FRITH RESOURCE MANAGEMENT

Options Appraisal–Nottingham City Council

12/09/2022

Acknowledgements:

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Disclaimer:

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CAPEX	The money spent to purchase fixed assets relating to an organisation or corporate entity. For a Local Authority waste service this includes the purchase of vehicles and potentially containers.
Defra	Department for Environment, Food and Rural Affairs
DMR	Dry-mixed recycling
DRS	A policy tool which involves paying a deposit for an item (added to the retail price at point of purchase) which is then redeemed when it is returned to a designated point. Through the National Resources and Waste Strategy for England, the Government has announced that a DRS for England, Wales and Northern Ireland will be introduced from 2025 for drinks containers. The aim of the scheme is to boost recycling rates, reduce littering and improve the quality of material collected for recycling.
EPR	A policy tool which requires producers to be responsible for the packaging they place on the market at the end of its life. It is intended to promote packaging design which considers resource inputs and easier end of life recovery (e.g. reuse or recycling) of the resources within the products. The new EPR system announced in the National Resources & Waste Strategy for England (which is intended to be implemented from 2024) will require packaging producers to pay for the full net costs of collecting, handling, recycling and disposing of packaging waste.
FA	Fly ash
FRM	Frith Resource Management
HH	Household
HWRC	Facilities operated by Local Authorities to provide a site for residents wanting to dispose of and recycle a wide range of materials, further to the service provided at the kerbside. Commonly referred to as 'tips'
IBA	Incinerator bottom ash
KAT	Kerbside Analysis Tool
KPI	Key performance indicator
L	Litre
LA	Local authority
LACW	Local authority collected waste
MRF	Materials recovery facility
MWCA	Metropolitan waste collection authority
NCC	Nottingham City Council
Net Zero	Net Zero means achieving a balance between the total greenhouse gas emissions released into the atmosphere, and the total emissions removed from the environment (for example through natural carbon sinks such as forest and oceans). The net zero target for the UK is defined as the total greenhouse gas emissions released into the atmosphere being equal to or less than the emissions removed from the environment.[1]
RAWPIC	Resource and Waste Policy Impact Calculator developed by Suez in partnership with LARAC, Project Integra and the Kent Resource Partnership
R&WS	Resources & Waste Strategy
UA	Unitary Authority
WDF	Waste Data Flow
WHB	Wheelie bin
WRAP	Waste & Resources Action Programme
WRATE	Waste and Resources Assessment Tool for the Environment

[1] Net zero and the different official measures of the UK's greenhouse gas emissions - Office for National Statistics

Executive Summary

Frith Resource Management (FRM) has been engaged by Nottingham City Council (referred to as 'NCC', Nottingham or 'the Council') to support the update of its Municipal Waste Management Strategy. A Municipal Waste Management Strategy (MWMS), in this case termed a 'Resources & Waste Strategy for Nottingham', requires an Options Appraisal to help prioritise between alternative waste management options for the purposes of service delivery, procurement, and planning. This report provides a summary of the collection options.

The recycling options have been modelled using the Kerbside Analysis Tool (KAT[2]) which gives comparative annualised costs for different collection systems. Each option has been evaluated against modelled costs and recycling performance criteria. It also takes into consideration the future policy landscape, operational flexibility, health & safety, public acceptability and social value factors. In support of a transition to a circular economy and aspirations for Nottingham to be carbon neutral by 2028 (see CN28), the project also assesses the environmental impact of providing a waste management service (including from collection, transporting and onward transfer and processing of materials).

The five selected alternative options were agreed during a workshop with representatives from Nottingham City Council. The options modelled (in addition to the baseline / current service) are summarised in the following table. Any change from the baseline is highlighted in purple.

Option	Collection Stream	Frequency	Capacity
Baseline *As current*	Residual	Fortnightly	240L Wheeled Bin
	Dry Recycling (co-mingled)	Fortnightly	240L Wheeled Bin
	Food waste	None	
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 1 *Twin-stream collection with weekly food waste*	Residual waste	Fortnightly	240L Wheeled Bin
	Dry recycling (Twin-stream + film + cartons)	Fortnightly	1x 70L bag – paper & card, 1x 180L WHB – plastic, cartons, glass and metals
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 2 *Twin-stream collection with weekly food and restricted residual capacity*	Residual waste	Fortnightly	140L Wheeled Bin
	Dry recycling (Twin-stream + film + cartons)	Fortnightly	(1x 70L bag – paper & card, 1x 180L[3] WHB – plastic, cartons, glass and metals)
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 3	Residual waste	Fortnightly	240L Wheeled Bin

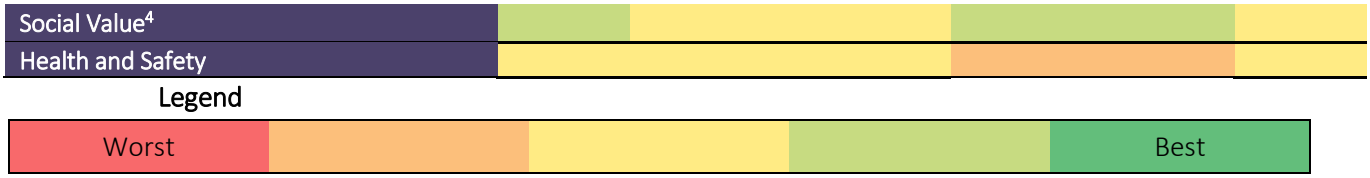
[2] The Kerbside Analysis Tool (KAT) is a publicly available model developed by WRAP for comparing the costs of different household waste collection systems. More information is Section provided in **Error! Reference source not found.**.

[3] There would also be the option of swapping the current 240L residual bin to be used for the recycling, and issuing a new 140L bin for residual waste. This option has been considered in the 'cost of change' section of this report.

Option	Collection Stream	Frequency	Capacity
Multi-stream recycling with weekly food waste	Dry recycling (Multi-stream + film + cartons)	Weekly	3x 40L boxes; paper & card; glass &metals; plastic & cartons
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 4 *Multi-stream dry recycling with weekly food waste and restricted residual capacity*	Residual waste	Fortnightly	140L Wheeled Bin
	Dry recycling (Multi-stream, + film + cartons)	Weekly	3x 40L boxes; paper & card; glass & metals; plastic & cartons
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 5 *As Option 1 with co-collection of paper and food.*	Residual waste	Fortnightly	240L Wheeled Bin
	Dry recycling (Twin-stream, + film + cartons)	Frequency varies Paper & card – co-collected (with food) on podded vehicle – weekly Plastic, glass, cartons and metals – fortnightly	1x 70L bag – paper & card 1x 180L WHB – plastic, glass, cartons and metals
	Food waste	Weekly (co-collected with paper and card)	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin

The results are presented using quantitative results from the modelling, where available, and for other more qualitative criteria a 'traffic' light system is applied, whereby green presents the 'best' option and red presents the 'worst' performing option, against each criterion, relative to the other options. Shades of green, amber and red are used for intermediate rankings. The summary of the options appraisal evaluation is as follows:

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
Total cost (Collection, Treatment and Disposal)	£13.4m	£14.5m	£14.4m	£13.6m	£13.7m	£14.6m
Kerbside Recycling performance (%)	22.57%	29.14%	37.12%	28.50%	34.64%	29.67%
Total Environmental Benefit (carbon, $kgCO_2$-eq)	642,300	-13,700	-2,834,260	-31,400	-2,156,579	-287,600
Cost of Change (initial Capex)	N/A	£6m	£6.4m - 8.7m	£3.2m	£5.9m	£4.5m
Alignment to R&WS / TEEP /National Policy						
Public acceptability						
Operational flexibility (deliverability)						

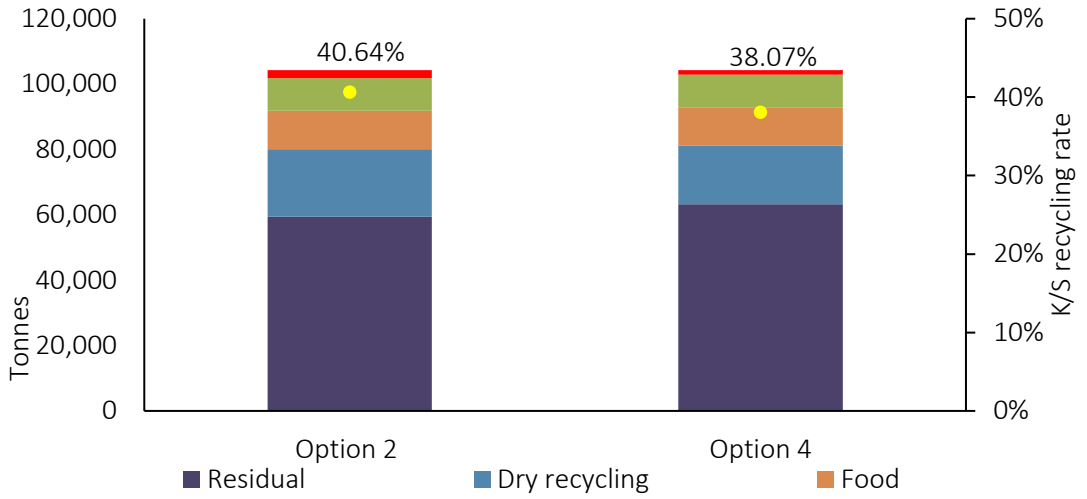


- In terms of recycling performance, all options have an improved kerbside recycling rate (%) from the baseline (22.57%), with option 2 performing the highest (37.12%) followed by option 4 (34.64%). Option 2 models a twin-stream collection with restricted residual collections (smaller bins) whilst option 4 models a kerbside-sort dry recycling collection also with restricted residual collections.
- This includes the full suite of materials proposed by the Consistent Collections policy being implemented by Government. Each option includes the current range of materials collected by NCC, plus food waste collections, plastic film and cartons.
- All alternative options result in an increased kerbside collection costs relative to the current service ranging from £2.36 million to £2.73 million in additional costs. The option with the greatest annualised collection costs is option 4. Option 1 results in the lowest additional annualised gross collection cost compared to the baseline, which models a twin-stream dry recycling service, separate food waste collection and retains the current residual waste collection service.
- Options 4 and 3 have the cheapest treatment and disposal costs of the options modelled at £5 million and £5.6 million respectively. Notably these are the only options that generate a revenue for the treatment of dry recycling. This is driven by the increased recyclate quality obtained via the multi-stream collection system.
- In terms of total net whole-system costs, the baseline and options 3 and 4 are the most cost-effective options.
- All options will incur a cost of change (i.e. procuring new vehicles and containers), ranging from c. £3.2 million (option 3) – c. £8.7 million (option 2), with options 3 and 5 incurring the lowest CAPEX costs.
- The baseline (current) waste management service across NCC is modelled to result in an overall net emission of 642t CO_2-eq. All options have a significantly improved carbon performance relative to the baseline, with option 2 providing the highest amount of net savings (-2,834t CO_2-eq).
- Of the qualitative criteria (those with traffic light colouring), the multi-stream collections (options 3 & 4) score lower on public acceptability, operational flexibility and health and safety, but score well as regards alignment to proposed national policy and social value. The two stream collections (options 1, 2 and 5) and the baseline score higher on public acceptability and operational flexibility but may not fully align to the Resources & Waste Strategy. The results show that there is a trade-off between alignment with Government Policy versus public acceptability, operational flexibility and Health & Safety in particular.
- No weighting has been applied to the evaluation criteria, the preferred option will be ultimately determined by which elements NCC deem most important or have the highest priority.

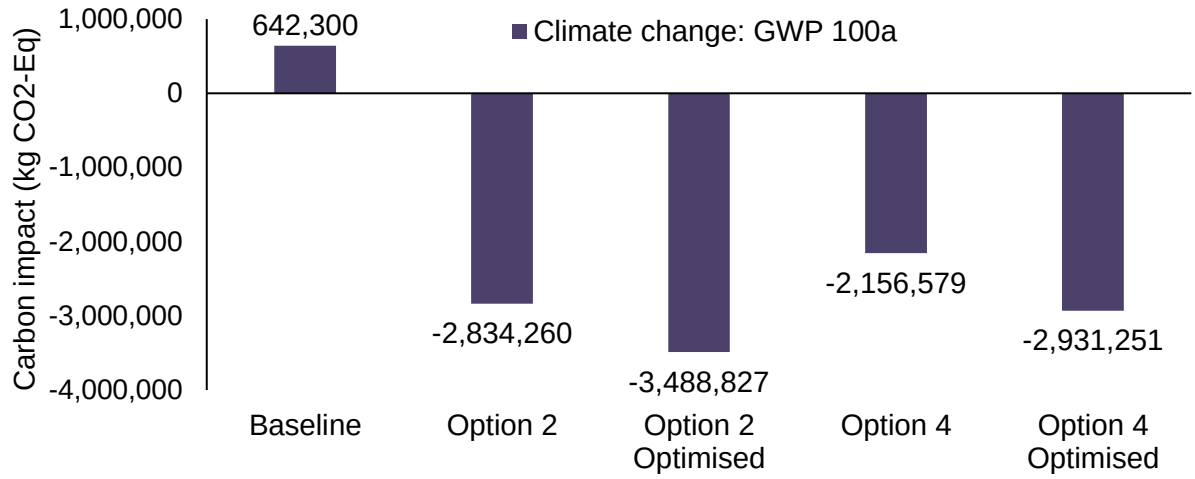
[4] Job creation, wider health benefits, well-being, community benefits. See Appendix E for further detail

In addition to the main options appraisal, the impact of communications and public outreach is also considered and modelled on the highest performing options (options 2 and 4) to assess the full potential of adapting the service to these options.

For the optimised options 2 and 4, the impact of public outreach and communications improves the recycling rate for options 2 (37.12%) and 4 (34.64%) to 40.64% and 38.07% respectively. Due to the improved recycling performance, the carbon impacts as shown below are considerably improved as well.



In order to determine the Nottingham City Council recycling rate it is necessary to adjust the kerbside recycling rate to take account of recycling and waste management in other aspects of the Nottingham service (e.g. the Household Waste Recycling Centre). This adds around 1.5% to the kerbside recycling rate meaning c. 42% recycling is acheivable using methods in this appraisal. Furthermore, national policy and intervention around aspects like mandatory labelling of packaging for recyclability, national communications campaigns and Extended Producer Responsibility[5] and further local initiatives around litter recycling and the HWRC service could enable citywide recycling rates of >50% to be achieved.



[5] Making packaging producers 100% responsible for the cost of collecting and managing those goods at the end of their life.

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1 Introduction

1.1 Background

Nottingham City Council are in the process of updating the current Municipal Waste Management Strategy (MWMS or 'the Strategy'). Frith Resource Management (FRM) has been engaged by Nottingham City Council (referred to as 'NCC', or 'the Council') to support in the process. A Municipal Waste Management Strategy (MWMS), in this case termed a 'Resources & Waste Strategy for Nottingham', requires an Options Appraisal to help prioritise between alternative waste management options for the purposes of service delivery, procurement, and planning. This report provides a summary of the collection options.

An overview of Nottingham's current (baseline) position has been developed to firstly understand how the current service is delivered. Benchmarking data allows us to compare the current performance against others, using different demographic groups as comparators. This is summarised in Section 2. The methodology for the Options Appraisal was discussed at workshops with NCC staff and representatives over 2 workshops, see Section 3 for more information. An appraisal of five alternative collection options, in comparison to the baseline, follows in Section 4.

Sensitivity analysis has been applied to the highest performing two options to explore the potential that increased communications and behaviour change campaigns (reflecting both local and national opportunities). This is discussed in Section 4.2.4.

1.2 Alternative Options

Table 1 outlines the alternative collection options which have been modelled. These options have been agreed with NCC staff and representatives over 2 workshops carried out for this project. These alternative options apply to the core (kerbside) collection service and do not include additional tonnage collected through bulky waste, street sweepings or commercial waste.

The baseline situation represents the current service, whilst all other options add food waste collection to the service (using a 23L bin + small kitchen caddy), as well as also adding plastic film and cartons to the recycling collection. It is also noted that the garden waste collection service remains identical to the baseline service in all the options. Any change from the baseline is highlighted in purple.

Options 1 and 2 change the current commingled service to a twin-stream whereby the paper and card are collected in reusable bags with 180L WHBs. Food waste is collected on separate 7.5t dedicated food waste vehicles, and these 2 options differ from each other in that option 2 provides a restricted residual waste capacity, in the form of 140L WHBs (reducing the average weekly capacity available to households from 120L to 70L).

Options 3 and 4 represent a multi-stream dry recycling collection (where materials are sorted into different compartments on a specialist vehicle at the kerbside), which is collected weekly alongside the food waste (which is placed in a separate compartment on the collection vehicle). Options 3 and 4 differ in that option 4 provides a restricted residual waste capacity in the form of a 140L bin. Option 5 is very similar to option 1, with the only change being that the food waste is collected on the same vehicle as is used to collect the separated paper and card collection. This is via a specialist collection vehicle with a pod for the food waste.

Table 1 – Details of alternative options modelled in KAT

Option	Collection Stream	Frequency	Capacity
Baseline *As current*	Residual	Fortnightly	240L Wheeled Bin
	Dry Recycling (co-mingled)	Fortnightly	240L Wheeled Bin
	Food waste	None	
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 1 *Twin-stream collection with weekly food waste*	Residual waste	Fortnightly	240L Wheeled Bin
	Dry recycling (Twin-stream + film + cartons)	Fortnightly	1x 70L bag – paper & card, 1x 180L WHB – plastic, cartons, glass and metals
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 2 *Twin-stream collection with weekly food and restricted residual capacity*	Residual waste	Fortnightly	140L Wheeled Bin
	Dry recycling (Twin-stream + film + cartons)	Fortnightly	(1x 70L bag – paper & card, 1x 180L[6] WHB – plastic, cartons, glass and metals)
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 3 *Multi-stream recycling with weekly food waste*	Residual waste	Fortnightly	240L Wheeled Bin
	Dry recycling (Multi-stream + film + cartons)	Weekly	3x 40L boxes; paper & card; glass &metals;, plastic & cartons
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 4 *Multi-stream dry recycling with weekly food waste and restricted residual capacity*	Residual waste	Fortnightly	140L Wheeled Bin
	Dry recycling (Multi-stream, + film + cartons)	Weekly	3x 40L boxes; paper & card; glass & metals; plastic & cartons
	Food waste	Weekly	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin
Option 5 *As Option 1 with co-collection of paper and food.*	Residual waste	Fortnightly	240L Wheeled Bin
	Dry recycling (Twin-stream, + film + cartons)	Paper & card – co-collected (with food) on podded vehicle - weekly Plastic, glass, cartons and metals – fortnightly	1x 70L bag – paper & card 1x 180L WHB – plastic, glass, cartons and metals
	Food waste	Weekly (co-collected with paper and card)	Kerbside caddy + kitchen caddy
	Garden waste (free)	Fortnightly	240L Wheeled Bin

[6] There would also be the option of swapping the current 240L residual bin to be used for the recycling, and issuing a new 140L bin for residual waste. This option has been considered in the 'cost of change' section of this report.

2 Baseline Performance & Benchmarking

This section summarises the current waste and recycling services provided by NCC. It provides a high-level assessment of the council's recycling performance and how this compares to others, based on published data. Information was taken from WasteDataFlow and WRAP's Local Authority portal to supplement data provided by each of the councils.

Benchmarking is carried out in order to understand each council's current performance in comparison to other local authorities with similar demographics and household waste collection services. Using the WRAP LA portal, users are able to access data on local authority waste and recycling services, including performance benchmarking.

The most recent data uploaded to the WRAP LA portal data is 2019/20. This covers kerbside collected tonnages and excludes additional Local Authority Collected Waste (LACW) such as bring banks and RHWS's. The six core dry recycling materials reported on the portal are paper, cardboard, cans, glass, plastic bottles and plastic tubs and trays (PTT). Where plastic film is collected by the districts, this is also included.

Table 2 shows the current collection service operated by NCC. The frequency of all waste collections is currently fortnightly, dry recycling service is commingled and a separate food waste collection is not currently provided.

Table 2 – NCC's current waste collection service

Collection	Frequency	Container
Residual	Fortnightly	240L WHB
Dry Recycling (commingled)	Fortnightly	240L WHB
Food waste	Not Provided	
Garden waste (free)	Fortnightly	240L WHB

The following provides a breakdown of the treatment and/or disposal routes for each of the waste streams for NCC as understood by FRM and used for the purposes of this Options Appraisal:

- Residual: 94% of total tonnage to Eastcroft EfW[7], during shutdown and maintenance 6% goes to a residual waste materials recovery facility (MRF)[8] where some materials are separated for recycling (e.g. metals), a fraction sent for use as a fuel at a cement kiln and rejects are sent to landfill.
- Dry recycling: sent to a MRF for materials separation before being sent for reprocessing
- Garden waste: The garden waste collected is sent for composting (at Simpro Ltd)

Table 3 provides a summary of the WRAP LA Portal benchmarking analysis for NCC for 2019/20. Other than the paper yield (which is in the bottom 50% of similar authorities in terms of performance),

[7] Eastcroft EfW Facility: https://eastcroft.fccenvironment.co.uk/

[8] A residual waste materials recycling facility is also known as a 'dirty MRF', as distinct from a materials recycling facility that separates comingled recycling, which is a 'clean MRF', or simply a MRF.

NCC ranks in the bottom 25% for the cumulative and individual yields of all 6 key recyclable materials collected when compared against similar LA's, cities and university towns in England.

Table 3 – WRAP LA Portal benchmarking analysis results (2019/20)

Detail	6 core materials	Paper	Card	Cans	Glass	Plastic bottles	Plastic tubs
Nottingham City Council Yield (kg/hhd/yr)	120.1	51.1	18.9	6.2	32.1	8.4	3.3
How NCC compare against other UK authorities	180.9	65.9	29.7	10.5	54	14.8	5.9
How NCC compare against other Las in the East Midlands							
How NCC compare against other authorities with similar characteristics – ONS classification **'University Towns and Cities Las'**							
How NCC compare against other authorities in the same rurality ***'Predominantly urban, high deprivation Las'***							

Key

Authority is in bottom 25% of LAs. | Authority is in bottom 50% of LAs | Authority is in top 50% of LAs | Authority is in top 25% of LAs

Figure 1 shows NCC's historic kerbside recycling rate since 2005/6. A steep increase is noted up until 2009/10 followed by a gradual decline up to 2020/21. This upward trend between 2005/6 and 2009/10 can be attributed to the expansion of the recycling service in Nottingham over this time. Since this peak, as of 2020/21, the recycling rate for Nottingham was 23.9%. This is substantially below the average national performance of 43.8% for the same period. Between 2005/6 and 2010/11 an improvement in performance can be seen, however, since the peak performance of 35.9%, the recycling performance has steadily decreased over time. There are a number of factors which could be attributed to this decline, including a change in the definition of recycling (and as such the materials which could be counted towards the Council's recycling performance), impacts of austerity, and in recent years the effects of the Covid-19 pandemic (which has nationally shown a small decrease in recycling rate).

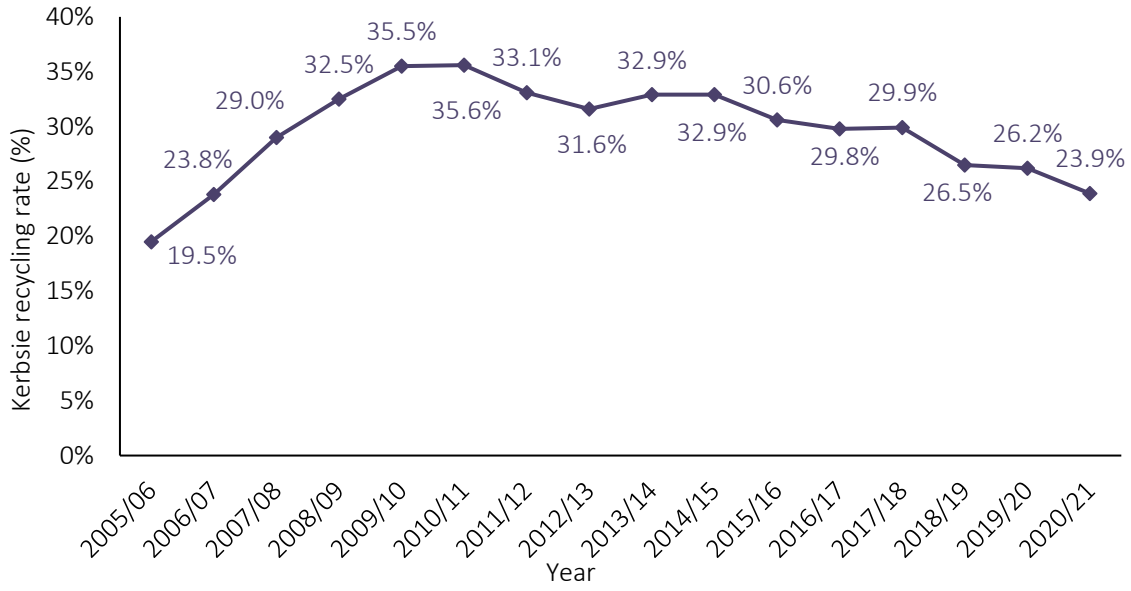


Figure 1 – NCC's historic kerbside recycling rate.[9]

As shown in Figure 2, NCC's residual waste yields are relatively consistent and generally stay within the c. 600-700 kg/household. The yield for 2020/21 was 621.6 kg/household which was above the average for the East Midlands region (590 kg/household) and the national average (553 kg/household) for the same period.

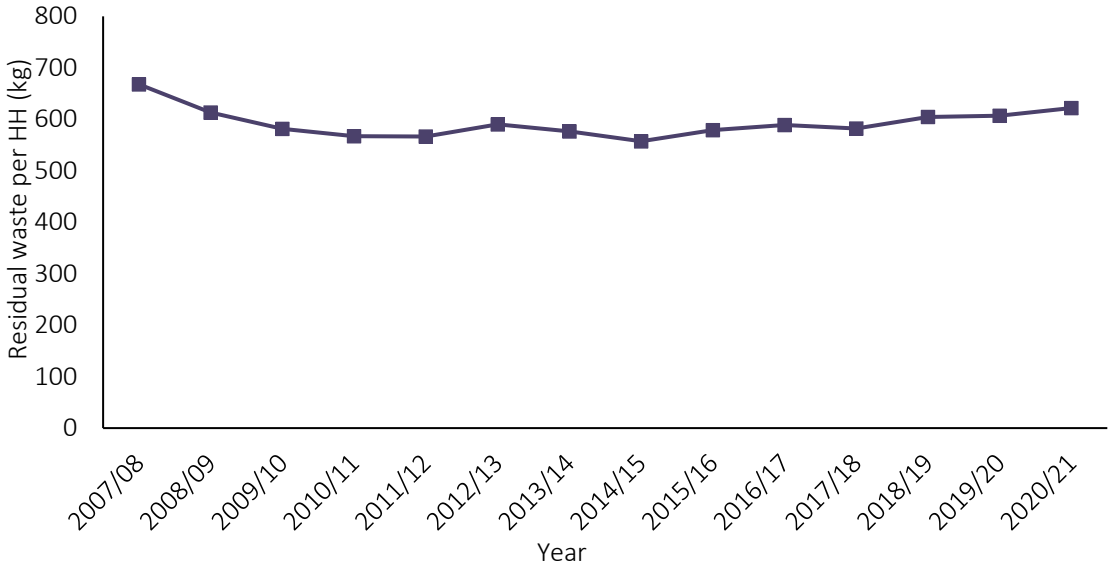


Figure 2 – NCC's historic residual waste yield per household.[4]

Figure 3 illustrates a comparison of NCC's kerbside recycling performance against nearest neighbours via a benchmarking group, while Figure 4 shows a comparison against core cities in England. NCC ranks on the lower end of the scale for both the analyses.

[9] Source: Defra and WDF

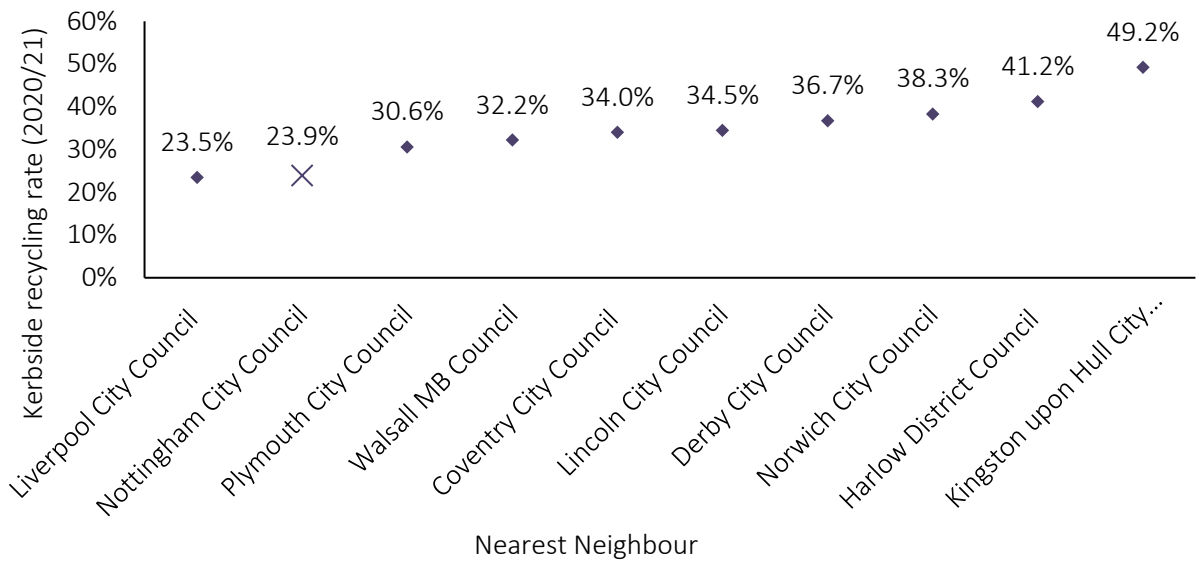


Figure 3 – NCC's nearest neighbour benchmarking analysis for kerbside recycling rate.[10]

Following the above, Table 4 provides details for the waste collection services offered by the highest performing nearest neighbours respectively to highlight where there are any substantive differences in the services offered by the respective Local Authorities. It is noted that all the high performers all provide a commingled dry recycling service as per Nottingham, however each offer food waste collections, whether that be separately collected or co-collected with garden waste. It is noted that two of the top three performers also provide a charge for the collection of garden waste.

Table 4 – Service details for NCC's highest performing nearest neighbours

Local Authority	Collection	Frequency	Container
Kingston upon Hull City Council	Dry recycling (commingled)	Fortnightly	240L WHB
	Garden waste (free)	Fortnightly	240L WHB
	Food waste	Fortnightly	Collected with garden waste
	Residual	Fortnightly	240L WHB
Harlow District Council	Dry recycling (commingled)	Fortnightly	240L WHB
	Garden waste (charged - £42/year)	Fortnightly	240L WHB
	Food waste	Weekly	Kerbside + kitchen caddy
	Residual	Fortnightly	240L WHB
Norwich City Council	Dry recycling (commingled)	Fortnightly	240L WHB
	Garden waste (charged - £39.90 or £54.60/year dependent on bin size)	Fortnightly	180L or 240L WHB
	Food waste	Weekly	Kerbside + kitchen caddy
	Residual	Fortnightly	240L WHB

[10] Source: Defra and WDF

Figure 4 – Core cities benchmarking analysis for NCC's kerbside recycling rate.[11]

Table 5 details the various waste collection services offered by the highest performing core cities from Figure 4 above. It is noted that the highest performer (Bristol City Council) has a smaller residual waste bin (180L), it also provides a charged garden waste collection service. All the top performers offer either a Multi stream (kerbside sort) or twin-stream dry recycling collection system. This options appraisal looks at both multi-stream and twin stream recycling options for Nottingham as well as restricting the residual waste capacity.

Table 5 – Service details for the highest performing core cities from the analysis above

Local Authority	Collection	Frequency	Container
Bristol City Council	Dry recycling (kerbside sort)	Weekly	2 x boxes, 1 x bag
	Garden waste (charged - £32/year)	Fortnightly	240L WHB
	Food waste	Weekly	Kerbside + kitchen caddy
	Residual	Fortnightly	180L WHB
Newcastle upon Tyne City Council	Dry recycling (twin stream)	Fortnightly	240L WHB + black caddy (glass separate)
	Garden waste (free)	Fortnightly	240L WHB
	Food waste	Not provided	
	Residual	Fortnightly	240L WHB
Manchester City Council	Dry recycling (twin stream)	Fortnightly	2 x 140L WHB (paper and card separate)
	Garden waste (free)	Fortnightly	240L WHB
	Food waste	Fortnightly	Collected with garden waste
	Residual	Fortnightly	140L WHB

Figure 5 shows a cost-of-service comparison for NCC's current service against all English authorities in terms of cost per person. It is shown that NCC operates a very cost-effective service. Furthermore, the only authorities that perform better than NCC (lower £/person) are relatively larger combined

[11] Source: Defra and WDF

authorities with a considerably larger scale of operation (i.e., economies of scale). Excluding these, only the Isle of Wight offers a more cost-effective service. There is a relationship between the cost of the service (particularly as regards collection and public engagement) and the recycling performance.

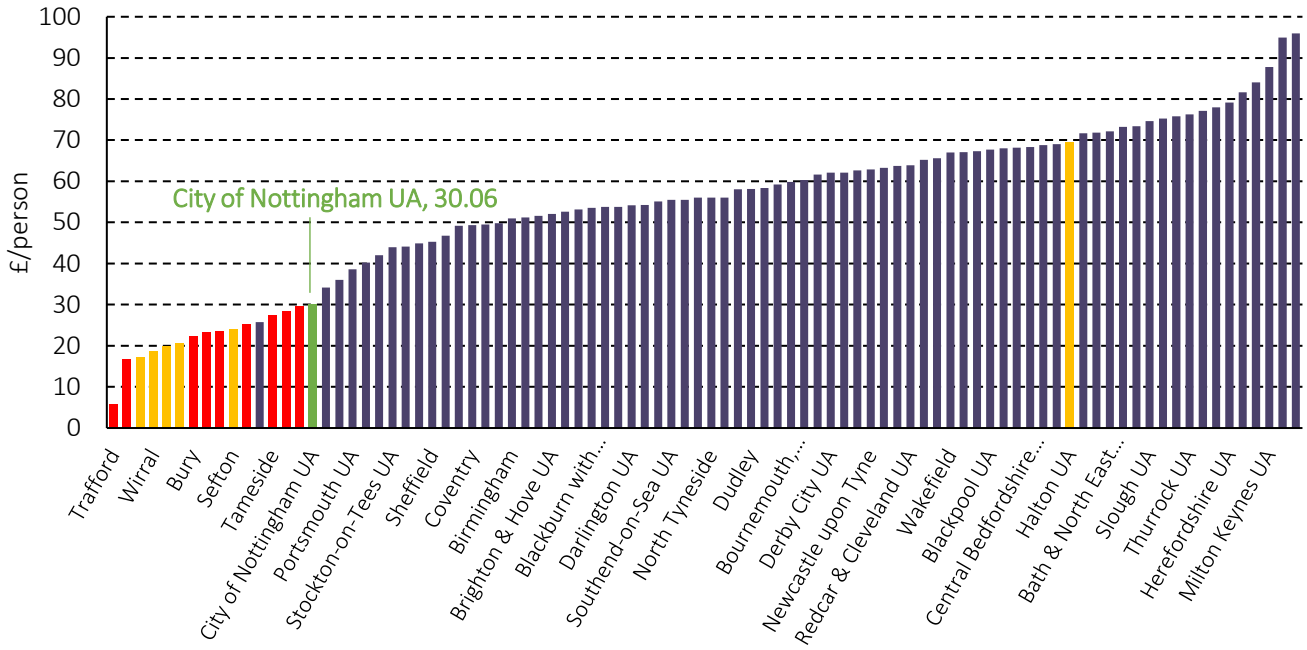


Figure 5 – Cost of service benchmarking analysis for NCC.[12]

2.1 Current Service (Baseline)[13]

Table 6 below shows an estimate of the total kerbside collection cost for NCC's current service as per the KAT modelling (see Section 3 for full details on methodology). It is estimated to be c. £5.5 million[14], with the largest proportion of the cost being attributed to the residual waste collection service, followed by dry mixed recycling (DMR) and garden waste collections respectively.

Table 6 – NCC's Current service collection cost and recycling rate

Kerbside collection (KAT) – 2020/21	Baseline	Tonnage
Annualised recycling collection cost	£1,738,700	13,535
Annualised garden waste collection cost	£1,548,800	9,997
Annualised residual waste collection cost	£2,280,300	75,935
Total gross collection cost	£5,567,800	99,468
Kerbside recycling rate	23.54%[15]	

[12] These are all Mets and Unitaries by cost of waste management per head. The red bars are Greater Manchester Combined Authority and the yellow bars are Liverpool City Region Combined Authority. Credit: Antony Greener, NCC

[13] All service costs rounded to nearest £100

[14] It should be noted that this will not be the same as the collection service budget, which will include a number of other overheads and costs

[15] This varies from the reported current NCC recycling rate (23.9%), due to other recycling and disposal activity not included within the kerbside model (e.g. the Household Waste Recycling Centre)

3 Methodology

3.1 KAT Modelling (Collection)

The Kerbside Analysis Tool (KAT) was utilised to provide a comparative assessment of cost and operational requirements for the baseline (current) collection service and will be used to model the agreed alternative collection scenarios. KAT data proformas were originally completed by council officers and further clarifications were provided on request.

The baseline models are designed to reflect the current service operation, at the time of modelling, and are therefore a good representation of the service. All cost elements are annualised, including existing bins, vehicles etc and consist of a mixture of actual and standardised costs so should be considered to be indicative. This approach allows a 'like for like' comparison against alternative collection systems but would not be reflective of the differential capital investment required to install a new system straight away. In order to calculate actual costs of an alternative system that takes account of existing infrastructure and vehicles, a more bespoke analysis should be undertaken including practical aspects of service implementation (e.g. swapping bins for different elements of the service, transferring/ selling redundant vehicles etc.).

The year 2020/21 has been chosen as the baseline year, and tonnage input data has been provided by NCC, as per information required for input into WasteDataFlow.

Please note that the costs identified by KAT for each scenario are annualised as noted above and the recycling rates outlined within this section are 'kerbside recycling rates' of the core[16] service rather than the total recycling rate of the council[17].

Appendix A provides a detailed breakdown of model assumptions used in KAT for all the modelled options.

3.2 Treatment & Disposal Costs

The estimated treatment and disposal costs associated with each option have been added onto the KAT model (collection) costings in order to derive an anticipated 'whole system' costs. These costs are based on gate fees provided by NCC for the baseline and are supplemented with WRAP gate fees reports and LetsRecycle recyclate prices where appropriate in the alternative scenarios. Material revenues for the kerbside sort material are based on 5-year averages market prices.[18] See Appendix B for further detail.

3.3 DRS & EPR

It was agreed that the potential impact of the introduction of a Deposit Return Scheme (DRS) and Extended Producer Responsibility (EPR), as per the Resources and Waste Strategy for England, will be modelled for the baseline. The implications of EPR and DRS were both modelled using the 'Resource and Waste Policy Impact Calculator' (RAWPIC).

The RAWPIC tool uses a series of assumptions to model the impact of a DRS and EPR, some inbuilt within the model and others which are 'user defined'. For the purposes of this project, the

[16] This does not include 'niche' elements of the collection service such as bring banks, bulky waste and certain specialist collections such as potentially from flats or clinical waste.

[17] The total Council recycling rate would also include the waste flows from Bring Banks and other household waste streams not collected via the standard kerbside collection service.

[18] As reported on Lets Recycle, and assuming a 20% cost for brokering / marketing materials

RAWPIC tool was used to calculate the percentage tonnage change for kerbside dry recycling (by material) and residual collection services.

Reforming the UK packaging producer responsibility (EPR) system aims to achieve better design of packaging (e.g., through increasing recycled material content, improving recyclability of packaging products, light weighting of material or producing refillable packaging). It is therefore assumed that more packaging items are able to be recycled and/or diverted from the residual waste stream.

A Deposit Return Scheme (DRS) aims to improve overall recycling and resource recovery by placing a redeemable deposit on 'in scope' materials. For the purposes of this report, it has been assumed that the DRS system implemented for England will be an 'all in' system (excluding glass, as per the latest consultation responses) which means it applies to all single use drinks containers (excepting HDPE plastics, primarily milk bottles). The deposit is modelled as a 20p value added to plastic and metal beverage containers.

3.3.1 EPR & Net-Burdens

The requirements within the Environment Act and Resources and Waste Strategy for England pose some of the most significant reforms to the management of waste and recycling that the industry has experienced over the last 50 years. Although much of the detail of these reforms is yet to be confirmed, the impact of the reforms proposed for Local Authority costs and operations is considerable. As such, as part of our analysis of the baseline, we have applied a sensitivity analysis comprising some high-level cost modelling to estimate how collection and disposal costs might look for NCC, based on some of the proposals within the national Strategy. This includes consideration of:

1. Full net cost recovery of obligated packaging material through the Extended Producer Responsibility (EPR) producer pays principle

2. Proposed Government commitment to cover any net new burdens placed on local government as a result of strategy obligations

The potential cost implications of each are presented as follows:

3.3.1.1 EPR

As part of the proposals for reforming Extended Producer Responsibility (EPR), Government are proposing that from the beginning of 2024[19], packaging producers will be responsible for covering the full net recovery costs of packaging items placed on the market. For Local Authorities, it is assumed that this includes the cost of collecting, transporting, recycling and treating/disposing of materials obligated within the reformed EPR schemes. Although the detail on how the financing arrangements will ultimately be determined is yet to be known, high-level cost modelling has been applied to the baseline to estimate the potential proportion of Local Authority costs that could be covered by producers through the EPR schemes.

The potential collection costs covered by EPR has been estimated based the proportion of dry recycling and residual waste which is classed as 'obligated EPR material'. On disposal and treatment, it is assumed that any revenue accrued from the onward sale of obligated EPR materials is provided to producers to reflect their net costs.

Our modelling is based on a series of assumptions derived from information within the latest round of consultation documents on the Resources and Waste Strategy for England. Any figures quoted are based on assumptions which may require update following the publication of the 2nd round of

[19] Subject to consultation. This timeline is as per latest proposals from the Resources & Waste Strategy

consultation responses (expected mid 2022). These cost estimates have been applied to the baseline and are indicative only.

3.3.1.2 Unredeemed DRS Deposits

The Government are also currently consulting on what will happen to unredeemed deposits i.e., those packaging items that are covered by the Deposit Return Scheme but that are not returned by a Reverse Vending Machine (RVM) or similar mechanism, and as such fall into the management of Local Authorities (either through kerbside collection or street cleansing of litter). Within the latest round of consultation on the Resources and Waste Strategy for England, it is proposed that unredeemed deposits will form one of the funding mechanisms for the Deposit Management Organisation (for example through the value of unredeemed deposits, revenue from the sale of materials and a producer fee). However, the Government are also considering a funding mechanism for Local Authorities to pay them for any material left within kerbside collections. Due to ongoing uncertainty this has not been considered as part of this project.

3.3.1.3 Net New Burdens

As part of the reforms to the waste and recycling industry, the Government has also committed to fully fund all net new burdens placed on local authorities arising from the Environment Act. This is in recognition of the financial pressures on local authorities and to ensure that any additional costs arising from new statutory duties will be covered. It includes changes that may necessitate additional equipment or resourcing, covering capital and operating costs.

This analysis includes a high-level assessment of the potential costs covered by the new burdens' doctrine, focusing on impacts on food waste and garden waste collection. The duration of how long these costs will be covered, remains to be seen, however Defra have confirmed that government will be funding local authorities for the operation of a separate food waste collection, even where there are existing food waste collections.

The detail regarding the calculation of a net burden payment for local authorities has not yet been published by government. Therefore, for the purposes of this modelling, it is assumed that the Government covers the total collection cost of free garden waste collection and food waste collections (i.e., any previous subscription costs would not be reimbursed).

To estimate the 'new burdens' cost of a food waste service, we have assumed that NCC will implement a dedicated food waste collection (or be paid the equivalent of doing so), and the annualised collection cost from KAT has been used. However, it should be noted that the collection costs for food waste can vary significantly depending on the collection arrangement, i.e. separate dedicated food waste or co-collected with other materials such as a split-back vehicle with a pod, or via a kerbside sort vehicle (e.g., Terberg or Romaquip).

As mentioned, Defra have confirmed that government funding for local authorities will cover the total collection cost and total **net**[20] disposal cost of a separate food waste collection, even where there are existing food waste collections at present. The disposal of organics is cheaper than the alternative treatment method (residual waste disposal). Furthermore, it is unclear from the definition of 'net costs' whether any savings would be deducted from additional collection costs or not. As such we have excluded this element of the costings and are these not included as part of this modelling.

[20] Our interpretation of 'net costs' covers the total difference in net disposal costs between sending food for Anaerobic Digestion and sending to EfW (as if food waste remains in the residual waste stream) – equivalent to £58/t.

3.4 WRATE Assessment

To derive environmental impacts (including carbon) for the options, FRM have applied the Waste & Resources Assessment Tool for the Environment (WRATE), version 4.0.1.0 throughout the Strategy review and Options Appraisal stages. This is a Life Cycle Assessment model developed by the Environment Agency specifically for the purpose of modelling municipal waste management systems and is recognised as the industry standard.

The Waste & Resources Assessment Tool for the Environment (WRATE), version 4.0.1.0, is the latest version of the Life Cycle Assessment model, developed by the Environment Agency specifically for the purpose of modelling municipal waste management systems. It allows users to quantify and compare the relative environmental burdens of equivalent waste management systems across their entire life cycle.

WRATE calculates the potential impacts arising from all processes in the waste management system including the collection, transportation, transfer, treatment, disposal and recycling of materials. The model takes account of the construction and operation of infrastructure and vehicles, and offsets this burden against the avoided burdens associated with materials and energy recovery. All inputs of waste, energy and materials, and outputs of energy, process residues, materials and emissions are accounted for.

In using WRATE the user specifies the waste stream(s) to be managed, then defines the way in which the waste is to be managed, step by step, including (as appropriate) the collection medium, vehicles, intermediate facilities, treatment, recovery and/or final disposal. WRATE calculates and presents the environmental impacts in terms of six default impacts: global warming potential, acidification, eutrophication, freshwater aquatic ecotoxicity, human toxicity and resource depletion. These are outlined below.

As a waste management model, one of the key outcomes is the avoided impact of effective waste management, for example emissions displaced from extracting / processing of virgin materials versus secondary materials recovery for recycling. Similarly, energy recovery from waste can offset some of the emissions from fossil fuel-based alternatives.

All emissions relating to global warming impacts (e.g., methane, carbon dioxide, nitrous oxide) are converted to kg of CO_2 equivalent, over a 100-year timeframe. This is standard practice for models considering carbon impacts of waste management processes.

It should be noted that, the lower the number, the lower the impact (or in the case of negative numbers a -1000, is better than a -800). Negative numbers arise where recycling and energy recovery, as noted above, has offset more damaging, carbon intensive processes, such as primary resource extraction and burning of fossil fuels.

See Appendix E for detail on the additional impact indicators derived from WRATE.

3.4.1 Key Assumptions for WRATE

All collection activity utilises the vehicle types and mileages from the KAT (Kerbside Analysis Tool). The exception are the food waste vehicles for which there is not an equivalent vehicle to a specialist food waste collection vehicle, as a consequence a 7.5t caged recycling vehicle was used as an alternate. The mileages are included in Appendix D.

Contamination within recyclables is assumed to be left in the residual stream to account for the impacts of disposal of this material. The consequences of transporting it are captured in the vehicle mileage modelled in KAT.

The transport distances to key sites and facilities are detailed beow:

- Recyclate reprocessing, transport to Eastcroft, ash (IBA, FA) disposal/reuse, – 50
- Compost / digestate application to land – 20

Details of the modelled options and scenarios are presented below, with schematics presented in Appendix C for visual representation of the WRATE models. Appendix D provides a breakdown of vehicle mileages used for the WRATE models (obtained from KAT).

3.4.1.1 Baseline

Within the baseline WRATE model, the collection scheme reflects the existing service offered by NCC as detailed earlier. Once collected, 94% of the residual waste stream is directed to Eastcroft EfW facility and 6% is taken to a dirty MRF for sorting, with some recycling, a fraction sent to a cement kiln for use as fuel and the rejects going to landfill. This is done so as to mimic schedules of outage of the EfW plant for routine maintenance. The IBA is sent for recycling into secondary aggregate and metals are recovered for recycling, whilst the fly ash is landfilled. The garden waste is taken for composting with the resulting product recycled for land application. The mixed recyclables are taken to a MRF and sorted for production and appropriate reprocessing of recycled materials. See Appendix C for a detailed schematic.

3.4.1.2 Option 1

Treatment and disposal of the leftover residual stream and garden waste remains identical to the baseline. However, food waste collections and dry recycling collections are modified in this option. To that effect, the paper and card are taken to a transfer station instead of a MRF and sorted and separated for appropriate recycling. The rest of the dry recycling is taken to the MRF where it is separated out and materials processed for appropriate reprocessing. Here, plastic film is also included in recycling to reflect anticipated incoming changes to legislation. See Appendix C for a detailed schematic.

3.4.1.3 Option 2

This option is identical to Option 1 with restricted residual waste capacity (smaller bins), which then impacts the diversion of the total tonnage, as shown in the results sections. See Appendix C for a detailed schematic.

3.4.1.4 Option 3

This option is a multi-stream recycling collection using boxes rather than bins, and sorting the materials on the vehicle rather than at an MRF. This allows for higher quality recycling and is reflected in more glass being sent for remelt applications rather than aggregate use. See Appendix C for a detailed schematic.

3.4.1.5 Option 4

This option is identical to Option 3 with restricted residual (which impacts tonnage breakdown). See Appendix C for a detailed schematic.

3.4.1.6 Option 5

This option is very similar to Option 1. However, the food waste is collected with the dry recycling (paper / card) in a separate pod on a specialist vehicle. See Appendix C for a detailed schematic.

4 Options Appraisal Results & Discussion[21]

This section presents and evaluates the performance of all the modelled options based on their performance against an agreed set of evaluation criteria. The results are either presented in terms of quantified results (e.g. cost or carbon), or for more qualitative options are colour coded (using a traffic light scheme), whereby green presents the 'best' option and red presents the 'worst' performing option. Shades of green, amber and red are used for the intermediate ratings.

The criteria with which each of the options are assessed was agreed at a workshop with Council officers and members. The agreed criteria are as follows:

- Recycling performance – as modelled through KAT and using agreed assumptions
- Financial cost - developed through an industry standard model for collection systems known as KAT[22] and additional information on cost from the Council. This has been separated out by collection costs and treatment and disposal costs.
- Environmental benefit - developed through a bespoke Life Cycle Assessment tool for municipal waste systems, known as WRATE[23] with a focus on climate change impacts
- Alignment with National Policy – considers how well each option aligns against proposals within the National Resources and Waste Strategy and TEEP
- Public Acceptability – considers how residents would perceive the service
- Social Value – considers a variety of indicators including air quality (from transport miles), wellbeing and community benefits.
- Operational Flexibility & Deliverability – considers the quantity and quality of materials collected at the kerbside, the contingency use of vehicles for different waste streams and considers the ease of introducing the service change
- Health & Safety – Staff, considers operational aspects of the service and health & safety considerations

Each option has been modelled to determine the performance against the quantitative criteria of cost, kerbside recycling performance and environmental performance (carbon equivalent savings) and are combined with the qualitative criteria. The results of the evaluation are discussed in turn within this chapter. It should be noted that no weighting has been applied to the evaluation criteria, and as such the preferred option may be determined by the criteria which are considered most important.

High-level analysis has also been undertaken on the baseline to estimate the potential impacts of DRS, EPR & net burdens.

[21] All costs rounded to nearest £100

[22] Kerbside Analysis Tool, developed and managed by WRAP, the Waste & Resources Action Programme

[23] Waste & Resources Assessment Tool for the Environment, developed by the Environment Agency and managed by Golder Associates

4.1 Kerbside Recycling Performance

Figure 6 and Table 7 present a detailed breakdown of total tonnage and recycling performance of all the options. The modelling assumes the same waste arisings in all options (i.e., no waste reduction). There is increased material collected for recycling (dry recycling, food and garden combined) in all alternative options. Plastic film and cartons have been added to the dry recycling collection system in all alternative options.

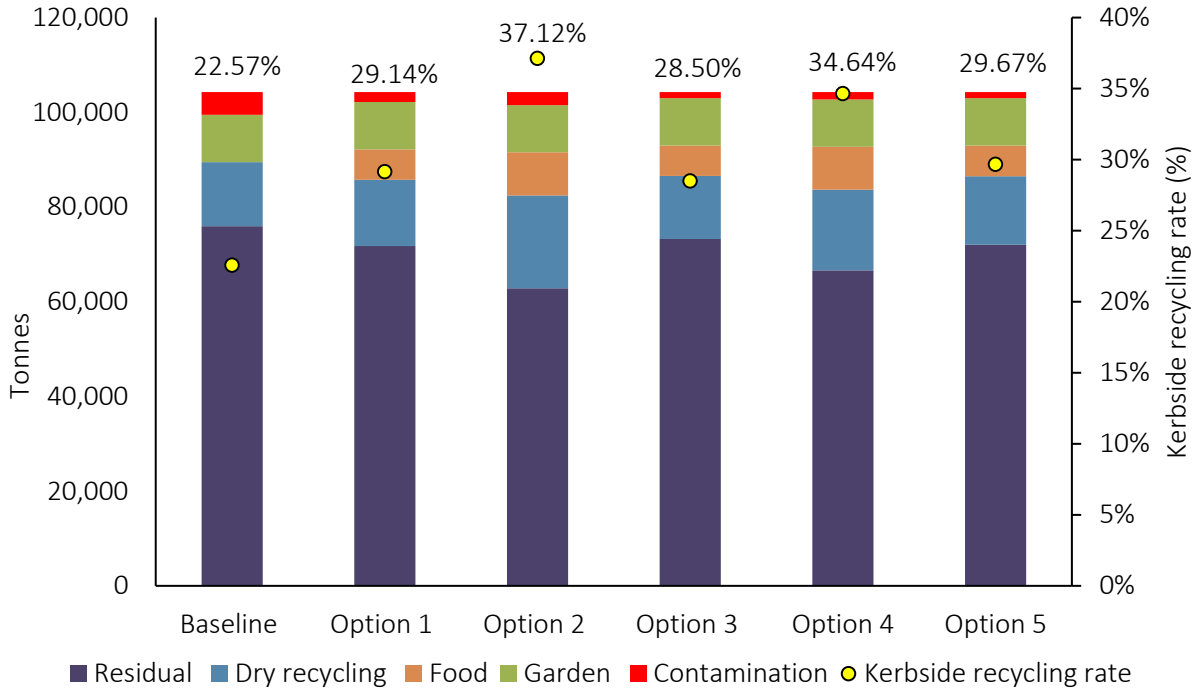


Figure 6 – Recycling performance results for the options modelled

The kerbside recycling performance increases in all alternative options above the baseline (22.57%), ranging from 28.50% (option 3) to 37.12% (option 2). It is evident that options 2 and 4 are the highest performing. Option 2 models a twin-stream collection with restricted residual waste collections (smaller bins) whilst option 4 models a kerbside-sort dry recycling collection also with restricted residual waste collections. The reduction in average weekly residual capacity (from 120L to 70L) incentivises the use of alternative bins, and therefore increases the total amount of recyclate collected. Option 2 performs higher than option 4 as it is assumed that a twin-stream collection would yield slightly higher dry recycling tonnages than a kerbside-sort system. In multi-stream collections the level of material sorting influences the level of contamination, and this is modelled to perform best in terms of (low) contamination levels.

Option 5 results in the highest kerbside recycling rate of the options modelled without any residual waste capacity restriction. In this option dry recycling is collected via a twin-stream collection, separating paper and card from the remaining recyclables. In this option however, it is collected on a weekly basis alongside the food waste. Introducing separate food waste collections increases the kerbside recycling rate by at least c. 6%.

Table 7 – Kerbside recycling performance breakdown for each option

Waste Stream	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	*Two-stream (paper & card out) + food*	*Two-stream (paper & card out), + food + restricted residual*	*Kerbside sort with food waste*	*Kerbside sort with food waste + restricted residual*	*Two-stream with weekly co-collected paper & food*
Residual	75,935	71,786	62,817	73,267	66,610	71,198
Dry recycling	13,535	13,935	19,626	13,264	17,033	14,487
Food	0	6,459	9,089	6,460	9,092	6,459
Garden	9,997	9,997	9,997	9,997	9,997	9,997
Contamination	4,809	2,100	2,748	1,289	1,545	2,136
Kerbside recycling rate	22.57%	29.14%	37.12%	28.50%	34.64%	29.67%
Change in Recycling Tonnage		+6,858	+15,179	+6,188	+12,590	+7,411

4.2 Total Indicative Recycling Performance

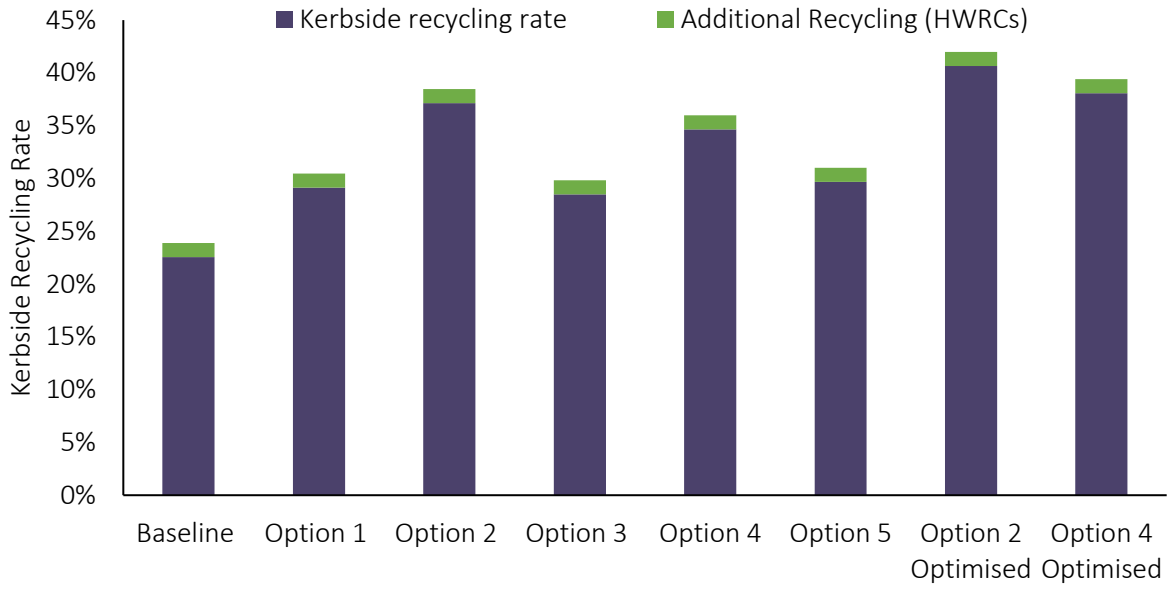


Figure 7 - NCC's total indicative recycling rate

Table 8 - NCC's total indicative recycling performance

	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5	Option 2 Optimised	Option 4 Optimised
NCC Recycling Rate	23.90%	30.48%	38.46%	29.83%	35.97%	31.01%	41.97%	39.40%

As shown above, including HWRC's has a small positive impact on NCC's kerbside recycling performance to collectively yield a total indicative recycling performance. It is noted that this was

calculated for the baseline (obtained via Defra stats) and for all the other options, it was assumed that it stays at this figure (i.e., an addition of 1.33% across the board).

4.3 Total Gross Operational Cost

4.3.1 Kerbside Collection Cost

Table 9 illustrates the total annualised kerbside collection costs of each option, broken down by each collection stream. Costs are presented as gross annualised indicative costs. This means that any capital costs, such as bins and vehicles are included and depreciated over the assumed service lifetime. In all options, the current garden service is retained. As such there are no changes to the annualised garden waste collection service or costs.

All alternative options result in an increased kerbside collection costs relative to the current service, ranging from £2.36 million to £2.73 million in additional costs. A large proportion of this cost can be attributed to the introduction of a food waste collection. In option 1 and 2 where this is provided as a dedicated service, it is estimated to cost in the region of £1.7 and £1.8 million per annum. In options 3, 4 and 5, food waste is co-collected with dry recycling. The annual cost of the residual waste collection service remains broadly consistent across all options. This shows that although there is a decrease in the total residual tonnage, this does not have a material impact on annual residual waste costs (this is linked to the resource required, in terms of vehicles and crew – See Appendix F for vehicle numbers and crew).

The option with the greatest annualised collection costs is option 4, which models a kerbside sort dry recycling collection with restricted residual collection. Option 1 results in the lowest additional annualised gross collection cost compared to the baseline, which models a twin-stream dry recycling service, separate food waste collection and retains the current residual waste collection service.

Note, these costs exclude the costs/revenues for the collected wastes and recyclates which are presented in 4.2.2Error! Reference source not found.

Table 9 - Breakdown of annualised collection costs for the modelled options

Cost	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Annualised recycling collection cost	£1,738,700	£2,382,100	£2,791,200	£4,123,800	£4,468,100	£4,266,100
Annualised food waste collection cost	n/a	£1,720,900	£1,808,400			
Annualised garden waste collection cost	£1,548,800	£1,548,800	£1,548,800	£1,548,800	£1,548,800	£1,548,800
Annualised residual waste collection cost	£2,280,300	£2,280,900	£2,086,300	£2,280,600	£2,281,300	£2,238,100
Total gross collection cost	**£ 5,567,800**	**£ 7,932,700**	**£ 8,234,800**	**£ 7,953,200**	**£ 8,657,600**	**£ 8,052,900**
Difference		£2,364,893	£2,666,966	£2,385,408	£3,089,769	£2,485,095
Kerbside recycling rate	22.57%	29.14%	37.12%	28.50%	34.64%	29.67%

Figure 8 provides a breakdown of where additional collection costs of each option arise, relative to the baseline. Small residual waste collection savings are shown in options 2, 4 and 5, however these are more than offset by additional collections costs from food waste in particular. Figure 9 shows the collection cost per household of each option, in comparison to the baseline. All options incur an additional cost per household of roughly £20 per household, ranging from c. £63 / hh (option 1 and 3) to £68 / hh (option 4).

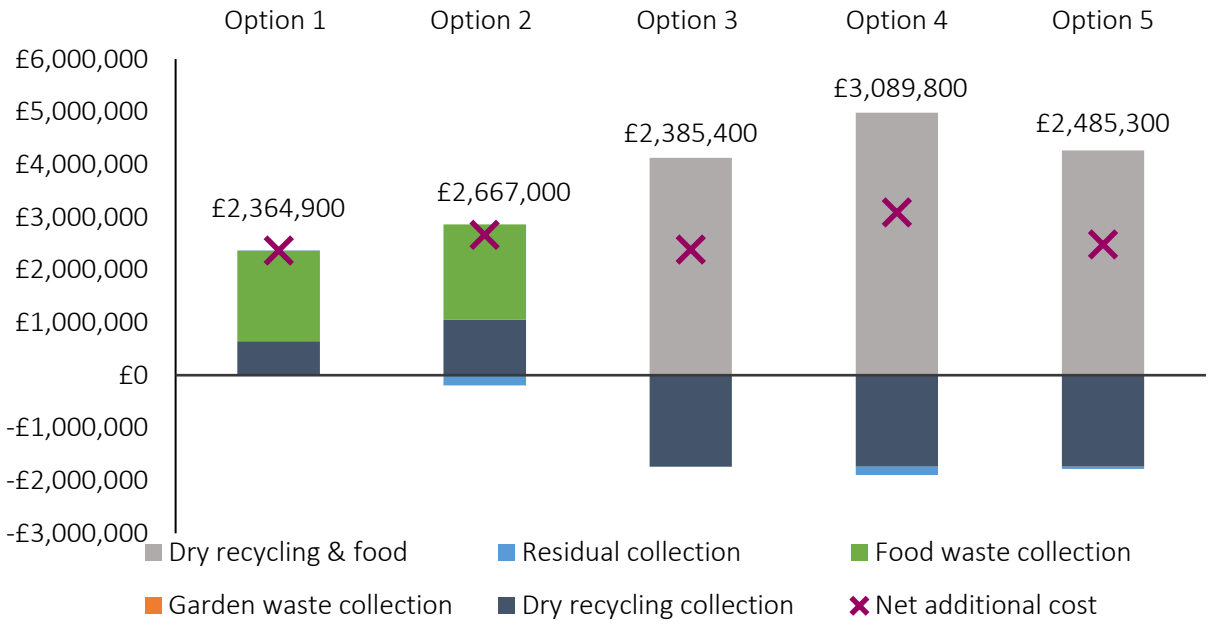


Figure 8 - Collection costs of modelled options relative to baseline

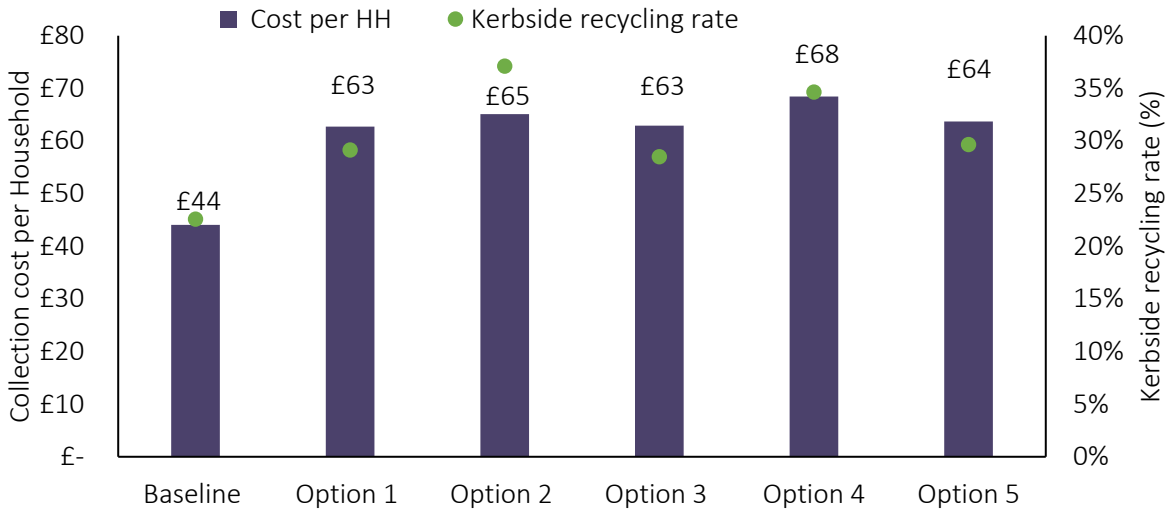


Figure 9 - Collection cost per household for the modelled options

4.3.2 Treatment & Disposal Costs

The tables below provide treatment and disposal costs (Table 10), as well as whole-system costs (including revenue) for the options modelled (Table 11). All of the alternative collection options result in lower total treatment and disposal costs than the current service (c.£7.8million). At present, NCC process the DMR via a MRF at an estimated annual cost of £1.37 million per annum. Where material is source separated (the paper and card fraction in option 1, 2 and 5, and for all materials in option 3 and 4) it is assumed this material could be sold to reprocessors, usually for a revenue. This results in much reduced recycling processing costs for option 1, 2 and 5 as the revenue accrued from the on sale of paper and card can be offset against the cost of sending the remaining material (glass, plastic and metals) to the MRF. Overall, processing dry recycling will still be at a cost to the Council in these options. In options 3 and 4 where material is source separated it is estimated that NCC could receive in the region of £0.8 - 1 million per annum[24].

Options 4 and 3 have the cheapest net treatment and disposal costs of the options modelled at £5 million and £5.6 million respectively. Notably these are the only options that generate a revenue for the treatment of dry recycling. This is driven by the increased recyclate quality obtained via the multi-stream collection system. There are residual waste treatment savings in all alternative collection options[25]. NCC may be required to review contract arrangements where substantial changes in collected tonnage are anticipated

[24] Based on moderated LetsRecycle 5year material average price

[25] Assuming there are no penalties in contractual terms for missing any Guaranteed minimum tonnages or other relevant threshold criteria.

Table 10 - Breakdown of treatment and disposal costs for all the modelled options

Detail	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Dry Recycling (gate fee or revenue)	£1,092,900	£202,400	£278,700	-£844,900	-£1,090,200	£190,000
Food Waste Treatment	N/A	£202,800	£285,400	£ 202,800	£285,500	£ 202,800
Garden Waste Treatment	£275,400	£275,400	£275,400	£275,400	£275,400	£275,400
Residual Waste Treatment EfW	£5,751,400	£5,262,900	£4,670,200	£5,310,600	£4,854,700	£5,223,600
Haulage (All tonnage)	£312,800	£312,800	£312,800	£ 312,800	£312,800	£312,800
Transfer (All tonnage)	£364,900	£364,900	£364,900	£364,900	£364,900	£364,900
Total Treatment & Haulage	**£7,797,500**	**£6,621,400**	**£6,187,500**	**£5,621,800**	**£5,003,200**	**£6,569,600**

As shown in Table 11, the option with the cheapest whole system cost is the baseline, followed by options 3, 4, 2, 1 and 5 respectively. This shows that that the additional collection costs are not offset by lower treatment costs in all of the alternative collection options. However, this does not take into account the impacts of EPR and new net burdens which may go a substantial way to reducing NCC costs.

Table 11 - Net cost of each modelled option

Costs and Revenue	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Kerbside collection costs (KAT) (cost)	£5,567,800	£7,932,700	£8,234,800	£7,953,200	£8,657,600	£8,052,900
Treatment Cost (Total)	£7,797,500	£6,621,398	£6,187,487	£5,621,800	£5,003,200	£6,569,600
Net (Collection, Revenue and Treatment)	**£13,365,300**	**£14,554,100**	**£14,422,300**	**£13,575,100**	**£13,660,800**	**£14,622,600**
		£1,188,800	*£1,056,900*	*£209,700*	*£295,400*	*£1,257,200*

Figure 10 provides a whole system cost normalised per household. It is evident that relative to all modelled options the current service has the cheapest cost per household. This increases to c. £115 per household in options 1, 2 and 5 and is reduced to c. £105 per household in options 3 and 4, demonstrating the impact of receiving revenue for source-segregated material could have on the whole system costs in NCC.

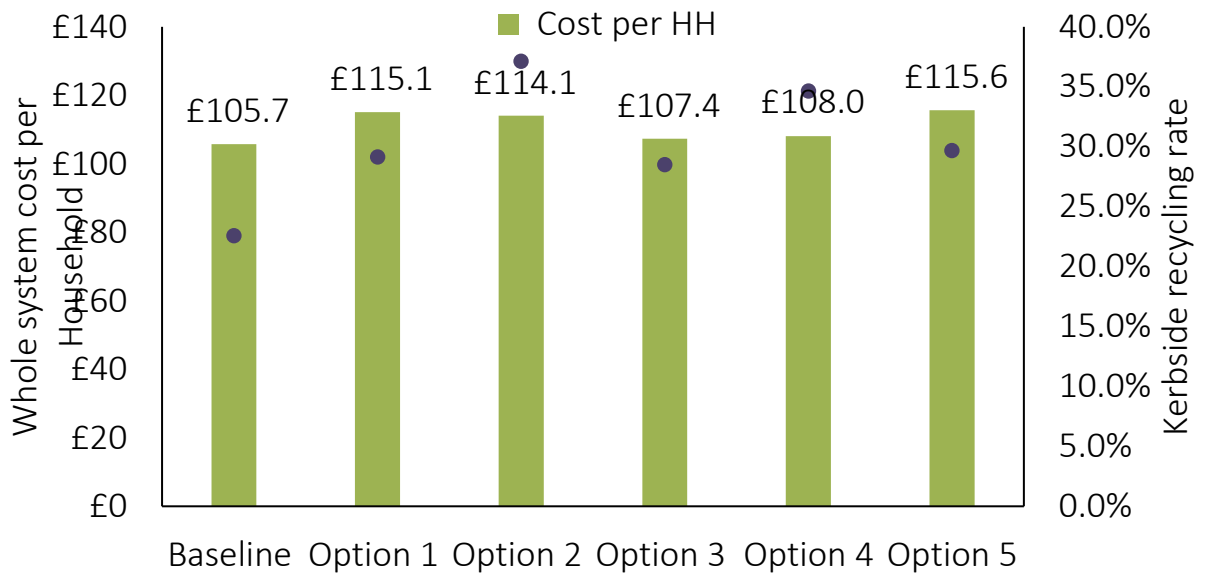


Figure 10 - Whole system cost of each option per household

4.3.3 Cost of Change

The KAT model calculates an annualised capital cost of vehicles and containers for comparative purposes and does not consider the additional cost burden would be required to move from the current baseline position, i.e. the 'cost of change'.

As such, Table 12 below details the CAPEX costs associated with each option. These CAPEX costs take into account the cost of providing food waste collection containers, which is common in all the options, as well as the cost of new vehicles required and additional containers (specific to each collection service). As shown below, the cheapest option to change to would be option 3, followed by options 5, 4, 1, and 2. It is noted that in option 1, option 2 and option 5 it would be a lot cheaper to switch to if the 240L WHB from the current dry recycling is reused/retained for the recycling containers, this takes a large chunk out of the costs and may very well happen in practice.

Note that the cost of change includes the Capex for new vehicles and containers. It does not include any other costs associated with a change of service, e.g., procurement, communications, enforcement or other infrastructure requirements that may be required. However, if the overall costs of the service have increased, the annualised costs will have more overheads included within them (as this is a percentage applied on top of the total annual service costs), which may account for some of these elements.

Table 12 - CAPEX cost of each option

Detail	Vehicles	Containers	*Summary - cost of change*
Option 1	12 x REL 65%/35%, 21 m3 17 x 7.5t dedicated food waste vehicles	126,448 x 70L reusable bag, 180L WHB, kitchen caddy + kerbside caddy	£6,041,800
Option 2	14 x REL 65%/35%, 21 m3	126,448 x 70L reusable bag, 180L WHB, 140L	£8,726,300 (£6,339,600)

	18 x 7.5t dedicated food waste vehicles	WHB, kitchen caddy + kerbside caddy	
Option 3	22 x Stillage 37m3	126,448 x (3 x 40L boxes), kitchen caddy + kerbside caddy	£3,193,100
Option 4	27 x Stillage 37m3	126,448 x (3 x 40L boxes), kitchen caddy + kerbside caddy	£5,868,400
Option 5	12 x REL + front pod 75%/25% 22m3 total	126,448 x 70L reusable bag, 180L WHB, kitchen caddy + kerbside caddy	£4,491,600 (£2,152,300)

4.3.4 Optimised Collection Options

This options appraisal considers the implications of altering the ways in which the dry recycling is collected e.g. via the materials that are collected for recycling, the levels of materials sorting, and the types of containers that are used to collect those materials. There are additional methods which can be utilised to increase recycling performance thereby 'optimising' the service. At a local level, new or wider communications can be rolled out to enhance an existing service, or to introduce a new service, or to tackle a particular issue (e.g. identifying cases of contamination). At a wider level, with upcoming EPR, we are likely to see mandatory labelling for packaging materials which should make it easier with consistent messaging on items to assist with recycling.

For this reason, additional modelling has been undertaken on the two highest performing options, option 2 (twin-stream recycling with separate food waste and restricted residual) and option 4 (kerbside sort recycling with food waste and restricted residual waste), to explore how an 'optimised' service might perform. it is assumed that the impact of increased communication and public outreach improves the dry recycling yields, as well as the food waste tonnage yields and also decreases the contamination in the dry recycling streams. The details of these are included in Appendix A. The recycling performance and cost implications are as follows:

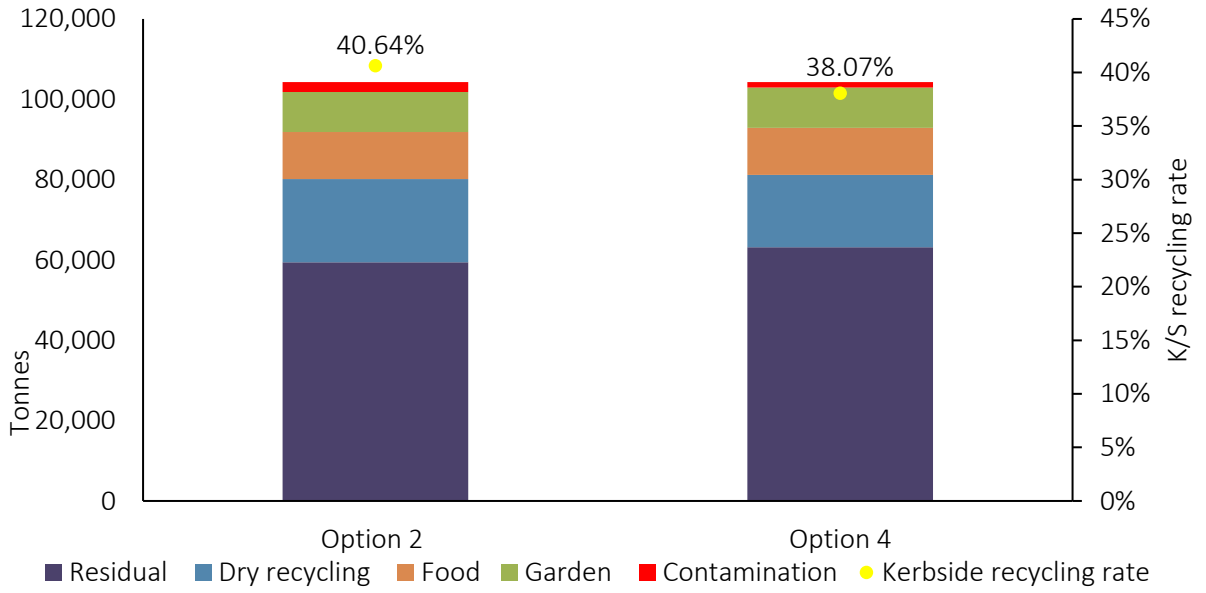


Figure 11 – Recycling performance results of optimised options 2 and 4

Table 13 – Breakdown of tonnage for optimised options 2 and 4

Waste Stream	Baseline	Option 2	Option 2 (Comms)	Option 4	Option 4 (Comms)
	Business as usual	***Two-stream (paper & card out), + food + restricted residual***	***Two-stream (paper & card out), + food + restricted residual (Optimised)***	***Kerbside sort with food waste + restricted residual***	***Kerbside sort with food waste + restricted residual (Optimised)***
Residual	75,935	62,817	59,451	66,610	63,186
Dry recycling	13,535	19,626	20,661	17,033	17,984
Food	0	9,089	11,719	9,092	11,719
Garden	9,997	9,997	9,997	9,997	9,997
Contamination	4,809	2,748	2,449	1,545	1,391
Kerbside recycling rate	22.57%	37.12%	40.64%	34.64%	38.07%
Change in Recycling Tonnage		+15,179	+18,844	+12,590	+16,168

In options 2 and 4, improved performance is achieved in both the cases due to the impact of communication and outreach campaigns. Option 2 noticeably reaches 40.64% in recycling performance, whereas option 4 reaches 38.07%. As shown below, however, with increased recycling performance, there are cost implications as well. In option 2, the change in collection costs (Table 14) is negligible, whereas in option 4, an increase of c. £400,000 is noted, as an additional two recycling vehicles are required.

Table 14 – Collection costs for optimised options 2 and 4

Cost	Baseline	Option 2	Option 2 (Comms)	Option 4	Option 4 (Comms)
	Business as usual	***Two-stream (paper & card out), + food + restricted residual***	***Two-stream (paper & card out), + food + restricted residual (Optimised)***	***Kerbside sort with food waste + restricted residual***	***Kerbside sort with food waste + restricted residual (Optimised)***
Annualised recycling collection cost	£1,738,700	£2,791,200	£2,706,268	£4,468,100	£5,327,700
Annualised food waste collection cost	n/a	£1,808,400	£1,808,400		
Annualised garden waste collection cost	£1,548,800	£1,548,800	£1,548,800	£1,548,800	£1,548,800
Annualised residual waste collection cost	£2,280,300	£2,086,300	£2,086,300	£2,281,300	£2,125,900
Total gross collection cost	£ 5,567,800	£ 8,234,800	£ 8,149,900	£ 8,657,600	£ 9,002,500
Difference		£ 2,666,965	£ 2,582,053	£ 3,089,765	£ 3,434,664
Kerbside recycling rate	22.57%	37.12%	40.64%	34.64%	38.07%

Table 15 – Treatment and haulage costs for optimised options 2 and 4

Detail	Baseline	Option 2	Option 2 (Comms)	Option 4	Option 4 (Comms)
	Business as usual	***Two-stream (paper & card out), + food + restricted residual***	***Two-stream (paper & card out), + food + restricted residual (Optimised)***	***Kerbside sort with food waste + restricted residual***	***Kerbside sort with food waste + restricted residual (Optimised)***
Dry Recycling (gate fee or revenue) -	£1,092,900	£278,700	£293,100	-£1,090,200	-£1,162,200
Avoided penalty on contaminated recyclate[26]	N/A	N/A	(-£313,700)	N/A	(-£182,700)
Food Waste Treatment	N/A	£285,400	£367,900	£285,500	£368,000
Garden Waste Treatment	£275,400	£275,400	£275,400	£275,400	£275,400
Residual Waste Treatment EfW	£5,751,400	£4,670,200	£4,409,100	£4,854,700	£4,599,800
Haulage (All tonnage)	£312,800	£312,800	£312,800	£312,800	£312,800
Transfer (All tonnage)	£364,900	£364,900	£364,900	£364,900	£364,900
Total Treatment & Haulage	**£7,797,500**	**£6,187,500**	**£5,709,800**	**£5,003,200**	**£4,576,100**

The treatment costs decrease (Table 15) for the optimised counterparts, as a larger quantity of high quality recyclate generates more revenue offsetting treatment costs. Moreover, due to the contamination rates falling below the maximum allowable contamination rate set within the current MRF contract, it has been assumed that the MRF gate fee would not include the penalties currently paid for by NCC. This results in c. £300,000 of savings on average. As such, overall, due to the aforementioned reasons, the optimised options are less expensive to operate in terms of whole system costs (Table 16). It should be noted that no additional communications costs have been attributed to this analysis.

Table 16 – Total system costs for optimised options 2 and 4

Costs and Revenue	Baseline	Option 2	Option 2 (Comms)	Option 4	Option 4 (Comms)
	Business as usual	***Two-stream (paper & card out), + food + restricted residual***	***Two-stream (paper & card out), + food + restricted residual (Optimised)***	***Kerbside sort with food waste + restricted residual***	***Kerbside sort with food waste + restricted residual (Optimised)***
Kerbside collection costs (KAT) (cost)	£5,567,800	£8,234,800	£8,149,900	£8,657,600	£9,002,500
Treatment Cost (Total)	£7,797,500	£6,187,500	£5,709,900	£5,003,200	£4,576,100

[26] Avoided penalty is taken at the rate provided by NCC (£174.83/tonne) for contamination above 14% and based on the contamination tonnage on the standard, non-optimised versions of options 2 and 4

Net (Collection, Revenue and Treatment)	£13,365,300	£14,422,300	£13,859,700	£13,660,800	£13,578,600
		£1,056,900	*£494,300*	*£295,500*	*£213,280*

4.4 Carbon & Environmental Performance

The findings of the WRATE modelling exercise are outlined in this section. They represent Life Cycle Assessment results, and so consider the impact of vehicles and infrastructure as a proportion of their use and their life, so for example the impact of the Energy from Waste plant (including construction burdens and operational impacts) will be assessed over a 25-year life and annualised to reflect a years' impact.

Figure 12 shows the total carbon impacts of the baseline and the various modelled options.

The baseline (current) waste management service across NCC is modelled to result in an overall net emission of 642t CO_2-eq. This suggests that the recycling, composting and energy recovery (from Eastcroft EfW) activity does not currently offset the detrimental emissions from collection, transport, infrastructure development and the residual waste treatment process. Figure 12 shows the total carbon emissions of each option. All alternative collection options result in a net carbon saving and as shown below, option 2 gives the highest amount of carbon savings, followed by options 4, 5, 3, 1.

The addition of pots, tubs and trays and plastic film to the service contributes to a carbon benefit in all options, as this diverts fossil-derived plastics from the residual waste stream into the recycling. Whilst the diversion of plastic film and cartons reduces the calorific value of the residual waste going to the Energy from Waste plant, the increased food waste separation has the opposite effect. The removal of plastic film from the residual mix for recycling has a strong beneficial carbon balance as combustion of this material is a release of fossil carbon.

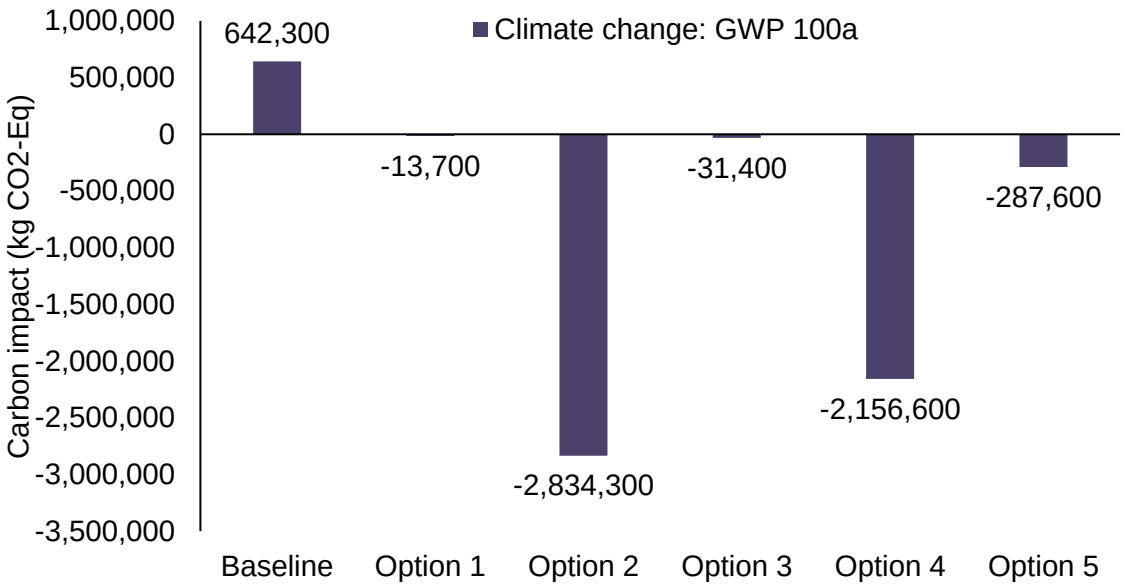


Figure 12 - Headline carbon impacts associated with each modelled option

A breakdown of climate change impacts by the individual service elements shows how each option performs in terms of collection, transportation, intermediate facilities, recycling and treatment and recovery. Table 17 shows the detail behind these headline figures; these results are classified as follows:

- Collection – this accounts for the environmental burdens of the collection containers (only), so the burdens in making the containers for the various collection systems
- Transportation - this accounts for emissions from the vehicles in terms of construction burdens as well as fuel related emissions. This covers both collection from households and bulk haulage.
- Intermediate Facilities – these are the environmental burdens of transfer stations, materials recycling facilities. They include the construction and operating burdens.
- Recycling – this is the environmental benefit of recycling, displacing primary resource extraction / refining.
- Treatment & Recovery - These are the environmental burdens of composting plants, AD facilities and Energy from Waste facilities. They include the construction and operating burdens, and also any benefits associated with energy recovery.
- Landfill – This comprises the environmental burdens of landfill (with some benefits associated with energy recovery from landfill gas).

Of most significance, all options also have an improved 'treatment and recovery' and 'landfill' performance on account of less residual waste, and notably, less plastic into the EfW plant. All options also have lower 'intermediate' emissions, associated with processing less material at the MRF, however this is a small contributor to the overall carbon impact. Option 3 and 4 (the two kerbside sort options) result in the highest transport emissions, due to the number of vehicles required and total mileage.

Table 17 - Breakdown of carbon impacts for each option

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Collection	565,700	699,000	755,400	470,600	526,900	699,100
Transport	1,449,000	1,896,900	1,849,800	2,039,400	2,225,100	1,737,400
Intermediate Facilities	207,500	148,000	186,900	111,300	127,300	150,600
Recycling	-16,505,900	-16,559,900	-18,780,300	-16,490,900	-18,403,500	-16,730,600
Treatment and Recovery	13,804,000	12,796,600	12,245,800	12,826,700	12,436,900	12,857,500
Landfill	1,121,900	1,005,500	908,100	1,011,500	930,700	998,400
Total	**642,300**	**-13,700**	**-2,834,300**	**-31,400**	**-2,156,600**	**-287,600**

Additional WRATE results for miscellaneous environmental parameters are included in Appendix E for the sake of completion.

It is likely that there will be a variance between the carbon figures derived from the assessment of options within this option appraisal and figures reported by the Council as part of their wider carbon reporting. One reason for this is that the Options Appraisal seeks to understand the 'whole life' impact of the current service and any changes made to it. It used a tool, known as WRATE, which is a Life Cycle Assessment tool designed specifically for comparing municipal waste management systems, using a bespoke waste composition and modelling from the point that waste arises (e.g. at the household) to

the end of its life (e.g. if sent for landfill or reduced to ash in an incinerator or recovered as a secondary resource). The model also accounts for the imbedded carbon impacts from making containers (e.g. wheeled bins) for households and the construction impacts (e.g. for making refuse collection vehicles or waste management infrastructure), this will vary from simpler carbon reporting systems which may focus on vehicle miles and generic factors for waste management activity.

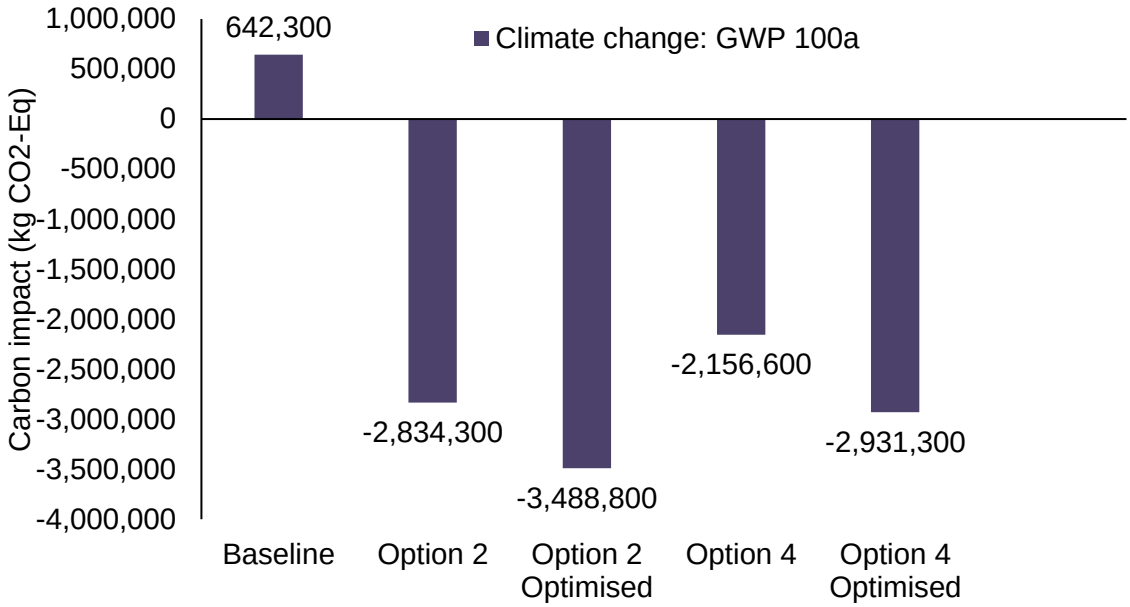


Figure 13 – Carbon assessment of optimised options 2 and 4

As shown in the figure above, optimising the best performing options (options 2 and 4, see Section 4.2.4) results with additional communications and public outreach campaigns boosts carbon performance in both the cases as well, since higher amounts of the waste at the kerbside are recycled and less is sent to EfW.

It is understood that NCC is transitioning their refuse collection fleet to electric. The maximum CO_2 reduction from electrification of fleet would be of the order of c. 60% of the respective transportation figure cited in Table 17. Although it should be noted that this assumes a 100% renewable energy source for the electricity used to power the vehicles, and that there was no additional carbon burdens from the construction of the eRCV versus conventional Refuse Collection Vehicles.

4.5 National Policy Alignment

Table 18 - National policy alignment assessment

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Compliance to R&WS / TEEP /National Policy						

Legend

Worst				Best

As regards alignment to upcoming national policy, the options have been scored based on their anticipated alignment with the Resources and Waste Strategy for England. Although this is still under consultation, there are aspects of the national strategy which are highly likely to be introduced (mandatory food waste collections and consistent collections agenda) with other areas requiring further insight (such as providing free garden waste collections).

There are Government requirements for a dedicated separate food waste collection on a weekly basis from all local authorities. All alternative options align with this policy. The alternative options also collect cartons and plastic film, which aligns NCC to the same core materials collected in the consistency in recycling collection proposals.

The baseline ranks the lowest, as it does not involve food waste collections and it is a commingled collection which is anticipated to be the 'least preferable' collection option within the consistent collections agenda. As options 1, 2 and 5 are twin-stream recycling collections, with weekly food collections, these may be considered satisfactory, however this is still likely to be subject to a TEEP[27] (or equivalent) assessment. However, for recyclate quality and from a consistent collections viewpoint, options 3 and 4 score the highest. See Appendix F for further detail on evaluation criteria.

4.6 Public Acceptability

This criterion considers how each option might be accepted by householders. The evaluation takes into account the ease for householders, and any potential change from the current service. The results are shown in Table 19.

Table 19 - Public acceptability assessment

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Public acceptability						

Legend

Worst — Best

In terms of public acceptability, it is hypothesised that the residents of Nottingham prefer the business-as-usual scenario, i.e., the baseline, as that service has been in practice for a few years and is the simplest system for householders and considered to be widely acceptable. As such, there is a 'comfort' element associated with this option. Moreover, studies suggest residents may find it 'easiest' to put all dry recyclables in one bin. As such, this option ranks highest in this category.

All alternative options require a change in the recycling collection service. It is assumed that householders may find a two-stream system with wheeled bins easier to operate than a kerbside sort system if they have sufficient storage space for additional containers. As such, following the baseline, options 5, 1 and 2 are ranked in second place as these are twin streams with (requiring less separation and initiative on the part of the residents in comparison to the multi-streams in options 3 and 4).

[27] A Technical, Economic and Environmental assessment of Practicability (TEEP) for alternative collection approaches.

Moreover, in option 5, the food waste is co-collected with part of the dry recycling, as such the residents can put these out on the same day, making it slightly more convenient than options 1 and 2.

For restricted residual waste, it is assumed that this is less preferable to the residents as such the options with restricted residuals rank lower than their unrestricted counterparts. See Appendix F for further detail on evaluation criteria.

4.7 Operational Flexibility & Deliverability

This criterion revolves around a number of factors to assess the deliverability of each option and its operational flexibility. It considers the quantity and quality of materials collected at the kerbside, the potential for the service to adapt to any changes that might be required and the resource required in terms of collection vehicles and collection crew.

Table 20 - Operational flexibility assessment

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Operational flexibility (deliverability)						

Legend

Worst				Best

All alternative options require new vehicles and containers to operate the service, all of which will need to be procured. In the current socio-political climate, significant concerns regarding supply-chain issues remain and the lead times for new vehicles are significant. As such, procuring new vehicles is likely to be affected, which weighs negatively for all the options except for the baseline. Moreover, currently, NCC could interchangeably use their RCVS in case of vehicle maintenance and associated operational matters (due to the current collection regime). However, in all the other options, this is likely to change. As such, the baseline scores highest in this regard. Option 5 offers some flexibility due to co-collection of food and paper-card (which could also be interchanged with the rest of the DMR if required).

From a materials perspective, the baseline, option 1, 2 and 5 may offer flexibility in the dry recycling mix, however this is dependent on the MRF being set up to separate those materials. Option 3 and 4 score well in this regard as it is considered that a kerbside sort / multi-stream system can adapt to changes in materials and not reliant on a third party facility, such as MRF. However, in terms of flexibility of vehicles across the kerbside service, these options rank lowest.

Options 1 and 2 use dedicated food waste collection vehicles; while this reduces the flexibility of the service, the food waste collections are entirely separate from all other waste streams, which provides a certain degree of contingency.

Getting new vehicles and revising the service will likely require crew training as well as a 'transitionary' period. This is likely of relevance and good planning ahead is advised with contingencies in place. See Appendix F for further detail on evaluation criteria and detail on vehicle numbers and crew for further operational implications and insights.

4.8 Social Value

Each option has been ranked based on its anticipated social value. The creation (and retention) of jobs, community well-being and wider health benefits (e.g., air quality) have all been considered when evaluating the score of each option. The scoring system is included in Appendix F.

Table 21 - Social value assessment

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Social Value[28]						

Legend

Worst				Best

Option 4, 3 and the baseline score the highest in this category as the former create the most jobs (but incur the highest travel), whilst the latter offers the least amount of travel (lowest impact on air quality). The creation of jobs is a trade-off for more general health impacts (e.g., air quality) as typically where those services provide a higher number of jobs this is due to more resource being required to operate the kerbside collection service (i.e. more vehicles require more drivers and crew, however this means more transport miles are required and higher levels of air pollution). See Appendix F for further detail.

The combination of both factors (which may be competing in their relative benefits) towards social value ranks the baseline, options 3 and 4 the highest for this criterion.

4.9 Health & Safety

Table 22 - Health and safety assessment

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
	Business as usual	***Two-stream (paper & card out) + food***	***Two-stream (paper & card out), + food + restricted residual***	***Kerbside sort with food waste***	***Kerbside sort with food waste + restricted residual***	***Two-stream with weekly co-collected paper & food***
Health and Safety						

Legend

Worst				Best

With regards to health and safety, none of the options score a 'green' as although the baseline service for example does not entail lifting of any of the bins, a significant amount of side waste is deposited, as discussed with NCC staff in an FRM-led workshop on 25-07-2022, which the operators have to additionally lift and transfer into the RCV). The other options add collection bags and boxes, which will need to be lifted to empty them into the collection vehicle. Moreover, introduction of food waste collections also involves a bio-safety component and will require an additional risk assessment

[28] Job creation, wider health benefits, well-being, community benefits. See Appendix E for further detail

and method statement for appropriate handling. Those options with glass in a box (options 3 and 4) have a slightly poorer H&S score due to both potential noise impacts in addition to manual handling, potential breakage risks. See Appendix F for further detail on evaluation criteria.

4.10 EPR & Net-Burdens

Using assumptions of the amount of material within the recycling and residual streams that will be obligated under EPR from the RAWPIC tool (see section 3.3), an estimation has been made as to the potential costs that could be covered by producers as part of the committed for producers to cover full net recovery costs. Under EPR, the obligated tonnage for recycling and residual is calculated at c. £4.4 million as shown in Table 23. Under the net-burdens funding, the food waste and garden waste costs are also likely to be fully covered[29], as such the collection costs for these are likely to be approximately c.£ 3,000,000 in total (£1,548,800, garden and c. £1,700,000, food waste).

Table 23 – Estimated EPR-obligated material income

Detail	% of EPR Obligated Material in Stream (Baseline)	Potential costs covered by EPR
Recycling	56.1	Collection: £975,400 Treatment: £613,100
Residual	26.3	Collection: £599,700 Treatment: £151,300
Sub-Total (EPR)		£2,339,500
New net-burdens[30]	Garden: £1,548,800 Food: £1,700,000	£3,000,000
Grand total		£5,339,500

[29] Subject to consultation
[30] Subject to consultation and assuming covers full cost of the collection service.

5 Summary & Concluding Remarks

Table 24 below shows a summary of the options appraisal results. No weighting has been applied to the evaluation criteria agreed for this options appraisal. Appendix E expands on the detail behind these scores.

Table 24 - Summary of key considerations for each option

Category	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
Total cost (Collection, Treatment and Disposal)	£13.4m	£14.5m	£14.4m	£13.6m	£13.7m	£14.6m
Kerbside Recycling performance (%)	22.57%	29.14%	37.12%	28.50%	34.64%	29.67%
Total Environmental Benefit (carbon, $kgCO_2$-eq)	642,300	-13,700	-2,834,260	-31,400	-2,156,579	-287,600
Cost of Change (initial Capex)	N/A	£6.1m	£6.4m -8.7m	£3.2m	£5.8m	£4.5m
Alignment to R&WS / TEEP /National Policy						
Public acceptability						
Operational flexibility (deliverability)						
Social Value[31]						
Health and Safety						

Legend

Worst — Best

- In terms of recycling performance, all options have an improved kerbside recycling rate (%) from the baseline (22.57%), with option 2 performing the highest (37.12%) followed by option 4 (34.64%). Option 2 models a twin-stream collection with restricted residual collections (smaller bins) whilst option 4 models a kerbside-sort dry recycling collection also with restricted residual collections.
- This includes the full suite of materials proposed by the Consistent Collections policy being implemented by Government. Each option includes the current range of materials collected by NCC, plus food waste collections, plastic film and cartons.

- All alternative options result in an increased kerbside collection costs relative to the current service ranging from £2.36 million to £2.73 million in additional costs. The option with the

[31] Job creation, wider health benefits, well-being, community benefits. See Appendix E for further detail

greatest annualised collection costs is option 4. Option 1 results in the lowest additional annualised gross collection cost compared to the baseline, which models a twin-stream dry recycling service, separate food waste collection and retains the current residual waste collection service.

- Options 4 and 3 have the cheapest treatment and disposal costs of the options modelled at £5 million and £5.6 million respectively. Notably these are the only options that generate a revenue for the treatment of dry recycling. This is driven by the increased recyclate quality obtained via the multi-stream collection system.
- In terms of total net whole-system costs, the baseline and options 3 and 4 are the most cost-effective options.
- All options will incur a cost of change (i.e. procuring new vehicles and containers), ranging from c. £3.2 million (option 3) – c. £8.7 million (option 2), with options 3 and 5 incurring the lowest CAPEX costs.
- The baseline (current) waste management service across NCC is modelled to result in an overall net emission of 642t CO_2-eq. All options have a significantly improved carbon performance relative to the baseline, with option 4 providing the highest amount of net savings (-2,157t CO_2-eq).
- Of the qualitative criteria (those with traffic light colouring), the multi-stream collections (options 3 & 4) score lower on public acceptability, operational flexibility and health and safety, but score well as regards alignment to proposed national policy and social value. The two stream collections (options 1, 2 and 5) and the baseline score higher on public acceptability and operational flexibility but may not fully align to the Resources & Waste Strategy.
- The results show that there is a trade off between alignment with Government Policy versus public acceptability, operational flexibility and Health & Safety in particular. No weighting has been applied to the evaluation criteria, the preferred option will be ultimately determined by which elements NCC deem most important or have the highest priority.

No weighting has been applied to the evaluation criteria, the preferred option will be ultimately determined by which elements NCC deem most important or have the highest priority.

For the optimised options 2 and 4, the impact of public outreach and communications improves the recycling rate for options 2 (37.12%) and 4 (34.64%) to 40.64% and 38.07% respectively. Due to the improved recycling performance, the carbon impacts as shown below are considerably improved as well. In order to determine the Nottingham City Council recycling rate it is necessary to adjust the kerbside recycling rate to take account of recycling and waste management in other aspects of the Nottingham service (e.g. the Household Waste Recycling Centre). This adds around 1.5% to the kerbside recycling rate meaning c. 42% recycling is acheivable using methods in this appraisal. Furthermore, national policy and intervention around aspects like mandatory labelling of packaging for recyclability, national communications campaigns and Extended Producer Responsibility[32] and further local initiatives around litter recycling and the HWRC service could enable citywide recycling rates of >50% to be achieved.

[32] Making packaging producers 100% responsible for the cost of collecting and managing those goods at the end of their life.

I. Appendix A - KAT Model Assumptions & Outputs

	Assumptions of specific alternative scenarios (KAT)						
Collection	Option 1	Option 2	Option 3	Option 4	Option 5	Option 2 (Optimised)	Option 4 (Optimised)
	Twin-stream collection with weekly food waste	*Twin-stream collection with weekly food waste and restricted residual capacity*	*Multi-stream recycling with weekly waste*	*Multi-stream recycling with weekly waste and restricted residual capacity*	*As Option 1 with co-collection of paper and food*	*Twin-stream collection with weekly food waste and restricted residual capacity*	*Multi-stream recycling with weekly waste and restricted residual capacity*
Dry	Two-stream dry recycling Fortnightly + plastic film + cartons Containers: • 1x 70L bag – paper and card • 1x 180L WHB – plastics (including film), metals, cartons and glass Vehicle: 70/30 split back vehicle Contamination: paper and card: 4% DMR: 14% Yields – Down 2% from commingled No change to set out Participation: -5%	Two-stream dry recycling Fortnightly + plastic film + cartons Containers: • 1x 70L bag – paper and card • 1x 180L WHB – plastics (including film), metals, cartons and glass Vehicle: 70/30 split back vehicle Contamination: paper and card: 4% DMR: 14% Yield - Up to benchmark level (predominantly urban, high deprivation) as per WRAP LA Portal	Kerbside sort Weekly + plastic film + cartons Containers: 3x box system • Box 1: Paper and Card • Box 2: Glass and cans • Box 3: Plastic (including film) and cartons Vehicle: 37m³ Romaquip vehicle. Utilisation 60% Contamination: 4% Yields – Down 7% Decreased set out (-5%)	Kerbside sort Weekly + plastic film + cartons Containers: 3x box system • Box 1: Paper and Card • Box 2: Glass and cans • Box 3: Plastic (including film) and cartons Vehicle: 37m³ Romaquip vehicle. Utilisation 60% Contamination: paper and card: 4% DMR: 14% Yield – Up to benchmark level (predominantly urban, high	Two-stream dry recycling Paper & card - weekly DMR – fortnightly + plastic film + cartons Containers: • 1x 70L bag – paper and card • 1x 180L WHB – plastics (including film), metals, cartons and glass Vehicles: REL + Pod (co-collected fibres and food) RCV - DMR Contamination: paper and card: 4% DMR: 7% DMR yield as per Option 1	Two-stream dry recycling Fortnightly + plastic film + cartons Containers: • 1x 70L bag – paper and card • 1x 180L WHB – plastics (including film), metals, cartons and glass Vehicle: 70/30 split back vehicle Contamination: paper and card: 3% DMR: 10% Yield - Up to benchmark level (between predominantly urban, high deprivation and comparable university	Kerbside sort Weekly + plastic film + cartons Containers: 3x box system • Box 1: Paper and Card • Box 2: Glass and cans • Box 3: Plastic (including film) and cartons Vehicle: 37m³ Romaquip vehicle. Utilisation 60% Contamination: paper and card: 4% DMR: 14% Yield – Up to benchmark level (between predominantly urban,

	Assumptions of specific alternative scenarios (KAT)						
Collection	Option 1	Option 2	Option 3	Option 4	Option 5	Option 2 (Optimised)	Option 4 (Optimised)
	Twin-stream collection with weekly food waste	*Twin-stream collection with weekly food waste and restricted residual capacity*	*Multi-stream recycling with weekly waste*	*Multi-stream recycling with weekly waste and restricted residual capacity*	*As Option 1 with co-collection of paper and food*	*Twin-stream collection with weekly food waste and restricted residual capacity*	*Multi-stream recycling with weekly waste and restricted residual capacity*
		Increased set out (+5%) Increased participation (+2%) (*Due to the residual capacity restriction)*	Decreased participation (-8%)	deprivation) as per WRAP LA Portal No change to set out Increased participation (+2%) (*Due to changing recycling system & residual capacity restriction)*	<u>Paper & card yield – Up 4%</u>	towns and cities) as per WRAP LA Portal Increased set out (+5%) Increased participation (+3% to OP 2) (*Due to the residual capacity restriction)*	high deprivation and comparable university towns and cities) as per WRAP LA Portal No change to set out Increased participation (+3% to OP 4) (*Due to changing recycling system & residual capacity restriction)*
Garden	Garden waste collection as is - BAU all options						
Food	Low WRAP ready reckoner tonnage - Set out 45% - Participation 55% - 23L bucket and kitchen caddy Separate weekly food waste collection Dedicated 7.5 tonne food waste vehicle Assume 1 crew member loading +	Mid WRAP ready reckoner tonnage - Set out 50% - Participation 60% - 23L bucket and kitchen caddy Separate weekly food waste collection - Dedicated 7.5 tonne food waste vehicle Assume 1 crew member loading +	Low WRAP ready reckoner tonnage - Set out 45% - Participation 55% - 23L bucket and kitchen caddy Weekly food waste collection - Collected on Romaquip	Mid WRAP ready reckoner tonnage - Set out 50% - Participation 60% - 23L bucket and kitchen caddy Weekly food waste collection. - Collected on Romaquip	Low WRAP ready reckoner tonnage - Set out 45% - Participation 55% - 23L bucket and kitchen caddy Separate weekly food waste collection - Co-collected with paper and card (REL + Pod)	High WRAP ready reckoner tonnage - Set out 50% - Participation 60% - 23L bucket and kitchen caddy Separate weekly food waste collection - Dedicated 7.5 tonne food waste vehicle Assume 1 crew member loading +	High WRAP ready reckoner tonnage - Set out 50% - Participation 60% - 23L bucket and kitchen caddy Weekly food waste collection. - Collected on Romaquip

	Assumptions of specific alternative scenarios (KAT)						
Collection	Option 1	Option 2	Option 3	Option 4	Option 5	Option 2 (Optimised)	Option 4 (Optimised)
	Twin-stream collection with weekly food waste	*Twin-stream collection with weekly food waste and restricted residual capacity*	*Multi-stream recycling with weekly waste*	*Multi-stream recycling with weekly waste and restricted residual capacity*	*As Option 1 with co-collection of paper and food*	*Twin-stream collection with weekly food waste and restricted residual capacity*	*Multi-stream recycling with weekly waste and restricted residual capacity*
	20% contribution from driver	20% contribution from driver				20% contribution from driver	
Residual	As per current service Decrease in yield – adjusted based on above impacts.	140L Wheeled bin Decrease in yield – adjusted based on above impacts.	As per current service Decrease in yield – adjusted based on above impacts.	140L Wheeled bin Decrease in yield – adjusted based on above impacts and restriction.	As per current service Decrease in yield – adjusted based on above impacts.	140L Wheeled bin Decrease in yield – adjusted based on above impacts.	140L Wheeled bin Decrease in yield – adjusted based on above impacts and restriction.

KAT Model Raw Outputs									
		Baseline	Option 1	**Option 2**	Option 3	**Option 4**	Option 5	Option 2 (Opt)	Option 4 (Opt)
Type of collection	Dry recycling	Kerbside co-mingled or single stream	Co-collected 2 dry recyclable streams	Co-collected 2 dry recyclable streams	Kerbside sorted (more than 2 streams)	Kerbside sorted (more than 2 streams)	Co-collected dry recyclables and compost	Co-collected 2 dry recyclable streams	Kerbside sorted (more than 2 streams)
	Dry recycling						Kerbside co-mingled or single stream		

	Food waste	select from list	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream		Kerbside co-mingled or single stream	Kerbside co-mingled or single stream
	Garden waste	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream	Kerbside co-mingled or single stream
	Refuse	Refuse collection	Refuse collection	Refuse collection	Refuse collection	Refuse collection	Refuse collection	Refuse collection	Refuse collection
Collection frequency	Dry recycling	every fortnight	every fortnight	every fortnight	once a week	once a week	once a week	every fortnight	once a week
	Dry recycling						every fortnight		
	Food waste	select from list	once a week	once a week	once a week	once a week		once a week	once a week
	Garden waste	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight
	Refuse	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight	every fortnight
Collection Vehicle	Dry recycling	RCV, 24m3	REL 65%/35%, 21 m3 total	REL 65%/35%, 21 m3 total	stillage, 37m³	stillage, 37m³	REL + front pod 75%/25% 22m3 total	REL 65%/35%, 21 m3 total	stillage, 37m³
	Dry recycling						RCV, 22m3		
	Food waste	select from list	Dedicated food 7.5T GVW	Dedicated food 7.5T GVW	select from list	select from list		Dedicated food 7.5T GVW	select from list
	Garden waste	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3
	Refuse	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3	RCV, 24m3
Collection	Dry recycling	3	3	3	4	4	3	3	4

crew size including driver	Dry recycling						3		
	Food waste		2	2				2	
	Garden waste	3	3	3	3	3	3	3	3
	Refuse	3	3	3	3	3	3	3	3
Number of households served	Dry recycling	126448	126448	126448	126448	126448	126448	126448	126448
	Dry recycling						126448		
	Food waste	0	126,448	126,448	0	0		126,448	0
	Garden waste	102,937	102,937	102,937	102,937	102,937	102,937	102,937	102,937
	Refuse	126448	126448	126448	126448	126448	126448	126448	126448
Percentage set out	Dry recycling	70%	70%	75%	65%	70%	30%	75%	70%
	Dry recycling						70%		
	Food waste	select from list	30%	40%	select from list	select from list		40%	select from list
	Garden waste	70%	70%	70%	70%	70%	70%	70%	70%
	Refuse	95%	95%	95%	95%	95%	95%	95%	95%
Percentage set out (2nd stream)	Dry recycling	select from list	70%	75%	75%	75%	45%	75%	75%
	Dry recycling						select from list		
	Food waste	select from list	select from list	select from list	select from list	select from list		select from list	select from list
	Garden waste	select from list	select from list	select from list	select from list	select from list	select from list	select from list	select from list

Average participation	Dry recycling	80%	75%	82%	72%	82%	55%	85%	85%
	Dry recycling								
	Food waste	100%	55%	60%	100%	100%		63%	100%
	Garden waste	80%	80%	80%	80%	80%	80%	80%	80%
Average capture	Dry recycling	64%	64%	64%	64%	64%	64%	64%	64%
	Dry recycling						51%		
	Food waste	100%	52%	67%	100%	100%		82%	100%
	Garden waste	95%	95%	95%	95%	95%	95%	95%	95%
Tonnes collected excluding contamination	Dry recycling	13535	13935	19626	19724	26125	13611	20661	29703
	Dry recycling						7335		
	Food waste	0	6459	9089	0	0		11719	0
	Garden waste	9997	9997	9997	9997	9997	9997	9997	9997
	Refuse	75935	71786	62817	73267	66610	72035	59451	63186
Tonnes of contamination collected	Dry recycling	4310	1277	1794	789	1045	286	1363	891
	Dry recycling						513		
	Food waste	0	323	454	0	0		586	0
	Garden waste	500	500	500	500	500	500	500	500

Tonnes of biodegradable material collected	Dry recycling	6876	6736	9534	12854	17343	13611	10038	20383
	Dry recycling						0		
	Food waste	0	6459	9089	0	0		11719	0
	Garden waste	9997	9997	9997	9997	9997	9997	9997	9997
Number of collection vehicles required	Dry recycling	8.5	11.7	13.7	21.9	26.9	12.5	13.9	28.8
	Dry recycling						8.5		
	Food waste	0.0	17.3	18.0	0.0	0.0		18.0	0.0
	Garden waste	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
	Refuse	12.0	11.5	10.2	11.7	10.7	11.5	10.2	10.1
Collection limited by weight or volume	Dry recycling	volume	volume	volume	volume	volume	weight	volume	volume
	Dry recycling						volume		
	Food waste	volume	weight	weight	volume	volume		weight	volume
	Garden waste	volume	volume	volume	volume	volume	volume	volume	volume
	Refuse	volume	weight	weight	volume	volume	volume	weight	volume
Number of loads collected per	Dry recycling	1.7	1.7	2.0	1.4	1.5	0.8	2.0	1.5
	Dry recycling						1.4		
	Food waste	1.0	0.5	0.7	0.1	0.1		0.9	0.1

vehicle per day	Garden waste	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
	Refuse	2.0	2.0	2.0	2.0	2.0	2.0	1.9	2.0
Number of households passed per vehicle per day	Dry recycling	1,483	1,085	922	1,153	940	2,031	908	878
	Dry recycling						1,483		
	Food waste	0	1,458	1,403	0	0		1,403	0
	Garden waste	1,371	1,371	1,371	1,371	1,371	1,371	1,371	1,371
	Refuse	1,054	1,099	1,234	1,077	1,185	1,095	1,234	1,249
Number of households collected from per vehicle per day	Dry recycling	1,038	759	691	749	658	914	681	615
	Dry recycling						1,038		
	Food waste	0	437	561	0	0		561	0
	Garden waste	959	959	959	959	959	960	959	959
	Refuse	1,001	1,044	1,172	1,023	1,125	1,041	1,172	1,186
Pass rate	Dry recycling	282	213	229	219	178	328	178	167
	Dry recycling						282		
	Food waste	0	223	215	0	0		215	0
	Garden waste	328	328	328	328	328	328	328	328
	Refuse	217	226	217	221	243	192	217	257
	Dry recycling	316	306	241	316	316	371	306	316

Productive time	Dry recycling						316		
	Food waste	382	392	392	250	392		392	392
	Garden waste	251	251	251	251	251	251	251	251
	Refuse	292	292	342	292	292	342	342	292
Non productive time	Dry recycling	130	140	205	130	130	75	140	130
	Dry recycling						130		
	Food waste	64	54	54	196	54		54	54
	Garden waste	195	195	195	195	195	195	195	195
	Refuse	154	154	104	154	154	104	104	154
Percentage of targeted materials collected	Dry recycling	36%	33%	47%	30%	40%	30%	49%	46%
	Dry recycling						39%		
	Food waste	0%	29%	40%	0%	0%		52%	0%
	Garden waste	76%	76%	76%	76%	76%	76%	76%	76%
Annual cost for containers	Dry recycling	£326,292	£412,493	£412,493	£328,649	£328,649	£457,961	£412,493	£328,649
	Dry recycling						£320,085		
	Food waste	£0	£137,876	£137,876	£0	£0		£137,876	£0
	Garden waste	£265,623	£265,623	£265,623	£265,623	£265,623	£265,623	£265,623	£265,623
	Refuse	£396,091	£396,091	£396,091	£396,091	£396,091	£396,091	£396,091	£396,091

Total capital cost of containers	Dry recycling	£2,326,643	£2,478,381	£2,478,381	£572,177	£572,177	£2,809,675	£2,478,381	£572,177
	Dry recycling						£2,282,386		
	Food waste	£0	£527,288	£527,288	£0	£0		£527,288	£0
	Garden waste	£1,894,041	£1,894,041	£1,894,041	£1,894,041	£1,894,041	£1,894,041	£1,894,041	£1,894,041
	Refuse	£2,326,643	£2,326,643	£2,326,643	£2,326,643	£2,326,643	£2,326,643	£2,326,643	£2,326,643
Annual capital cost of collection vehicles	Dry recycling	£252,431	£382,694	£446,476	£516,310	£633,653	£414,585	£446,476	£680,590
	Dry recycling								
	Food waste	£0	£250,223	£264,124	£0	£0		£264,124	£0
	Garden waste	£221,635	£221,635	£221,635	£221,635	£221,635	£221,635	£221,635	£221,635
	Refuse	£341,481	£341,481	£313,024	£341,481	£313,024	£341,481	£313,024	£313,024
Are vehicles used for more than one collection	Dry recycling	No	No	No	No	No	No	No	No
	Dry recycling						No		
	Food waste	select from list	No	No	No	No		No	No
	Garden waste	No	No	No	No	No	No	No	No
	Refuse	No	No	No	No	No	No	No	No
Total capital cost of vehicles	Dry recycling	£1,543,500	£2,340,000	£2,730,000	£3,157,000	£3,874,500	£2,535,000	£2,730,000	£4,161,500
	Dry recycling						£1,543,500		
	Food waste	£0	£1,530,000	£1,615,000	£0	£0		£1,615,000	£0

	Garden waste	£1,355,200	£1,355,200	£1,355,200	£1,355,200	£1,355,200	£1,355,200	£1,355,200	£1,355,200
	Refuse	£2,088,000	£2,088,000	£1,914,000	£2,088,000	£1,914,000	£2,088,000	£1,914,000	£1,914,000
Annual vehicle operating costs	Dry recycling	£1,054,530	£1,442,626	£1,756,557	£2,980,739	£3,655,835	£1,509,793	£1,679,363	£3,925,915
	Dry recycling						£1,054,812		
	Food waste	£0	£1,211,594	£1,278,574	£0	£0		£1,278,574	£0
	Garden waste	£965,064	£965,064	£965,064	£965,064	£965,064	£965,068	£965,064	£965,064
	Refuse	£1,402,480	£1,403,090	£1,252,040	£1,402,792	£1,287,218	£1,363,998	£1,252,040	£1,288,009
Annual overheads	Dry recycling	£105,453	£144,263	£175,656	£298,074	£365,584	£150,979	£167,936	£392,592
	Dry recycling						£105,481		
	Food waste	£0	£121,159	£127,857	£0	£0		£127,857	£0
	Garden waste	£96,506	£96,506	£96,506	£96,506	£96,506	£96,507	£96,506	£96,506
	Refuse	£140,248	£140,309	£125,204	£140,279	£128,722	£136,400	£125,204	£128,801
Annual gross collection cost	Dry recycling	£1,738,706	£2,382,075	£2,791,182	£4,123,771	£4,983,720	£2,533,318	£2,706,268	£5,327,746
	Dry recycling						£1,732,809		
	Food waste	£0	£1,720,852	£1,808,431	£0	£0		£1,808,431	£0
	Garden waste	£1,548,829	£1,548,829	£1,548,829	£1,548,829	£1,548,829	£1,548,833	£1,548,829	£1,548,829
	Refuse	£2,280,300	£2,280,971	£2,086,359	£2,280,643	£2,125,055	£2,237,969	£2,086,359	£2,125,925

Total gross collection cost	£5,567,835	£7,932,728	£8,234,801	£7,953,243	£8,657,604	£8,052,930	£8,149,887	£9,002,499

II. Appendix B – Treatment & Disposal Costs

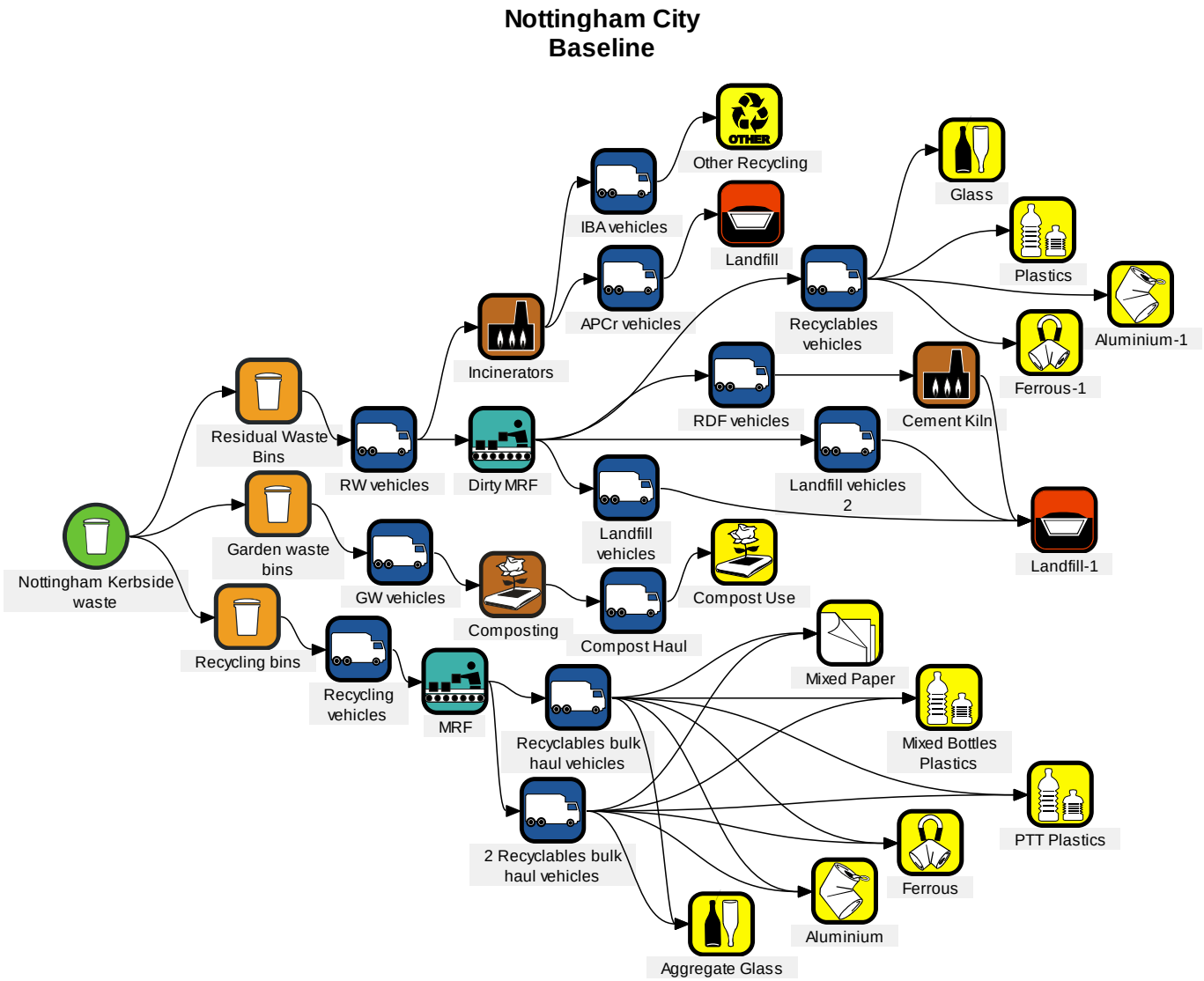
	Average material price 5yr average Lets Recycle (March 2017 - Feb 2022) -20%
Material	Price (£/tonne)
Cans: Aluminium: baled	-£719.54
Cans: Steel	-£99.86
Glass: Mixed	-£8.22
Paper: Mixed papers: domestic	-£34.93
Paper: News & Pams	-£71.75
KLS card	-£66.75
Non-corrugated card	-£66.75
Plastic bottles: Coloured PET	-£21.26
Plastic film	£101.74
Plastic bottles: Mixed bottles	-£66.17
Plastic: other dense	-£177.29

Treatment and/or Disposal Route[33]	Cost (£/tonne)
MRF Gate Fee	£80.74
Food waste treatment	£31.40
Garden waste treatment	£27.55
Residual waste treatment	£71.00
Transfer	£3.50
Haulage	£3.50

Note: negative values indicate revenue

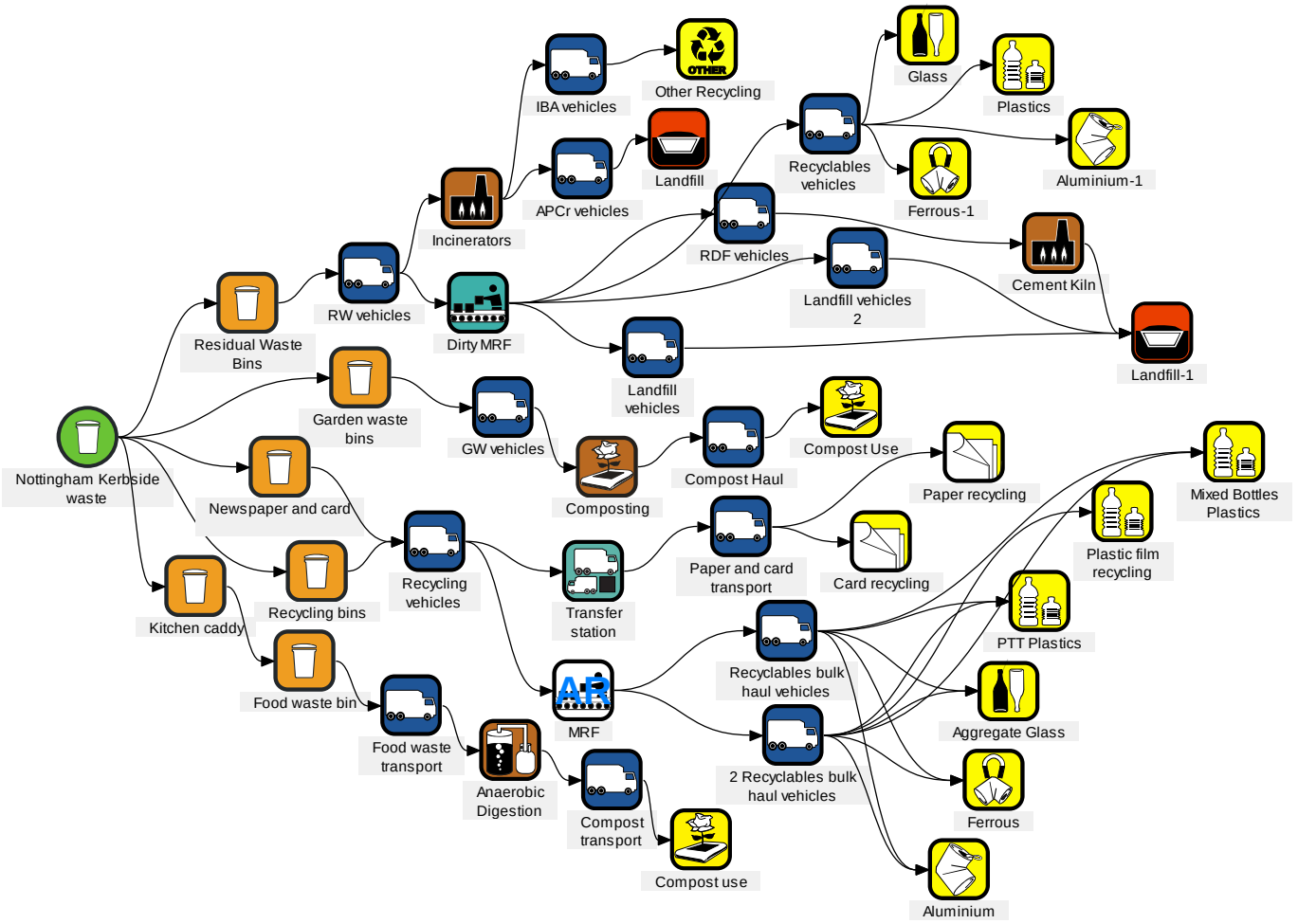
[33] WRAP Gate Fee Report 2015/16 - 2019/20 (5yr average), DMR, garden waste and residual treatment costs provided by NCC

III. Appendix C - WRATE Schematics



Date 20/06/2022
Software Version 4.0.1.0
Database Version 4.0.1.0

Nottingham City
Option 1



Date 20/06/2022
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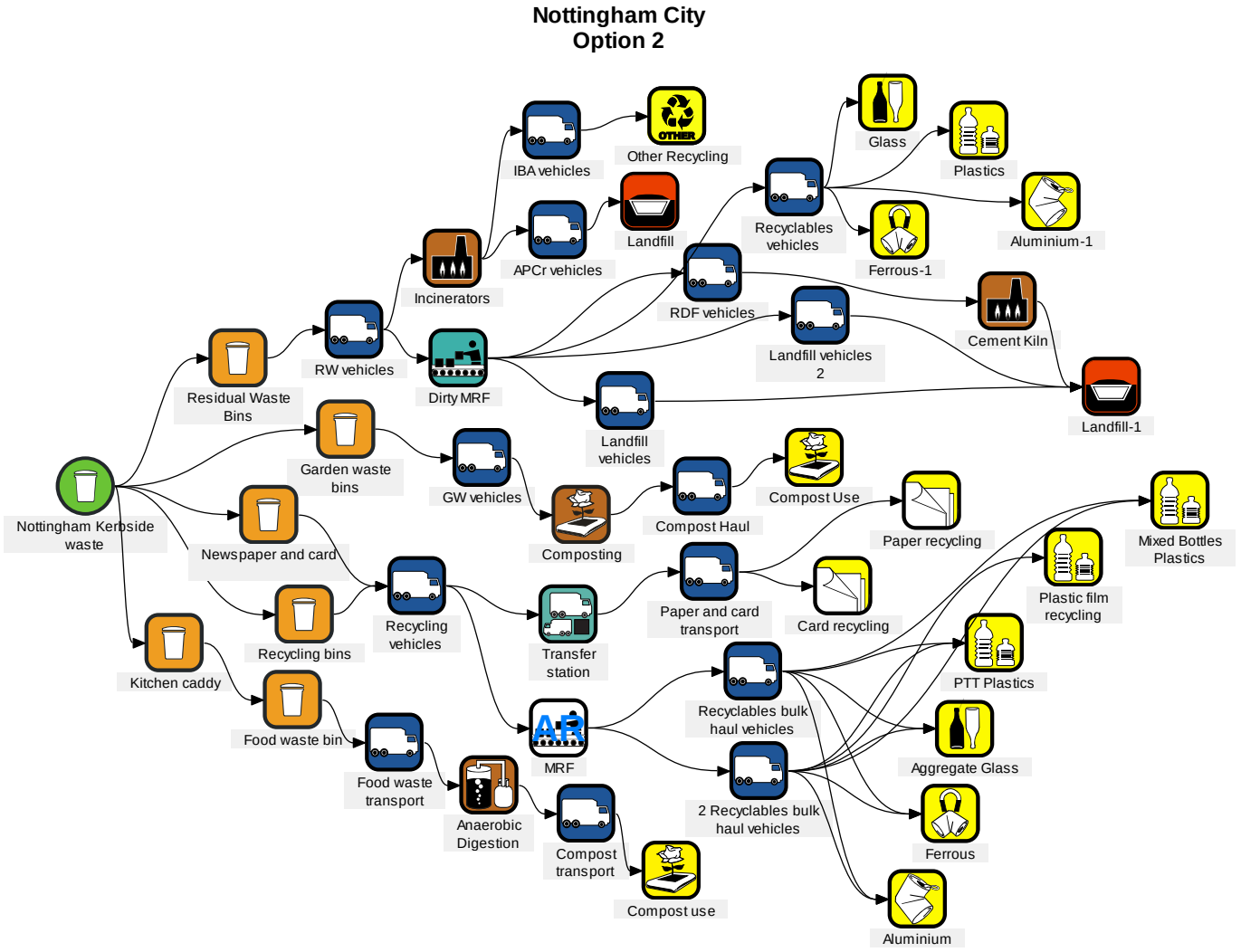

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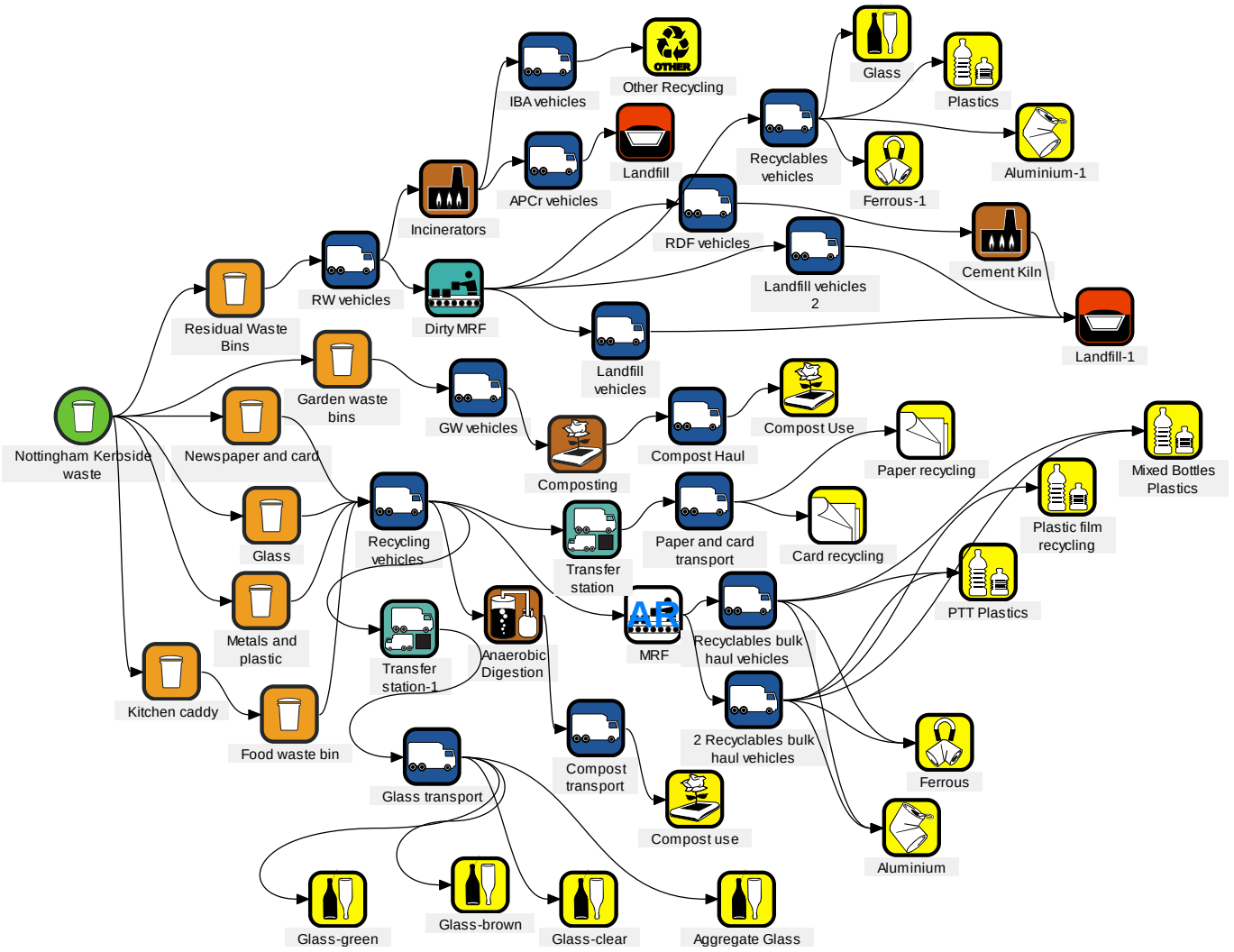
Nottingham City
Option 3



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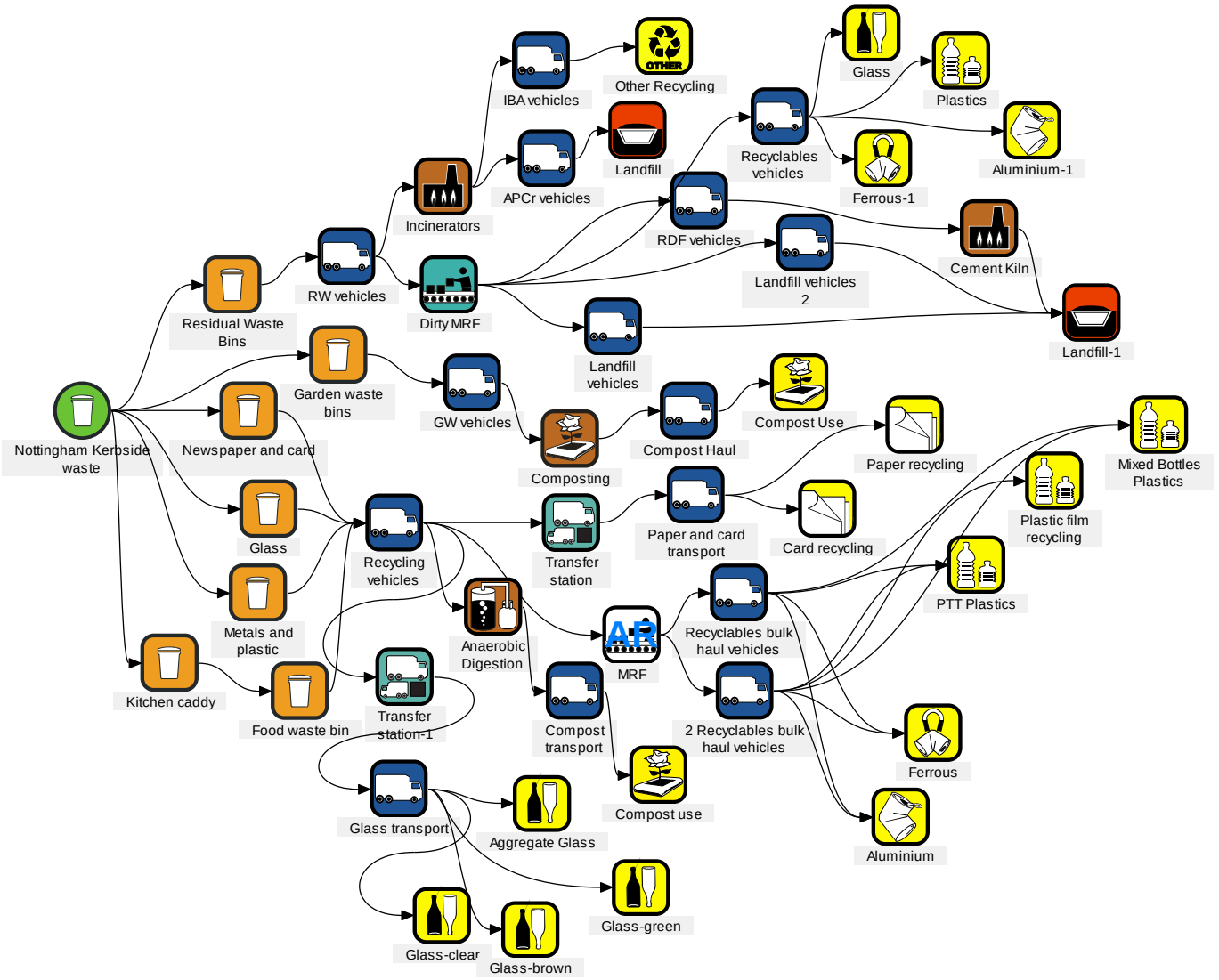
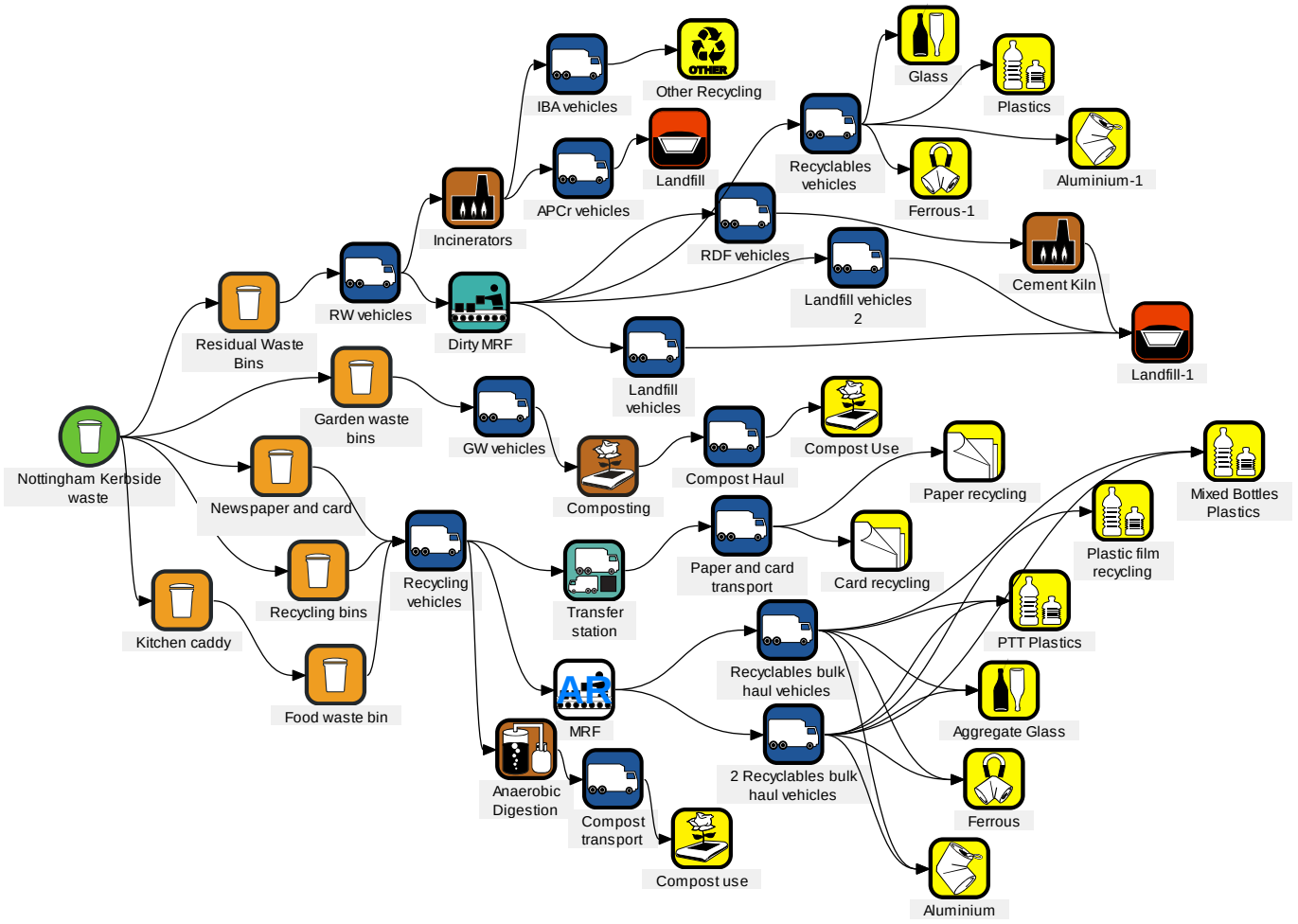
Nottingham City
Option 4



Date 20/06/2022
Software Version 4.0.1.0
Database Version 4.0.1.0

Nottingham City
Option 5



Date 20/06/2022
Software Version 4.0.1.0
Database Version 4.0.1.0

IV. Appendix D – WRATE Vehicle Mileages[34]

Option	Collection Stream	Annual Distance (KM)	Total Distance (KM)
Baseline *As current*	Residual	261,000	586,100
	Dry Recycling (co-mingled)	189,100	
	Food waste	N/A	
	Garden waste (free)	135,900	
Option 1 *Twin-stream collection with weekly food waste*	Residual waste	255,100	821,200
	Dry recycling (Twin-stream + film + cartons)	248,700	
	Food waste	181,400	
	Garden waste (free)	135,900	
Option 2 *Twin-stream collection with weekly food and restricted residual capacity*	Residual waste	162,900	774,300
	Dry recycling (Twin-stream + film + cartons)	287,000	
	Food waste	188,500	
	Garden waste (free)	135,900	
Option 3 *Multi-stream recycling with weekly food waste*	Residual waste	260,300	864,300
	Dry recycling (Multi-stream + film + cartons)	467,900	
	Food waste		
	Garden waste (free)	135,900	
Option 4 *Multi-stream dry recycling with weekly food waste and restricted residual capacity*	Residual waste	236,670	946,800
	Dry recycling (Multi-stream, + film + cartons)	574,224	
	Food waste		
	Garden waste (free)	135,900	
Option 5 *As Option 1 with co-collection of paper and food.*	Residual waste	183,500	696,000
	Dry recycling (Twin-stream, + film + cartons)	376600	
	Food waste		
	Garden waste (free)	135,900	

[34] Rounded to nearest 100km

Optimised Options	Collection Stream	Annual Distance (KM)	Total Distance (KM)
Option 2 *Twin-stream collection with weekly food and restricted residual capacity (**Optimised**)*	Residual waste	162,883	778,700
	Dry recycling (Twin-stream + film + cartons)	294,425	
	Food waste	188,475	
	Garden waste (free)	135,940	
Option 4 *Multi-stream dry recycling with weekly food waste and restricted residual capacity (**Optimised**)*	Residual waste	224,513	974,700
	Dry recycling (Multi-stream + film + cartons)	614,250	
	Food waste		
	Garden waste (free)	135,940	

V. Appendix E – Additional WRATE Results

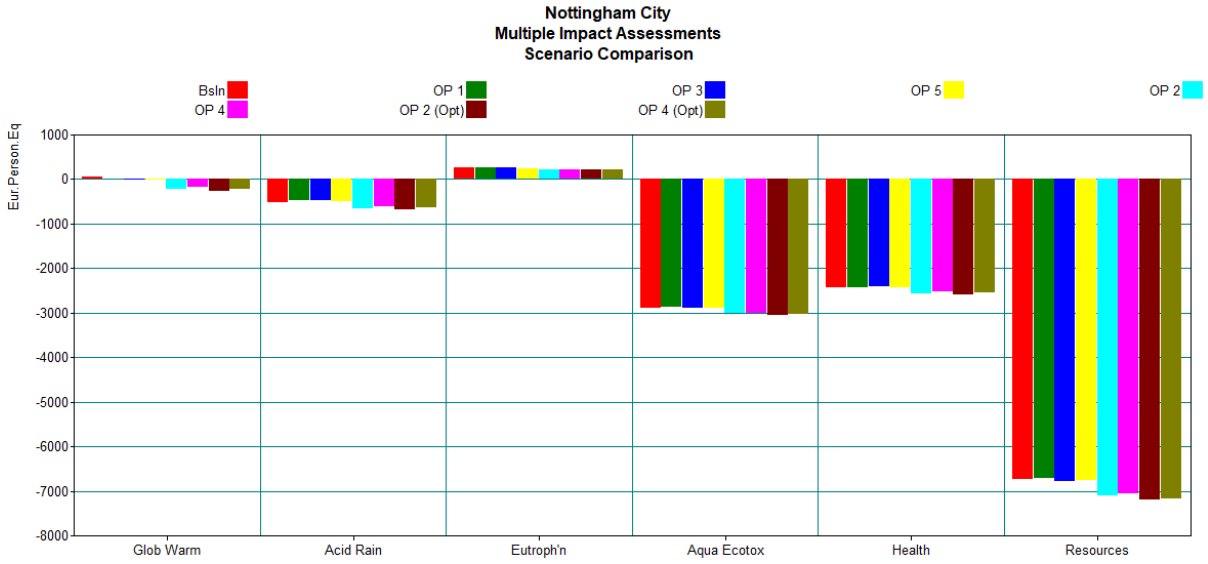
The overall environmental impacts encompassing other lifecycle analysis indicators for each of the modelled scenarios are presented below. In order to compare across different environmental fields a 'normalisation' measure is applied, in the latter using the measure of 'numbers of equivalent European persons' impact against each measure. Option 4 turns out to be all around the most environmentally friendly.

- Global Warming Potential (GWP100a)- This metric is an assessment of the amount of carbon dioxide and other gases emitted that cause global warming. Apart from CO_2, other major greenhouse gases including methane (CH_4) and Nitrous Oxide (N_2O) are also considered. Methane for example is considered 285 times more potent than CO_2 in terms of its effect on global warming over a 100-year period. Climate change impact in WRATE is expressed in kg CO_2-equivalent (eq).
- Acidification (kg SO_2-Eq)- This metric relates to the release of acidic gases such as sulphur dioxide that have the potential to react with water in the atmosphere to form 'acid rain' and causing damage to the environment.
- Eutrophication (kg PO_4-Eq)- This metric relates to the release of nitrate and phosphate. Increased concentrations in water and soils can result in increased algal growth reducing the oxygen in the water and damage to plant stability in soils, both damaging the environment.
- Freshwater Aquatic Ecotoxicity – FAETP infinite (kg1,4-DCB-Eq) - This metric relates to the impact of toxic substances on aquatic organisms and the bioaccumulation of toxins such as mobile heavy metals.
- Human Toxicity – HTP infinite (kg 1,4-DCB-Eq) - This metric relates to the impacts on human health. Characterisation factors, expressed as Human Toxicity Potentials (HTP) describe fate, exposure and the effects of toxic substances.
- Depletion of Resources (kg antimony-Eq) - This metric relates to the extraction of raw materials and resources. An abiotic depletion factor is determined for each mineral or fossil fuel based on the rate of extraction and the global resource reserves.

Miscellaneous environmental impacts for each modelled option

Impact Assessment	Unit	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
Climate change: GWP 100a	kg CO2-Eq	642,300	-13,700	-2,834,300	-31,400	-2,156,600	-287,600
Acidification potential: average European	kg SO2-Eq	-36,800	-33,300	-46,500	-33,400	-43,700	-35,600
Eutrophication potential: generic	kg PO4-Eq	8,800	8,800	7,200	8,800	7,600	8,400

Freshwater aquatic ecotoxicity: FAETP infinite	kg 1,4-DCB-Eq	-3,806,500	-3,790,900	-3,973,300	-3,804,800	-3,965,100	-3,802,900
Human toxicity: HTP infinite	kg 1,4-DCB-Eq	-47,897,200	-47,851,900	-50,637,700	-47,652,200	-49,686,300	-48,055,000
Resources: depletion of abiotic resources	kg antimony-Eq	-260,400	-259,100	-274,600	-261,800	-272,500	-261,000



Normalised miscellaneous environmental impacts for each option

VI. Appendix F – Evaluation criteria & Social Value Workings

Scoring mechanism	Unit	1	5
Carbon	*kg CO2/eq*	Highest carbon emissions eq.	Lowest carbon emissions eq.
Recycling performance	*Kerbside recycling rate*	Lowest kerbside recycling performance	Highest kerbside recycling performance
Cost	*£*	Highest total costs (collection & disposal)	Lowest total costs (collection & disposal)
Alignment with National Policy	*R&WS compliance*	All aspects not likely to align to R&WS	Most aligns to R&WS
Public Acceptability		Poorest public acceptability	Strongest public acceptability
Social Value		Little or no anticipated social value	Strongest social value benefits
Operational Flexibility		Little or no operational flexibility	Strongest operational flexibility
Deliverability		Greatest deliverability issues	Little or no deliverability issues

Impact Assessment	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
No. Jobs (collection)	85	127	131	146	163	121
MRF	*5*	*5*	*5*	*5*	*5*	*5*
Total Jobs	90	132	136	151	168	126
Total KM (Air Quality)	586,100	821,200	774,300	864,200	946,800	696,000
Range of Materials	Separate food waste collections. Plastic film & cartons collected with dry recycling (all alternative options)					

Impact Assessment	Baseline	Option 1	Option 2	Option 3	Option 4	Option 5
No. of Crew	85	127	131	146	163	121
Recycling	26	35	42	88	108	63
Garden	23	23	23	23	23	23
Food	N/A	35	37	N/A	N/A	N/A
Residual	36	35	31	36	33	35
No. of Vehicles	29	49	50	42	46	41