5,625	4,838	4,253	4,777
<b>Total Collection Cost (£,000)</b>	2,701	3,105	3,512	2,794	2,422	2,770	2,505	2,744	3,256	3,774	2,900	2,527	3,356
<b>Net Revenue/ Treatment Cost (£,000)</b>	-2	-212	-313	-186	-400	-356	-859	-420	-354	-585	-442	-356	-234
<b>Net Cost/ HH (£)</b>	100	108	118	102	101	107	115	110	116	134	115	101	114
<b>Recycling tonnage</b>	3,899	19,115	23,122	18,145	18,051	19,062	16,984	17,602	20,445	21,140	16,891	19,062	19,945
<b>Recycling rate</b>	11.3%	47.6%	54.4%	44.8%	42.3%	44.7%	39.8%	41.2%	48.1%	49.2%	39.6%	44.7%	49.4%
<b>Biowaste diversion rate</b>	16.7%	56.8%	64.5%	52.5%	50.0%	51.8%	48.5%	48.9%	58.7%	59.3%	47.6%	51.8%	59.2%

Figure 6: Comparison of different system inputs and outputs (HBC).

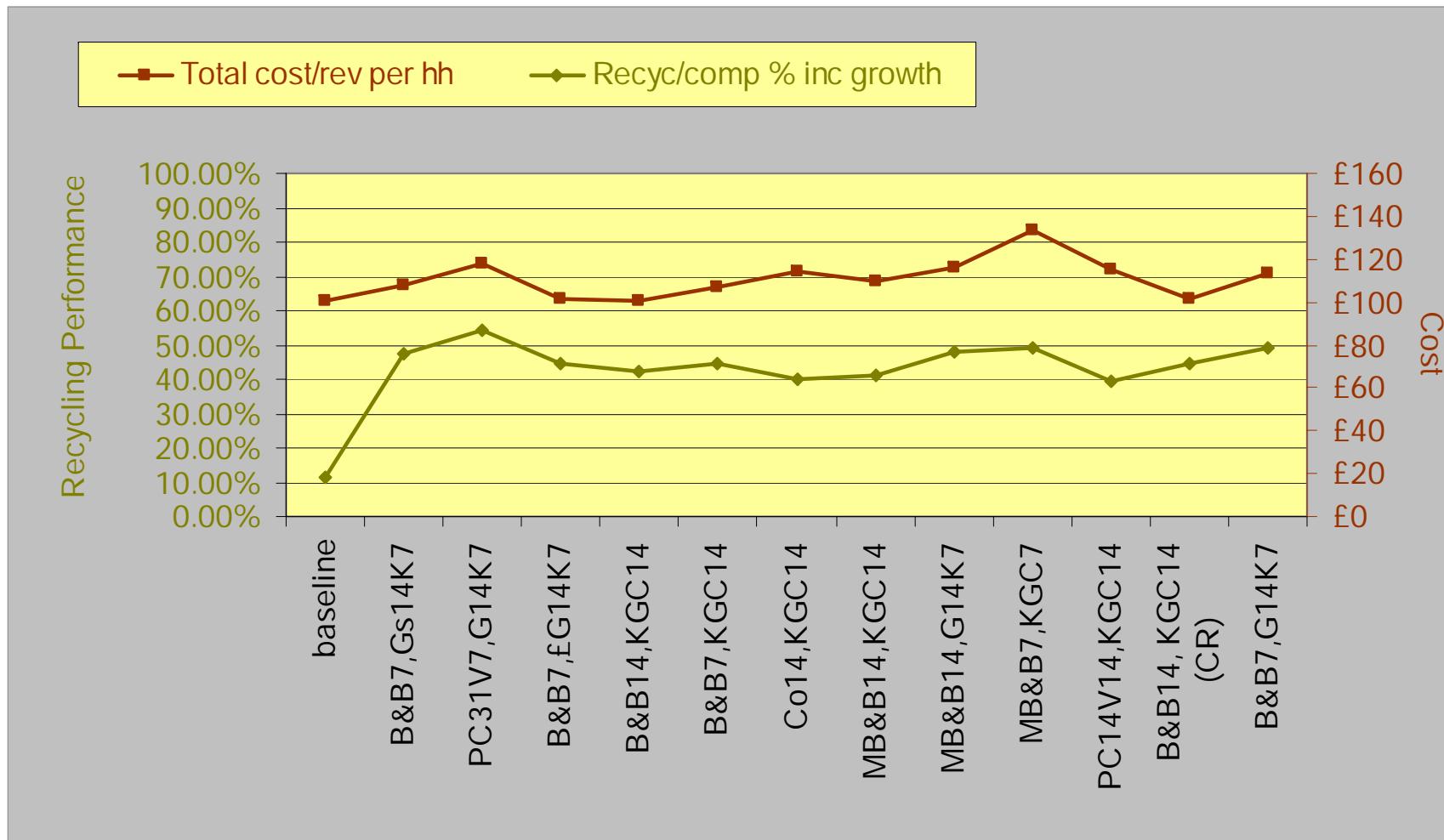


Table 16:- NHDC Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	5,378	6,161	6,726	5,812	5,928	6,212	6,738	6,410	6,677	7,711	6,717	5,826	6,485
<b>Total Collection Cost (£,000)</b>	3,676	4,000	4,556	3,571	3,183	3,613	3,292	3,596	4,223	4,931	3,818	3,226	4,339
<b>Net Revenue/ Treatment Cost (£,000)</b>	12	-332	-479	-293	-605	-542	-1,268	-636	-543	-886	-666	-542	-366
<b>Net Cost/ HH (£)</b>	103	111	121	105	107	112	121	115	120	139	121	105	117
<b>Recycling tonnage</b>	10,079	28,017	33,888	26,570	26,444	27,865	24,903	25,796	30,107	31,096	24,836	27,865	29,254
<b>Recycling rate</b>	19.4%	47.1%	53.8%	44.2%	41.8%	44.0%	39.3%	40.7%	47.8%	48.8%	39.2%	44.0%	48.8%
<b>Biowaste diversion rate</b>	21.5%	56.7%	64.3%	52.3%	49.8%	51.5%	48.3%	48.7%	58.8%	59.4%	47.6%	51.5%	59.1%

Figure 7: Comparison of different system inputs and outputs (NHDC).

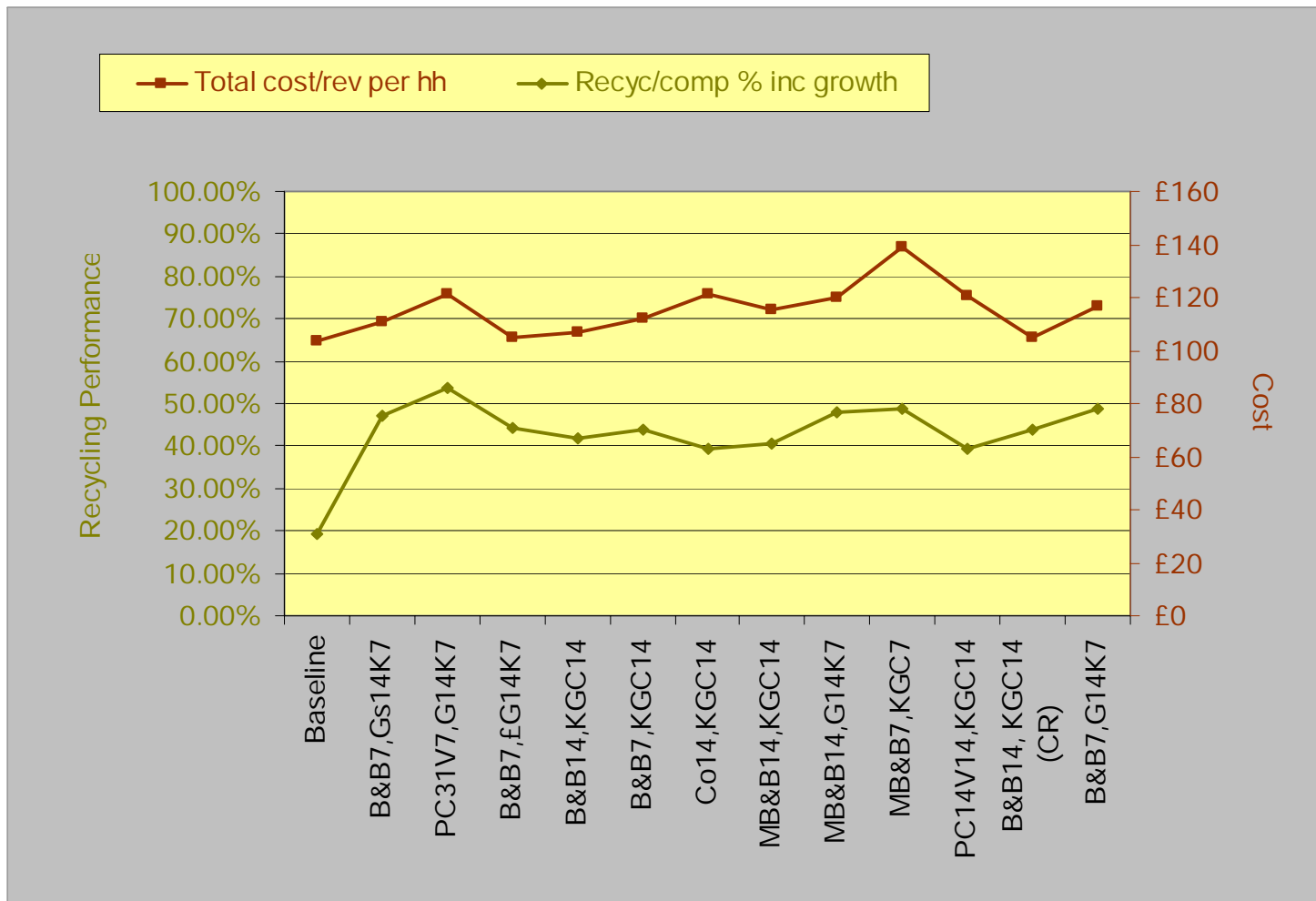


Table 17:- St Albans Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	4,217	5,886	6,496	5,481	5,577	5,947	6,440	6,108	6,437	7,494	6,423	5,537	6,236
<b>Total Collection Cost (£,000)</b>	2,765	4,162	4,761	3,685	3,269	3,798	3,387	3,726	4,407	5,155	3,939	3,388	4,525
<b>Net Revenue/ Treatment Cost (£,000)</b>	72	-204	-361	-169	-511	-448	-1,213	-541	-403	-745	-575	-448	-234
<b>Net Cost/ HH (£)</b>	75	99	109	92	93	100	108	102	108	125	108	93	104
<b>Recycling tonnage</b>	9,611	27,699	33,370	26,409	26,347	28,003	24,595	25,600	29,033	30,228	24,416	28,003	28,815
<b>Recycling rate</b>	20.5%	51.4%	58.5%	48.5%	46.0%	48.8%	42.9%	44.7%	50.9%	52.4%	42.6%	48.8%	53.1%
<b>Biowaste diversion rate</b>	25.1%	57.8%	65.7%	53.7%	51.5%	53.8%	49.7%	50.2%	58.6%	59.8%	48.6%	53.8%	60.1%

Figure 8: Comparison of different system inputs and outputs (SADC).

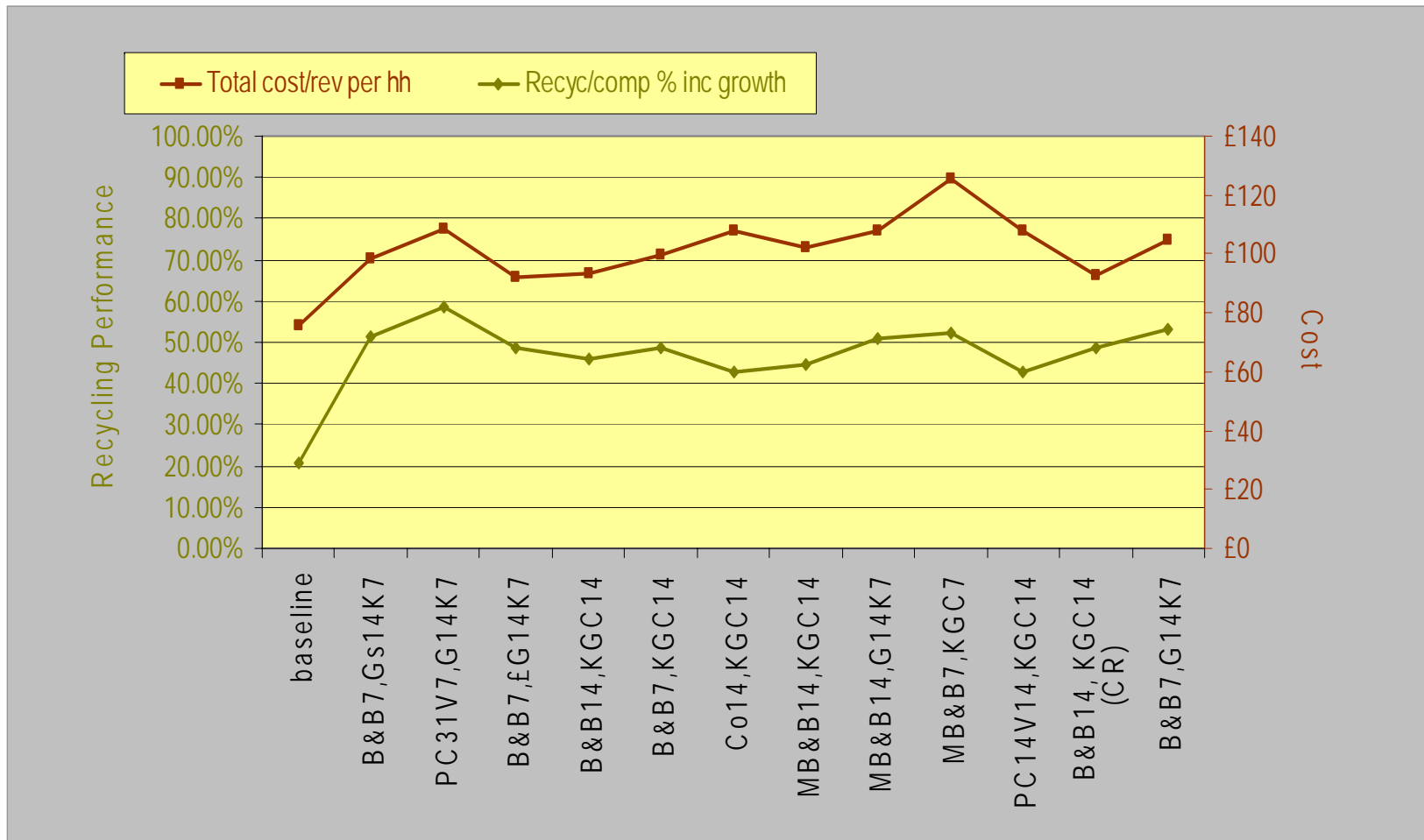


Table 18:- SBC Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	3,223	4,135	4,456	3,906	3,842	4,135	4,294	4,153	4,449	5,087	4,308	3,869	4,386
<b>Total Collection Cost (£,000)</b>	2,360	2,943	3,265	2,670	2,335	2,708	2,414	2,612	3,101	3,568	2,724	2,442	3,202
<b>Net Revenue/ Treatment Cost (£,000)</b>	66	-186	-264	-165	-326	-292	-683	-341	-300	-476	-356	-292	-204
<b>Net Cost/ HH (£)</b>	96	115	124	108	107	115	119	115	124	141	120	107	122
<b>Recycling tonnage</b>	5,212	15,204	18,476	14,415	14,199	14,976	13,430	13,880	16,386	16,794	13,391	14,976	15,880
<b>Recycling rate</b>	18.7%	46.7%	53.6%	43.8%	41.1%	43.3%	38.9%	40.2%	47.5%	48.3%	38.8%	43.3%	48.5%
<b>Biowaste diversion rate</b>	18.6%	56.4%	64.2%	52.0%	49.0%	50.7%	47.8%	48.1%	58.7%	58.8%	47.0%	50.7%	58.8%

Figure 9: Comparison of different system inputs and outputs (SBC).

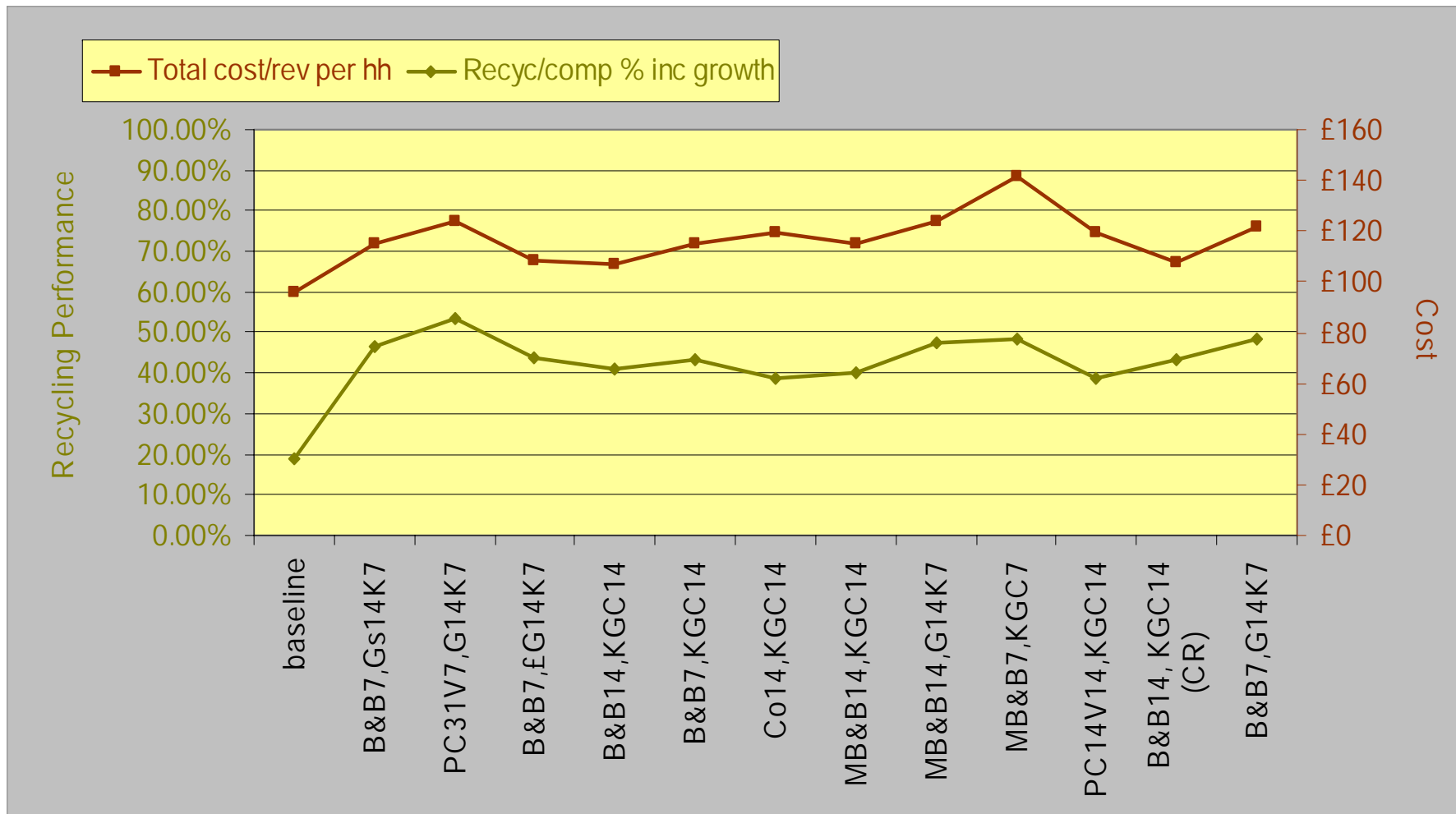


Table 19:- TRDC Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	3,235	3,802	4,264	3,542	3,581	3,797	4,072	3,907	4,182	4,788	4,096	3,589	4,030
<b>Total Collection Cost (£,000)</b>	2,504	2,769	3,223	2,471	2,254	2,559	2,325	2,536	2,979	3,440	2,670	2,352	3,004
<b>Net Revenue/ Treatment Cost (£,000)</b>	93	-134	-217	-115	-258	-223	-652	-276	-242	-396	-294	-223	-149
<b>Net Cost/ HH (£)</b>	93	102	115	95	96	102	110	105	112	129	110	97	108
<b>Recycling tonnage</b>	6,683	15,463	18,443	14,784	14,360	15,294	13,332	13,906	16,080	16,589	13,268	15,294	16,054
<b>Recycling rate</b>	25.0%	49.9%	56.5%	47.3%	43.8%	46.6%	40.7%	42.4%	49.2%	50.3%	40.5%	46.6%	51.5%
<b>Biowaste diversion rate</b>	23.6%	58.1%	65.4%	54.2%	50.5%	52.8%	48.5%	49.0%	58.6%	59.2%	47.4%	52.8%	60.2%

Figure 10: Comparison of different system inputs and outputs (TRDC).

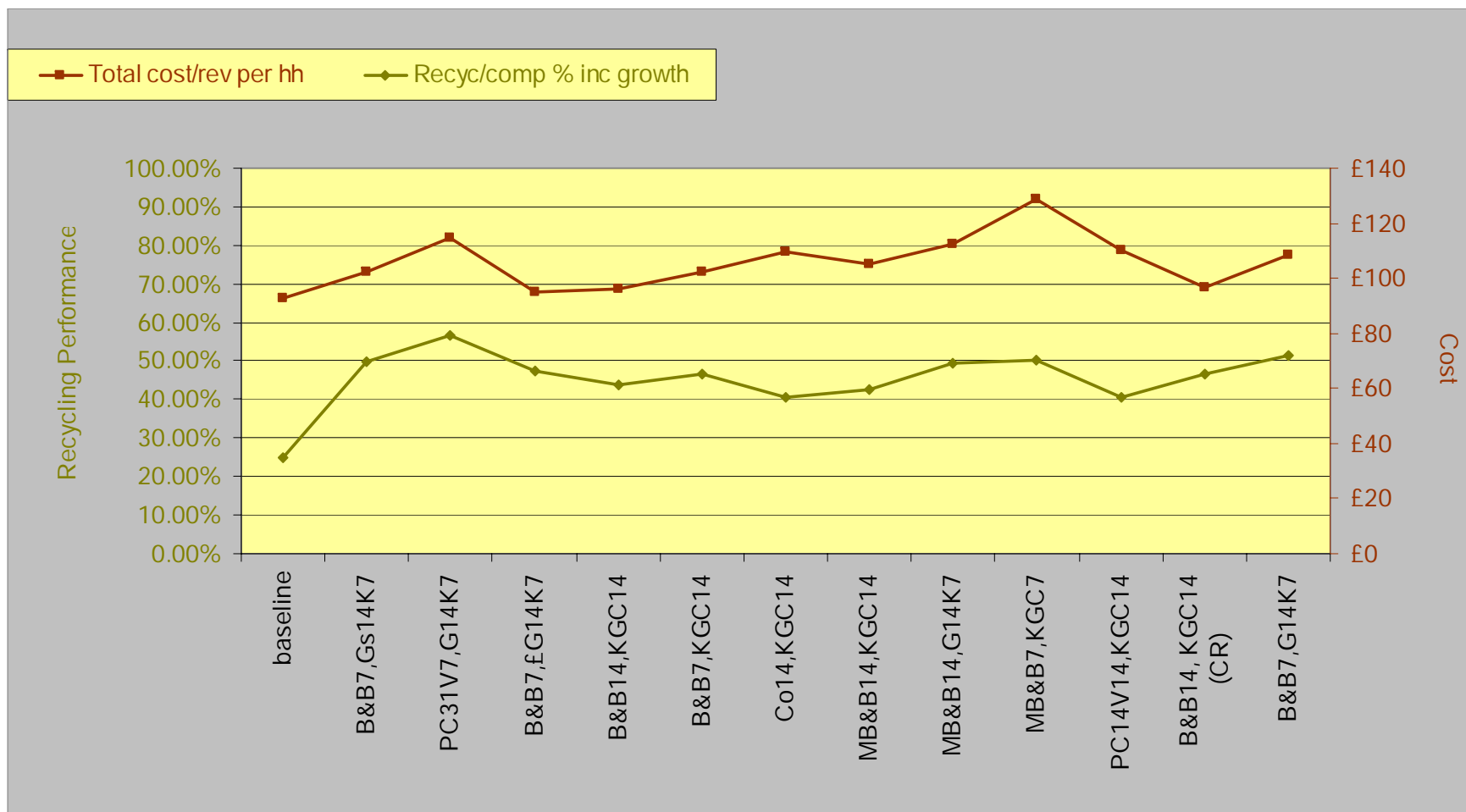


Table 20:- WBC Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	3,444	3,845	4,173	3,641	3,639	3,833	4,092	3,918	4,101	4,686	4,116	3,617	4,027
<b>Total Collection Cost (£,000)</b>	2,413	2,613	2,943	2,365	2,074	2,356	2,156	2,321	2,709	3,108	2,461	2,140	2,803
<b>Net Revenue/ Treatment Cost (£,000)</b>	-58	-163	-250	-142	-330	-295	-685	-344	-277	-471	-360	-295	-182
<b>Net Cost/ HH (£)</b>	101	106	115	100	100	106	113	108	113	129	113	100	111
<b>Recycling tonnage</b>	7,321	15,726	19,208	14,925	14,941	15,848	14,144	14,625	16,876	17,376	13,908	15,848	16,412
<b>Recycling rate</b>	23.6%	46.1%	53.2%	43.3%	41.2%	43.7%	39.0%	40.4%	46.8%	47.7%	38.4%	43.7%	47.7%
<b>Biowaste diversion rate</b>	28.9%	53.8%	61.8%	49.8%	47.9%	50.0%	46.6%	47.0%	55.8%	56.3%	44.8%	50.0%	56.1%

Figure 11: Comparison of different system inputs and outputs (WBC).

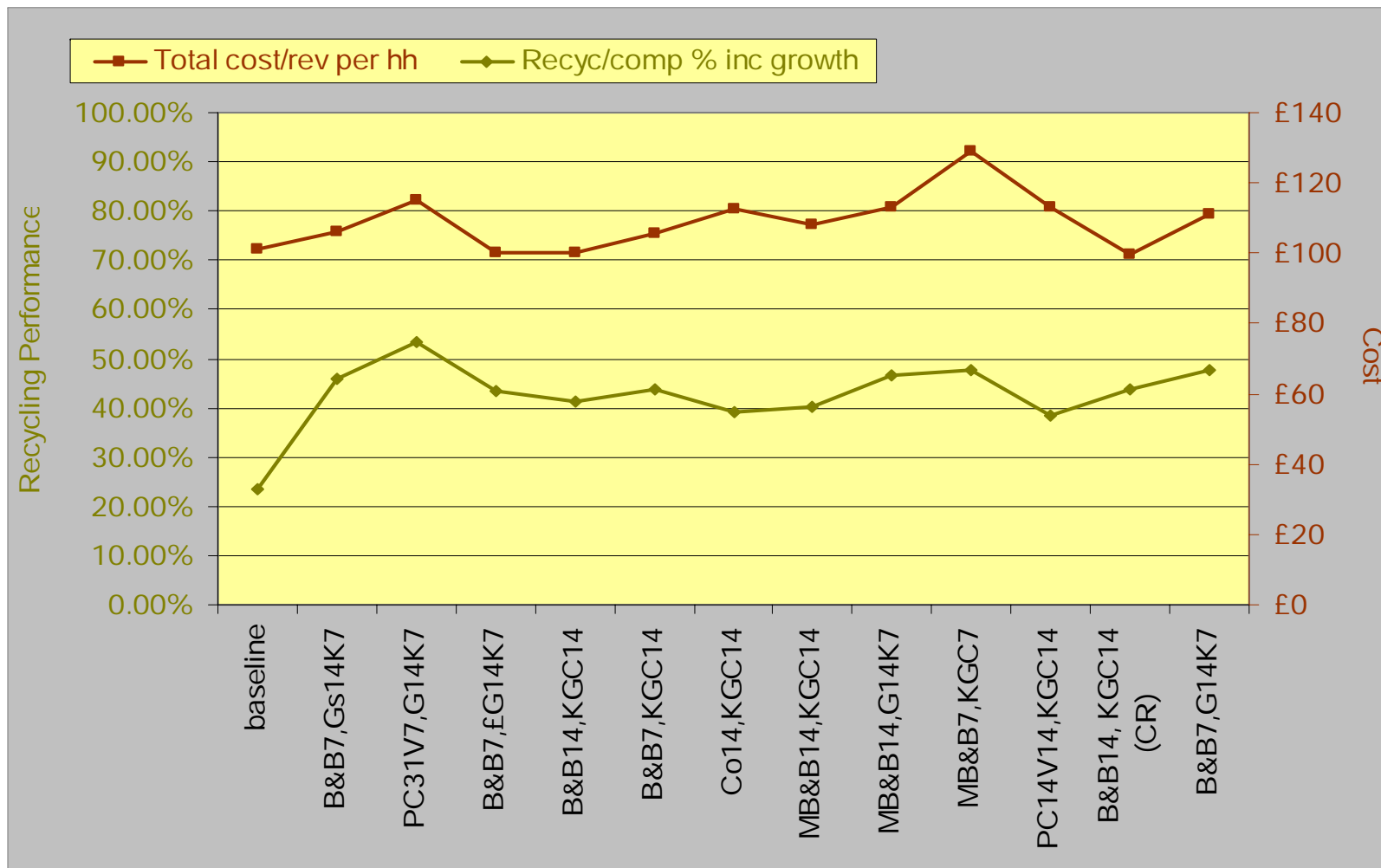


Table 21:- WHDC Modelling Summary Outputs

	Baseline	B&B7, Gs14K7	PC31V7, G14K7	B&B7, £G14K7	B&B14, KGC14	B&B7, KGC14	Co14, KGC14	MB&B14, KGC14	MB&B14, G14K7	MB&B7, KGC7	PC14V14 , KGC14	B&B14, KGC14 (CR)	B&B7, G14K7
<b>Total System Cost (£,000)</b>	3,393	4,340	4,880	4,030	4,091	4,347	4,618	4,478	4,785	5,483	4,682	4,109	4,606
<b>Total Collection Cost (£,000)</b>	2,424	3,141	3,675	2,785	2,556	2,905	2,647	2,901	3,407	3,932	3,050	2,668	3,416
<b>Net Revenue/ Treatment Cost (£,000)</b>	9	-172	-262	-150	-319	-280	-734	-337	-295	-477	-356	-280	-191
<b>Net Cost/ HH (£)</b>	80	96	108	89	91	96	102	99	106	122	104	91	102
<b>Recycling tonnage</b>	6,135	16,784	20,217	15,968	15,654	16,588	14,700	15,238	17,795	18,315	14,613	16,588	17,483
<b>Recycling rate</b>	20.5%	48.7%	55.4%	45.8%	42.8%	45.3%	40.2%	41.6%	48.8%	49.7%	39.9%	45.3%	50.4%
<b>Biowaste diversion rate</b>	23.6%	57.2%	64.8%	53.1%	49.8%	51.9%	48.2%	48.6%	58.6%	59.0%	47.2%	51.9%	59.5%

Figure 12: Graph showing comparison of different system inputs and outputs (WHDC).

