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Final report

Newcastle-under-Lyme Recycling and Waste Service Review

Cost, performance and service delivery options for the collection of household recycling and waste for NuLBC Borough Council

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Executive summary

1 Introduction

Newcastle-under-Lyme Borough Council (Newcastle or NuLBC) has already carried out a significant amount of work in order to understand how it might improve its recycling and waste collection service to achieve a 60% recycling target and deliver a better recycling service to residents whilst reducing costs. This has resulted in the decision to harmonise collection services, bringing all services back in-house. A number of service configurations have already been explored and assessed against a number of risks including materials markets, legislation, participation and treatment costs. The Council has subsequently arrived at the following preferred service configuration:

- Weekly dry recycling collections – 3 x 55l box
- Weekly food waste collections – kerbside caddie (collected with dry recycling)
- Fortnightly garden waste collections – 240l wheeled bin
- Fortnightly residual waste collections – 180l wheeled bin

The only major change from the current service configuration is the change in frequency of the dry recycling service from fortnightly to weekly collections and the number and type of containers provided for dry recycling. This report summarises the findings of modelling undertaken to understand the resource requirements for the increased-frequency dry recycling service under the Council's preferred service configuration. It is intended that this will support the Council in bringing the dry recycling collection service back in-house as part of the harmonisation of its collection services.

2 Modelling results

Core modelling was based on the following assumptions:

- Five day working week
- 6.5 hours of the working day utilised for collection
- 50% of vehicles with driver plus two loaders, 50% of vehicles with driver plus one loader
- A 10% driver contribution to loading for vehicles with two loaders, 25% driver contribution to loading for vehicles with one loader
- An 8% increase from 2013/14 dry recycling yield to 167kg/hh/yr

Based on these assumptions a total of 14 vehicles would be required to deliver the dry recycling collection service under the Council's preferred service configuration.

In order to understand the factors to which resource requirements are most sensitive, a number of variables were tested. The results of this analysis are summarised below.

- **Working day & crew configuration –**
    - Because of the time it takes to tip and return to the round, the contribution of additional loaders, utilised for collection for 6.5 hour of the working day, only reduces the number of vehicles required once *there are two loaders on all vehicles*. In this case only 12 vehicles would be required.
    - However, when the time utilised for collection is increased to 7 hours, resource requirements can generally be reduced through using additional loaders, *the exception being* the scenario where only 25% of vehicles have a driver plus two loaders, resulting in 14 vehicles still being required for the service.
    - It should be noted that the working week is 37 hrs for operational staff and an average collection time of seven hours per day would mean only 20 minutes/day for:
        - pre and post departure activities;
        - "Rest and Relaxation" (R&R) time; or
        - any task and finish incentive to maintain productivity.

      It should therefore not be assumed that this level of productivity is reasonably achievable.

- **Vehicle loading time –**

- Increasing the time taken to load a vehicle, per container set out, in order to account for a four bin system, has the greatest impact on vehicle numbers *where 100% of the vehicles have two loaders.*
    - The overall fleet for the scenario where 100% of vehicle have two loaders would still remain smaller than other fleet configurations.

- **Tipping time –**
    - The time taken to tip has the most influence on resource requirements when vehicles have to tip twice – this is mainly the case in the scenario where 100% of vehicles driver plus two loaders. Staggering the start times would mitigate this impact through avoiding vehicles returning to tip at the same time and thus reducing the time taken to tip off.
    - If vehicles are only tipping once, then staggered starts may have most benefit for the depot operators, who otherwise would be faced with emptying the majority of the fleet at the same time at the end of the day.
    - From a collection perspective, if the majority of vehicles are only tipping once, longer queueing times for unloading will not affect actual collection efficiency significantly.

- **Material yields –**
    - Where material yield increases are moderate (6% increase) vehicle requirements generally increase by one vehicle, regardless of the number of vehicles, when they have a driver plus two loaders configuration.
    - With a greater increase in material yields (11% increase) one additional vehicle is required, when *more* than 50% of vehicles have two loaders, and two additional vehicles are required when *less* than 50% of vehicles have two loaders.
    - Overall this suggests that a service in which more vehicles have a driver plus two loaders is more resilient to increases in material yields than where there are fewer loaders.

- **Housing growth –**
    - Two additional vehicles will be required to accommodate the anticipated growth in housing unless the proportion of vehicles with two loaders is greater than 50%, in which case only one additional vehicle is needed.

- **Food waste** –
    - Should participation in food waste increase by 10% this would have a limited impact on resource requirements and would not affect the amount of resource required to deliver the service.

3 Recommendations

Initial results suggest the optimal fleet configurations to be either:

- 14 vehicles with a driver plus two on 50% of the vehicles; or
- 12 vehicles but with a driver plus two on all vehicles.

A smaller fleet with more loaders may be able to service the authority; however, small reductions in available collection time (e.g. longer loading and tipping times or longer travel times) may quickly require additional vehicles or leave no spare capacity for breakdowns, delays and population growth. Likewise, a fleet of 14 vehicles with only 50% of vehicles with two loaders is operating optimally and provides no spare capacity for growth or spare vehicles.

On this basis, the recommended service configuration is:

- 13 operational vehicles
- 1 spare vehicle
- A minimum of 23 loaders

This configuration would allow additional capacity to be met by increasing the proportion of vehicles with two loaders and, in the longer term, utilising the spare vehicle on standard rounds. This also allows for increases in yield and set-out due to improved performance, increases in the number of households served and any potential increases in travel time or tipping time.

Contents

1 Introduction 6
1.1 Background 6
1.2 Overview of the report structure 7
2 Benchmarking 7
3 Collections options modelling 8
3.1 Methodology 8
3.2 Options modelling 9
3.3 Sensitivities 10
2 Operational considerations 18
3.4 Working patterns 18
3.5 Routing Considerations 18
4 Conclusions and recommendations 19
Appendix 1: Modelling results 20
Appendix 2: Assumptions 24

1 Introduction

1.1 Background

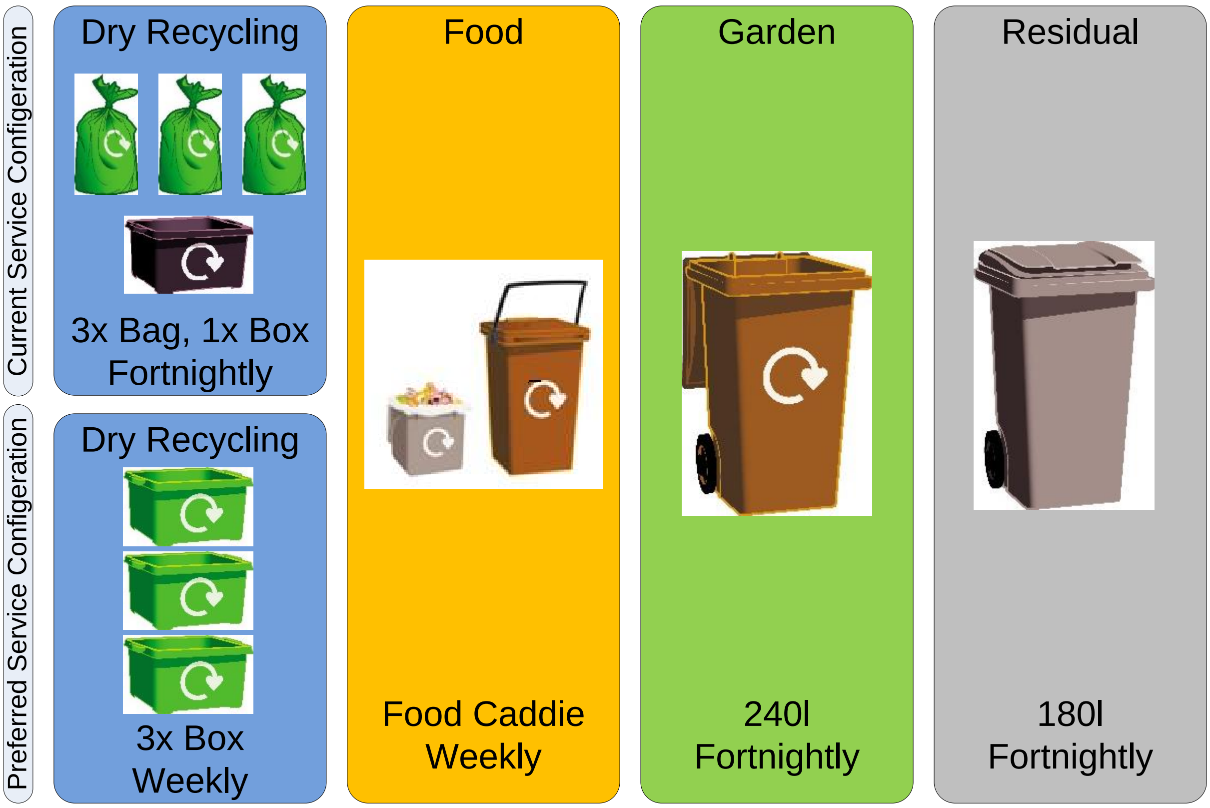
Eunomia Research & Consulting was commissioned by WRAP to provide support to Newcastle-under-Lyme Borough Council (Newcastle or NuLBC) to enable it to make informed decisions regarding the operational requirements of its planned future domestic recycling and waste collection service.

NuLBC is a district authority within the administrative area of Staffordshire County Council encompassing the towns of Newcastle-under-Lyme, Loggerheads, Madeley and Kidsgrove. It has a population of 123,900 (ONS 2011) living in 54,360 households (WDF, April 2013).

The Council delivers its collection services through a mixture of in-house and outsourced operations. Residual and garden waste is collected by the in-house service provider whilst the council's food waste service is delivered via an out sourced service structure. Acumen Distribution collect glass, cans, paper, plastic and card is collected via a kerbside sort solution. A separate food waste collection service is shared between the Council and the contractor, collecting on alternate weeks: Acumen Distribution collects food waste on the same pass as recycling one week with a separate pass by the Council's dedicated food waste vehicle the following week.

The Council is now looking to harmonise its collection services, bringing all services back in-house. As part of the harmonisation process, the Council has already undertaken a range of work to help it understand how to improve its kerbside collection system, in order to reach at least 60% recycling by 2020, whilst providing a simpler service to residents. This has included assessing a number of different service configuration options against a variety of legislative and operational risks so to arrive at the preferred service configuration as outlined in Figure 1.

Figure 1: Current and preferred service configuration



This report is intended to assist NuLBC Officers and Members in understanding the resource requirements of its preferred service configuration and to gain a greater understanding of the factors that most influence resource requirements and, therefore, costs. It is not the intention for this work to produce a business case for the preferred service configuration or present detailed operational costs. Any cost information presented is intended to give an indication of the *comparative variance* between options and sensitivities modelled rather than present the actual operational costs.

1.2 Overview of the report structure

The report is structured as follows:

- **Benchmarking:** this section compares the performance of NuLBC with other relevant authorities.
- **Collections modelling:** this section details the methodology and outputs of the collection modelling.
- **Sensitivity analysis:** this section looks at a number of variables to which the resource requirements may be sensitive.
- **Operational considerations:** this section details some operational issues which the Council may wish to consider in implementing the preferred service configuration.
- **Conclusion and recommendations:** this section brings together the key results and recommendations from the modelling.
- **Appendices:** as far as possible the technical detail and statistical analysis has been placed in the appendices.

2 Benchmarking

A benchmarking exercise was undertaken to help us understand how NuLBC's kerbside recycling performance compares to the recycling performance of other similar authorities. As well as helping to understand how the authority is doing, the data collected through this benchmarking, and the data comparisons, have been used to help to predict the capture of materials (quantity) that might be achieved in future for the purpose of service performance modelling, as described below.

Whilst benchmarking can be useful if used carefully, it is by no means a perfect science. Some caution should always be taken when comparing recycling performance across different authorities. A number of interrelated factors will contribute to an individual authority's performance, with these being difficult to unpick from one another. The benchmarking exercise enables us to tease out some of the broad themes in terms of system performance, which, alongside WRAP benchmarking data, analysis of national statistics and our experience elsewhere of these systems, helps us to predict reasonable capture rates and yields to be used in the modelling of NuLBC's future service configuration.

The social demography of an area is the main driver of both the total quantity and composition of the waste, as well as levels of participation in recycling activities. These social factors are then moderated by collection systems and polices. In general, the greater the relative capacity provision and frequency of the recycling service compared to the residual waste service the higher the capture rates. However, communications and enforcement are also important factors that influence recycling performance. It should also be noted that the services to which NuLBC is compared may have been rolled out a number of years ago and do not necessarily represent current good practice.

2.1.1 Nearest neighbour analysis

In order to allow us to undertake a meaningful analysis, comparator authorities were selected using two different methods:

- The Chartered Institute of Public Finance Accountants (CIPFA) Nearest Neighbours (NN) Model[1]; and
- ONS calcifications as used in the WRAP benchmarking tool.

The CIPFA nearest neighbour model attempts to adopt a scientific approach to measuring the similarity between authorities, taking into account a range of variables that have an impact on demographic profile and the likely demand on different services. It is generally accepted as a robust method of determining comparable authorities.

The model allows the selection of only those variables that are likely to be relevant to the compositions and capture of recyclables. The variables selected include those that are most likely to take social demography into account and are related to deprivation, age profile, rurality, household size and ethnic profile.

[1] *http://www.cipfastats.net/resources/nearestneighbours/profile.asp?view=select&dataset=england*

In carrying out such nearest neighbour analysis there is always a trade-off between comparing only very similar authorities and having enough data to be of any use. Our general approach is primarily to reduce the comparative data set from all English Authorities through the exclusion of authorities for which comparison is meaningless, rather than producing a group of perfect comparators. As such, it is important to reiterate that the benchmarking results should only be used as a general guide.

A total of 69 local authorities were identified for analysis: 65 most similar English authorities from the CIPFA Nearest Neighbour Model and 4 ONS Nearest Neighbour categorisation. In order to draw relative comparators from this group only those authorities with reduced residual collections (i.e. reduced containment and/or frequency) and multi-stream recycling collections were selected. Data was extracted from the most recent audited Waste Data Flow returns (2012/13) for each authority.

2.1.2 Benchmarking results

Table 1 shows the dry recycling tonnage captured for the two relevant recycling systems by benchmarked authorities. Newcastle's dry recycling yields are similar, if a little low, when compared to benchmarked authorities with similar collection systems. Unsurprisingly, authorities with weekly dry recycling collections perform better than those authorities with fortnightly collections with a 7-8% higher capture rate on average. It should be noted that North West Leicestershire's higher performance is likely a result of the collection of hard plastics (pots, tubs etc) and Wrexham's lower performance a result of the collection of cardboard with green waste.

Table 1: Comparison of average dry recycling tonnage between different recycling systems for benchmarked authorities

Recycling System	Authority	Nearest Neighbour Rank	Yield (kg/hh/yr)	Average
Fortnightly Multi-Stream	Newcastle-under-Lyme	-	155	161
	Carlisle City Council	6	156	
	North West Leicestershire District Council	15	172	
Weekly Multi-Stream	Cheshire West and Chester	19	193	175
	Sedgemoor District Council	62	182	
	Wrexham District Council	N/A	149	

These results are similar to what could be expected as a result of increases in participation and recognition due to the changes in scheme type and frequency shown by WRAPs National Benchmarking Project[2]. We would therefore expect that a similar uplift in performance could be achieved by Newcastle switching from fortnightly to weekly dry recycling collections.

3 Collections options modelling

3.1 Methodology

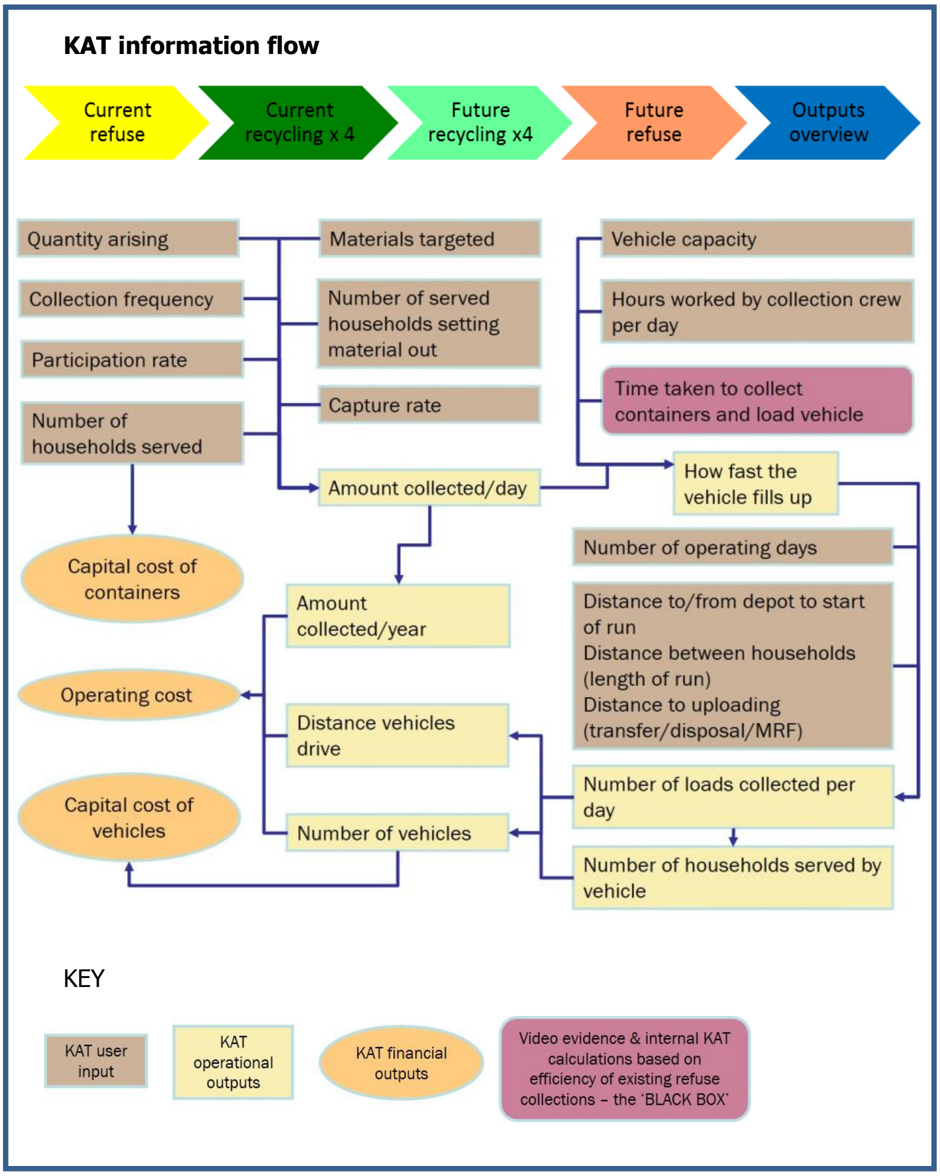
The resource requirements have been modelled using the Kerbside Analysis Tool (KAT), which is a Microsoft Excel based spreadsheet, allowing modelling of a range of refuse, dry and organic kerbside collection scenarios to enable the comparison of options. KAT was developed by Julia Hummel of Eco-Alternatives in 2001 and has been adopted by WRAP as its in-house model of choice for collections options appraisals. KAT has many default values based on extensive observations of kerbside collections and research into vehicles and containers. Default values can be replaced with local data to produce a model of collections reflecting local operating circumstances. KAT's main inputs, outputs and their inter-relationships are shown in Figure 2. KAT models the existing refuse and recycling services and enables up to four new separate recycling services plus waste collection services to be modelled. KAT optimises the number of vehicles and loads based on existing operational efficiencies which it replicates for future services.

[2] *WRAP (2008), Kerbside Recycling: Indicative Costs and Performance. Technical Annex, http://www.wrap.org.uk/sites/files/wrap/KerbsideReportAnnexFinal_1.pdf*

It provides outputs for the key service parameters: tonnes collected, logistical requirements (vehicles, drivers, loaders, containers) and selected capital and revenue costs. Costs are annualised to allow a one-year cost comparison between the various options. Cost and performance outputs can be given for individual service elements or for the whole service. Specifically, results include data on costs (revenue, capital), service configuration (vehicle, crew size, round size, containers, collection frequency, number of tips), performance (pass rate, participation, capture, tonnes diverted) and cost effectiveness (cost per household and cost per tonne).

KAT will provide average results for a whole authority and was not developed for round routing; this should be undertaken by appropriately trained staff, working in collaboration with operational staff to draw in detailed local knowledge.

Figure 2: KAT overview



3.2.1 Yield Assumptions

Most input assumptions used for the modelling have either been calculated from information provided by Newcastle or from Eunomia's own data sources and are detailed in Appendix 2. However, the yield assumptions are derived through a specific and carefully considered four-stage process, consisting of:

1. Benchmarking against similar authorities to understand relative performance;
2. Quantifying the impact of individual changes, such as the impact of moving to weekly recycling.
3. Understanding local circumstances.
4. Sense checking results against Eunomia's internal data and with WRAP's in-house team.

The yield assumptions in part drive the fill rates and collection times and thus drive the resource requirements of the service. The yields presented in Table 2 represent the central assumptions used in the preferred option modelling (a sensitivity analysis on these assumptions is carried out in section 3.3.4).

Table 2: Preferred option yield assumptions based on an 8% increase in yield from 2013/14 figures

Overall dry yield (kg/hh/yr)	Amount captured (kg/yr)	Yield (kg/hhd)
Newspapers and magazines	3,027	58.8
Corrugated card	568	11.0
Non-corrugated card	896	17.4
Plastic bottles	795	15.4
Glass flint	1,285	24.9
Glass brown	275	5.3
Glass green	1,050	20.4
Steel cans	509	9.9
Aluminium cans	157	3.0
Textiles	78	1.5
Overall Dry Recycling Yield	8,640	167.6
Overall food yield (kg/hh/yr)	**Amount captured (kg/yr)**	**Yield (kg/hhd)**
Food waste	2,812	54.6

3.2.2 Modelling Results

Table 3 shows the resource requirements for Newcastle's preferred service configuration. KAT calculates that 14 recycling vehicles would be required for Newcastle's preferred service configuration. This is based on 50% of the vehicles operating a driver plus one loader and 50% with a driver and two loaders and 6.5 hours of the working day utilised for collection[3]. In addition it is assumed that on vehicles with a driver plus one loader, drivers will contribute 25% of their time to loading and with a driver plus two loaders drivers will contribute 10% of their time to loading.

Note that, based on experience from other authorities, it is often the cardboard stillage that fills up first and determines the need to tip. The useable volume of the cardboard stillage of the vehicles used in the modelling is 4.2m^3 and can hold approximately 400kg of cardboard; the effect is that about 70% of the total volume of the vehicle is utilised before a tip is required. These figures represent the average for the whole fleet; individual rounds will differ, e.g. different number of properties served, longer or shorter working day, level of driver contribution to loading and/or different proportions of materials presented.

Table 3: Preferred service configuration resource requirements

Option	No. of vehicles	No. of tips per vehicle	Average crew size	No. of drivers	No. of loaders	Ave. round size
Preferred Service Configuration	14	1.0	2.5	14	21	740

The KAT model is also used to review the infrastructure required for the remaining residual waste. KAT suggests that, due to the switch to a five day week plus the lower amount of remaining residual waste that will be left over once recycling captures increase, the residual waste service fleet can be reduced by one vehicle from five to four.

3.3 Sensitivities

The analysis of the data shows the extent to which collections are sensitive to material volumes and the speed with which the compartments within the vehicle fill up. The aim is to only tip once per day to avoid a second tip

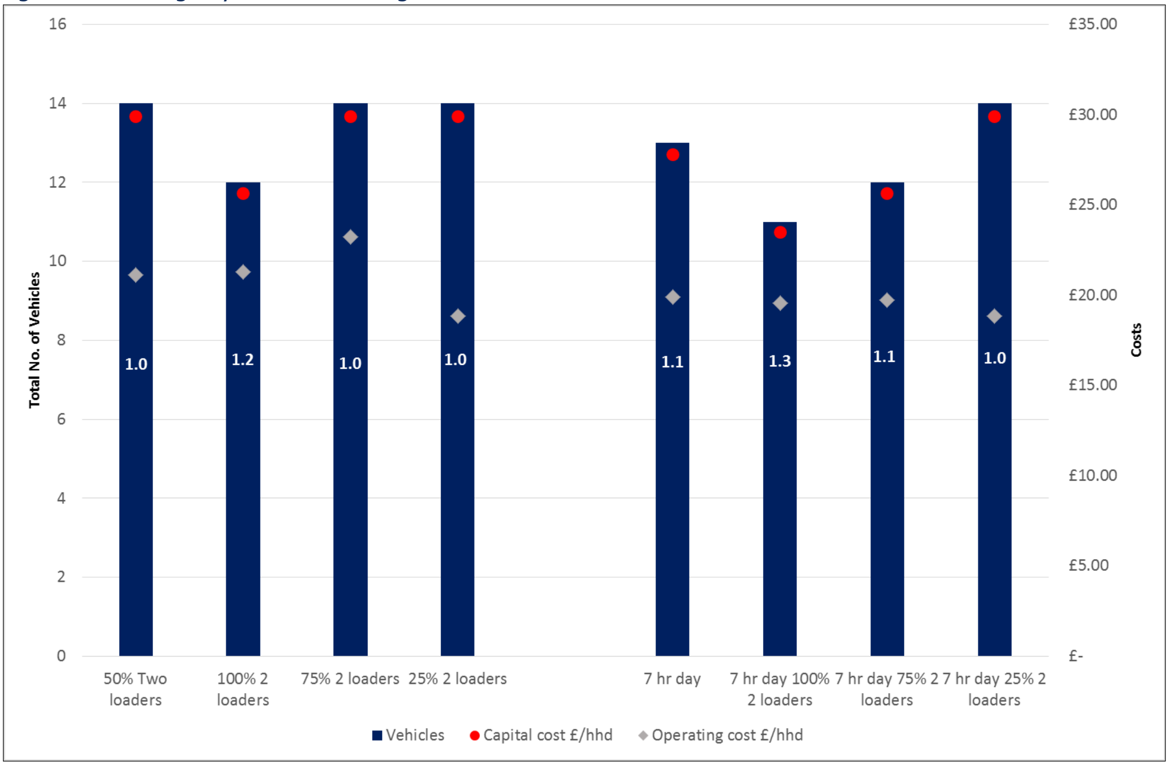
[3] *This is the time between leaving the depot in the morning and arriving at the depot after the last tip. It does not include activities such as pre-departure vehicle checks, toolbox meetings or refuelling.*

of only a small amount of material or two tips of only a partially filled vehicle. This section explores the sensitivity of the preferred service configuration to changes in operational parameters and household performance.

3.3.1 Working day and crew configuration

The impact of increasing the time utilised for collection, within standard contracted hours, by 30 minutes to 7 hours and also increasing the proportion of vehicles with two loaders was considered. The results are shown in Figure 3.

Figure 3. Working day and crew configuration



*Figures in column = number of tips/vehicle/day

The resource requirements of the service are sensitive to the time available for loading the vehicle i.e. the greater the time, the lower the number of vehicles required. An increase in available loading time can be achieved either through increasing the proportion of vehicles that have two loaders or increasing the amount of time utilised for collection within the working day. However, where 6.5 hours of the working day are utilised for collection, resource requirements are only reduced where there are two loaders on all vehicles. This is due to the time it takes to tip and return to the round.

If the amount of time in the working day utilised for collection is increased to 7 hours then the number of vehicles can generally be reduced, except in the scenario where only 25% of vehicles have two loaders. The lower vehicle requirement where all vehicles have two loaders, is off-set by the higher operational costs. This compares with for example, a service with 25% of vehicles with driver plus two loaders that has higher capital costs but lower operating costs.

Whilst this usefully demonstrates the degree of sensitivity to changes in time available for collection and tipping, it is not our view that this level of productivity gain is reasonably achievable. Given that the working week is 37 hours for operational staff, an average collection time of seven hours per day would mean only 20 minutes/day for pre and post departure activities and R&R time or any task and finish incentive to maintain productivity.

The unit costs shown in Figure 3 show the differences, for each sensitivity tested, between capital and operating costs[4]. There is a balance between higher capital costs and potentially lower operating costs[5]. In the scenario

[4] Note that the costs shown in the table include only limited operational costs using a combination of KAT default costs and costs agreed with Newcastle under Lyme (see assumptions in Appendix 2) for the purposes of comparing sensitivities. The costs do not represent actual expected costs which include other items such as depot costs, management costs and administration.

where 6.5 hours in the working day are utilised for collection, operating costs are similar for both scenarios where 100% and 50% of vehicles have two loaders, but capital costs are much higher for a driver plus two loaders on 50% of the vehicle scenario because two additional vehicles would be required.

In the scenario where 7 hours of the working day are utilised for collection, operating costs are similar for all configurations but capital costs vary significantly. If capital budgets can be secured then the initial results would suggest that one could achieve low operating costs by operating with fewer loaders but investing in more vehicles initially. However if capital budgets are limited then fewer vehicles could be purchased, but all operated with a driver plus two loaders for slightly higher operational costs.

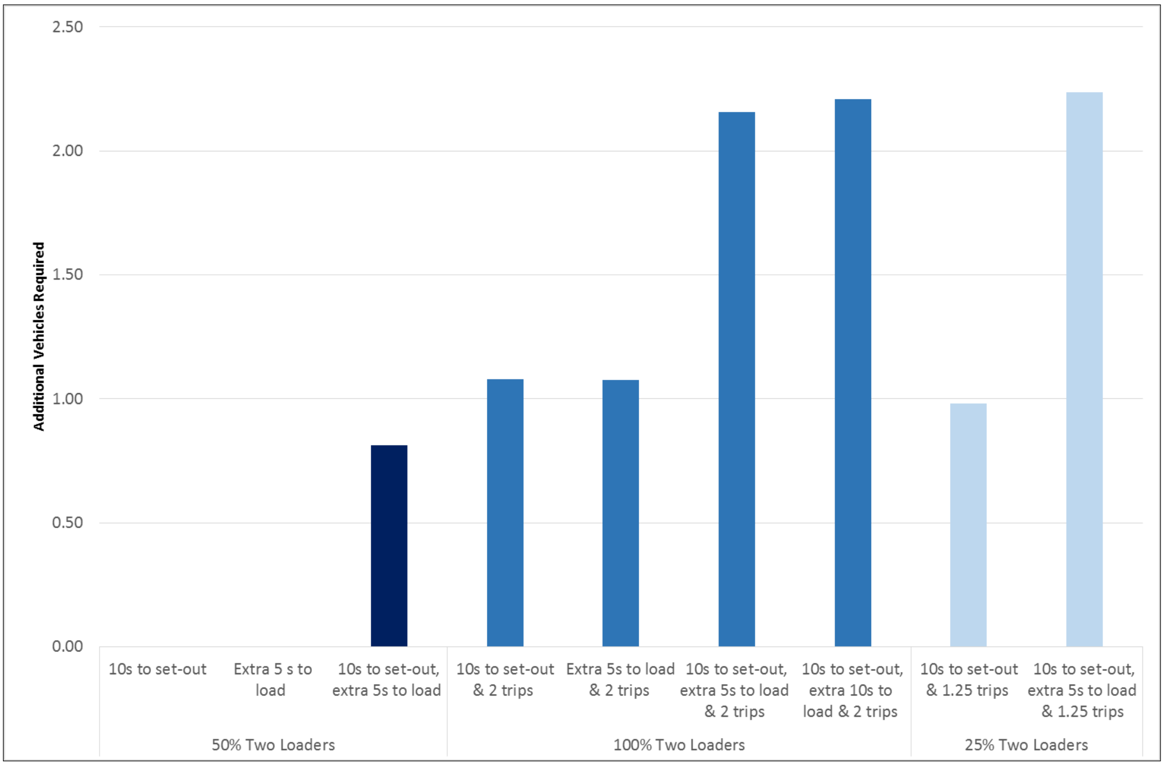
However the potential for use of additional loaders and vehicles, without any change to service configuration, needs to be considered in the light of the points raised above and the sensitivity analysis below to gain a better understanding of the balance between operational and capital costs.

3.3.2 Vehicle loading time

KAT has limited video evidence of four container systems as is planned in Newcastle (3 recycling boxes and 1 food caddie). It is therefore prudent to explore the sensitivity of the timings used for collecting and loading four containers. Timings have already been adjusted based on the assumption that four containers are likely to take longer for operatives to collect from each household and load than three container systems. We have also considered the fact that not all four containers will always be presented by participating households and therefore some set-outs will not require two operative trips to the set out. We have explored the impact of loading time by altering the time taken for a loader to collect and return containers (time taken for a trip to a set out) and time taken for a loader to empty material into the collection vehicle (time taken to load).

Figure 4 and Figure 5 show the additional number of vehicles required for the associated crew configuration due to changes in loading times. Figures are presented as fractions of vehicles to give an indication of the level of the impact, rather than the absolute changes in vehicle numbers suggested by KAT.

Figure 4: Additional vehicle requirements due to loading times (6.5hr collection day)



[5] *Operating costs include a cost for depreciation of vehicles over seven years (Appendix 2).*

Figure 5: Additional vehicle requirements due to loading time (7hr collection day)

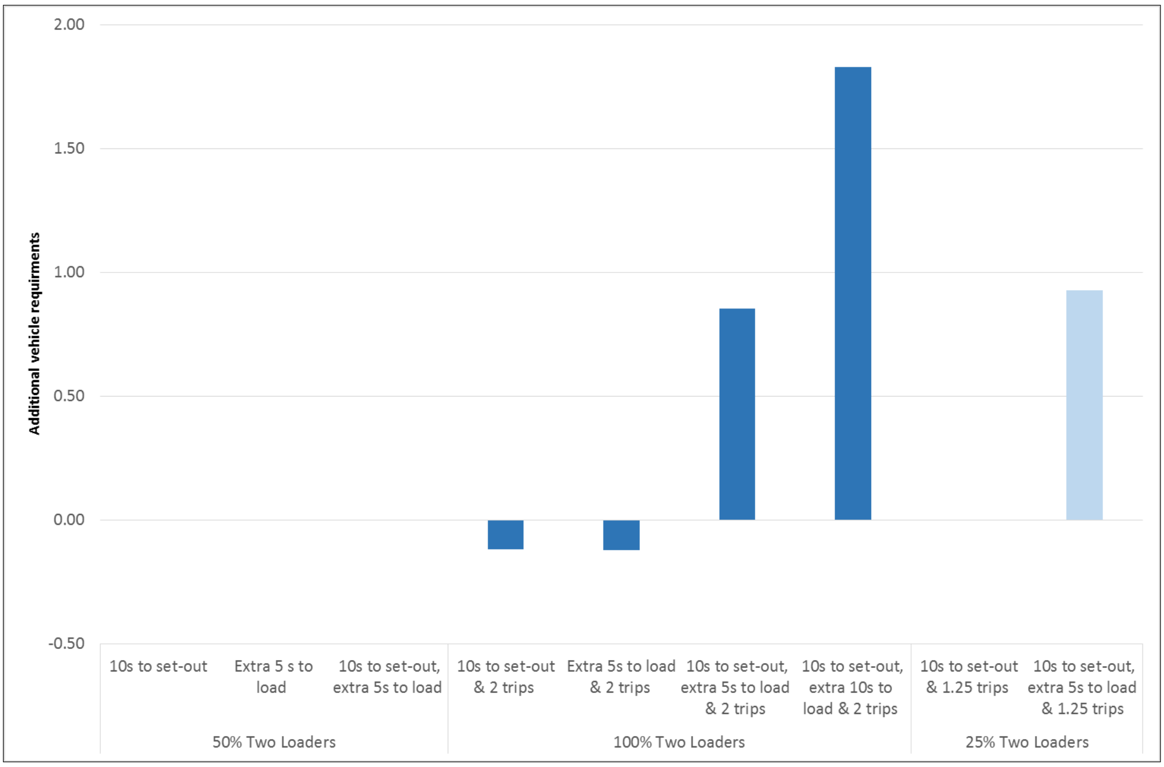


Table 4 shows that changing the timings for loading has the greatest impact on vehicles numbers in the scenario where 100% of the vehicles have two loaders or when loading times are increased significantly for the scenario where 50% of vehicles have two loaders. However, the overall fleet for the scenario where 100% of vehicles have two loaders would still remain smaller than other configurations.

Table 4: Overall fleet size due to changes in modelled loading time

Configuration	Preferred service configuration		10s to set-out		+ 5s to load		10s to set-out + 5s to load		10s to set-out + 10s to load	
	6.5h	7h	6.5h	7h	6.5h	7h	6.5h	7h	6.5h	7h
100% two loaders	12	11	13	12	13	12	14	13	14	14
50% two loaders	14	13	15	14	14	14	14	14	16	15
25% two loaders	14	14	15	14	N/A	N/A	16	15	N/A	N/A

3.3.3 Tipping times

Time taken for vehicles to tip was varied to replicate the impact of either extended queuing at the depot if all vehicles return at similar times (extra tipping time) or deploying staggered start times to avoid queuing (reduced tipping time). Increasing tipping times reduces the amount of time for actual collections. Figure 6 and Figure 7 show that the time taken to tip has the most influence on resource requirements where vehicles have to tip twice – mainly in the scenario where 100% of vehicles have two loaders, but also in the 7 hour day scenario with 50% of vehicles with two loaders. This is because the amount of time to deduct for available collection time is doubled where there are two tips compared with a one-tip set-up. Likewise reducing the tipping time benefits a two-tip set up most.

If vehicles are only tipping once, then staggered starts may have a greater benefit for the depot operators who otherwise would be faced with emptying the majority of the fleet at the same time at the end of the day. From a collection perspective, if the majority of vehicles are only tipping once, longer queueing times for unloading will not affect actual collections significantly.

Figure 6: Tipping time (6.5 hrs utilised for collection)

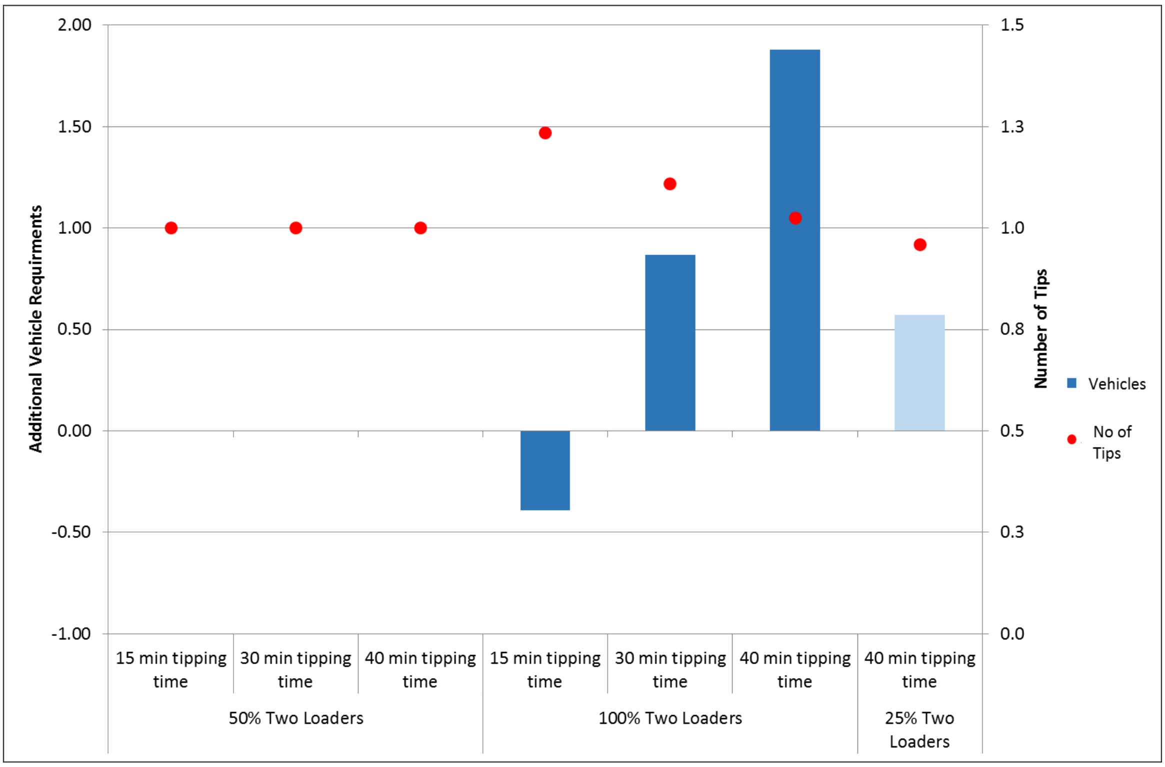
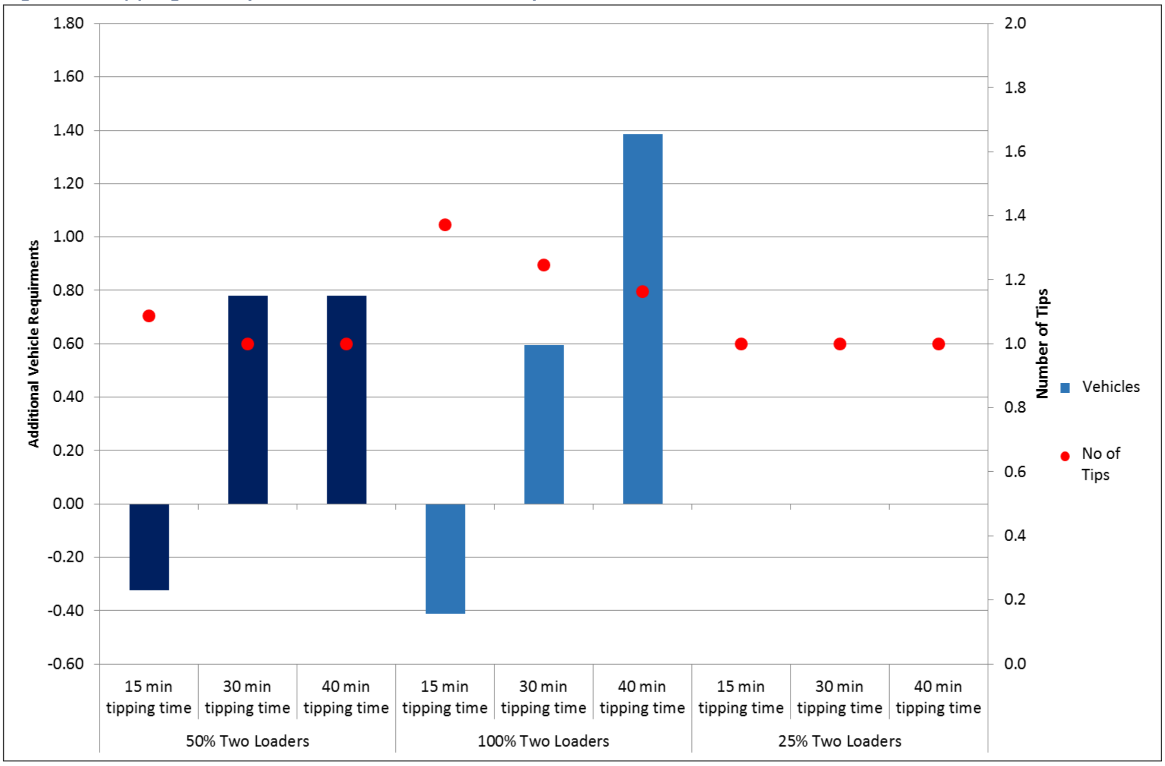


Figure 7: Tipping time (7 hrs utilised for collection)



3.3.4 Increasing yield

As outlined in section 2, the yield assumptions for Newcastle's preferred service configuration have been based on benchmarking of similar schemes. Participation and set-out rates have not been measured and figures used in modelling the existing services are estimates; future participation and set-out rates are relative increases from the existing service rather than absolute figures. The preferred service configuration has been tested for a range of higher yields by increasing the participation to reflect yields achieved in benchmarked authorities with similar schemes (see Table 1) and tested for different set-out rates. Table 5 shows the yield assumptions for both 15% increase in yield from the current service (6% increase from preferred configuration yield) to 180kg/hh/yr and a higher 22% increase in yield from the current service yield (11% increase from preferred configuration yield) to 190kg/hh/yr.

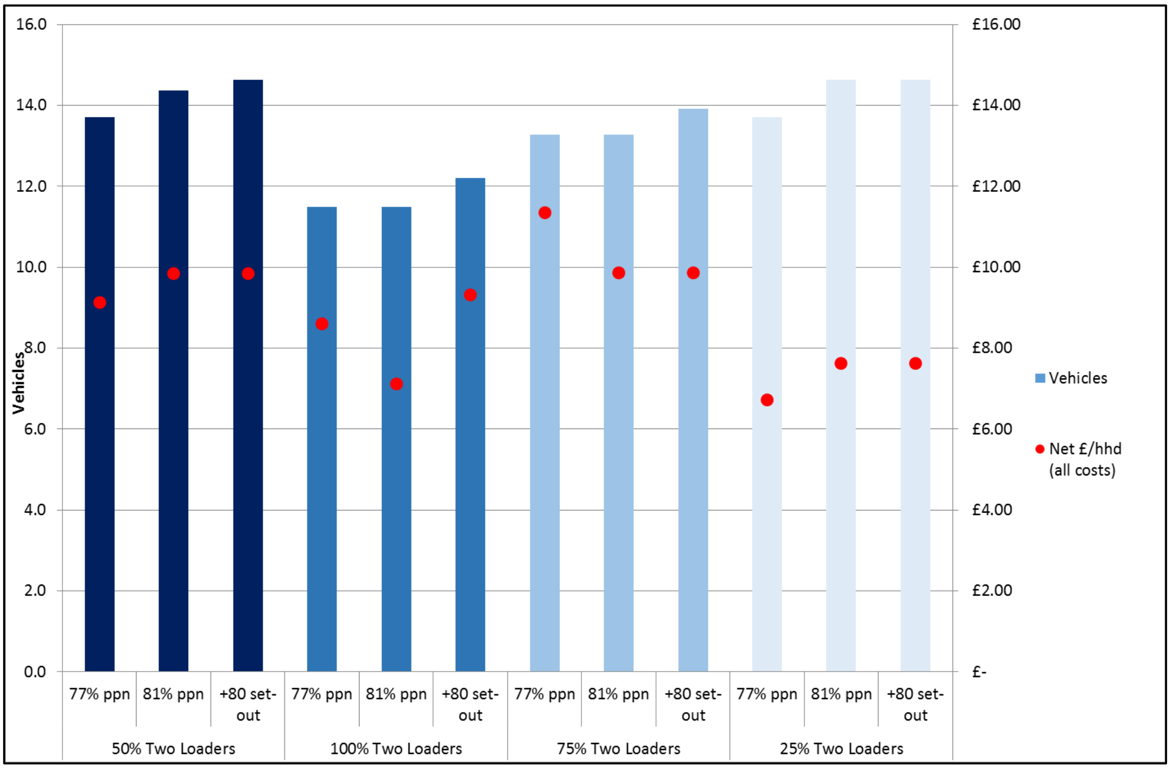
Table 5: Yield assumptions for dry recycling yield increase sensitivity

	Amount captured (kg/yr)		**Yield (kg/hhd)**	
Yield Increase from current service	**15%**	**22%**	**15%**	**22%**
Overall dry yield (kg/hh/yr)	**180**	**190**	**180**	**190**
Newspapers and magazines	3,259	3,420	63.3	66.4
Corrugated card	611	641	11.9	12.5
Non-corrugated card	965	1,013	18.7	19.7
Plastic bottles	848	889	16.5	17.3
Glass flint	1,371	1,439	26.6	27.9
Glass brown	293	308	5.7	6.0
Glass green	1,120	1,176	21.8	22.8
Steel cans	548	575	10.6	11.2
Aluminium cans	169	177	3.3	3.4
Textiles	101	106	2.0	2.1
Total (kg/yr)	**9,285**	**9,744**	**-**	**-**

Figure 8 shows that an increase in yield to 180 kg/hh/yr would require an extra vehicle in all cases except in the following scenarios if set-out does not increase:

- Where 75% of vehicles have two loaders; or
- Where all vehicles have two loaders.

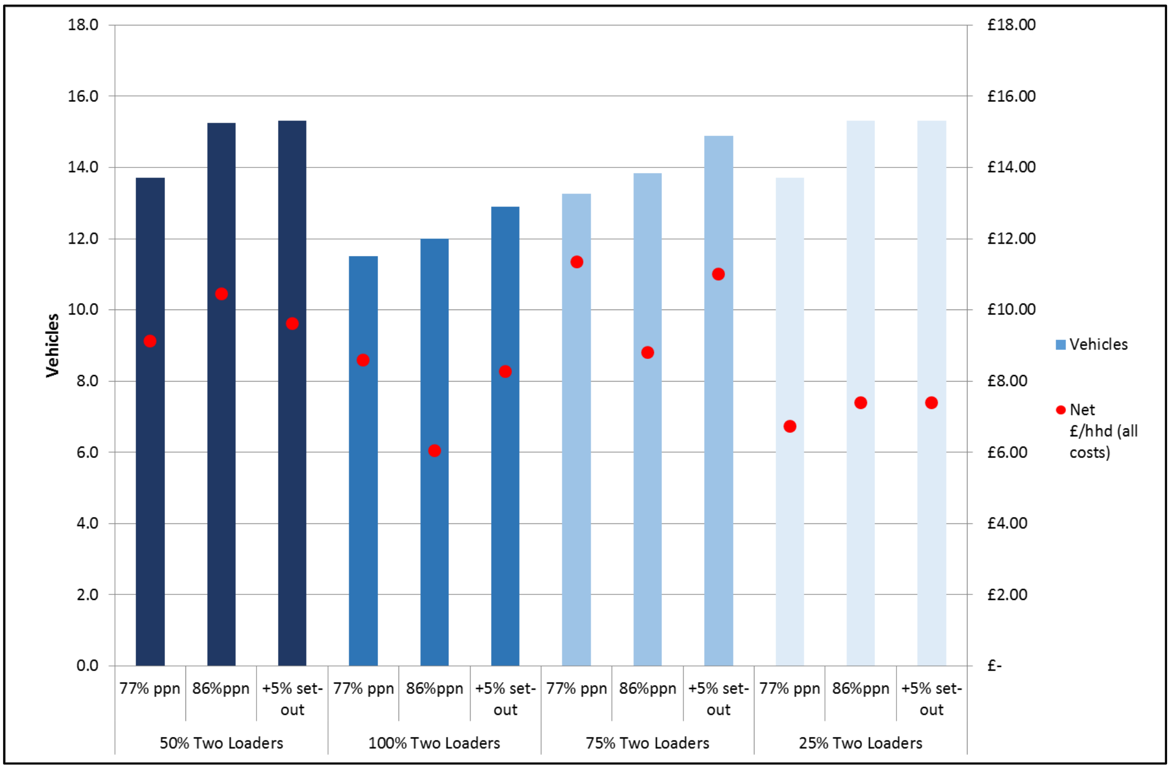
Figure 8: Resource requirements and net costs with 180kg/hh/yr dry recycling capture



Note: participation and set-out figures represent increases above the assumed baseline figures rather than absolute values

Figure 9 shows that increases in yield to 190 kg/hh/yr will require an additional 1.6 vehicles where 50% or less of the vehicles share a driver plus two. Only 0.5 additional vehicles are required where more than 50% of vehicles have two loaders unless set-out increases, in which case, an additional 1.6 vehicles are required: the actual tonnage is not the constraint, it is the time taken to serve the households. This suggests that a service in which more vehicles have a driver plus two loaders is more resilient to changes in uplift than where there are fewer loaders. This would also suggest that it may be possible to start a service with fewer loaders overall and increase the number as yields increase.

Figure 9: Resource requirements and net costs with 190kg/hh/yr dry recycling capture



Note: participation and set-out figures represent increases above the assumed baseline figures rather than absolute values

Residual waste containment volume is considered a key influence on scheme performance. NuLBC has a policy issuing 180 litre refuse bins when replacement bins are requested and therefore will replay the existing 240 litre residual bin stock gradually over time. It is assumed therefore that there is potential for the performance to increase to the higher levels assumed in the sensitivity in the future.

3.3.5 Housing growth

In order to determine the ability of the service to accommodate this growth in housing, the model was run with an increase to 54,100 households served and a dry recycling yield of 190kg/hh/yr. This is equivalent to a 1% increase in housing up to 2020. The results are presented in Table 6. Where the proportion of vehicles with two loaders is greater than 50% one additional vehicle is required; where the proportion of vehicles with two loaders is greater than 50% two additional vehicles are required.

Table 6: Vehicle requirements for increase in number of households

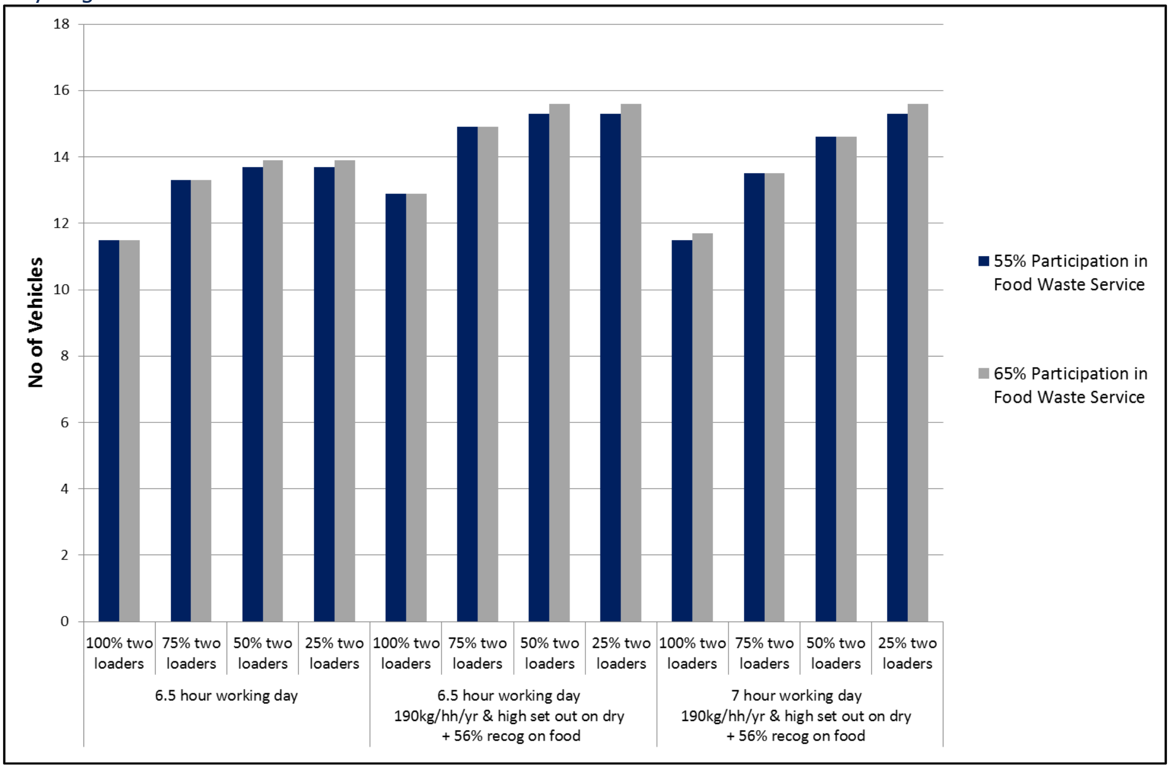
	51,800 Households		54,000 Households	
	Vehicles	Tips	Vehicles	Tips
25% two loaders	14	1.0	16	1.0
50% two loaders	14	1.0	16	1.0
75% two loaders	14	1.0	15	1.1
100% two loaders	12	1.2	13	1.3

3.3.6 Food waste

NuLBC already provides residents with a weekly food waste collection and it is unlikely that significant increases in food yield will be seen as a result of a service change to the Council's preferred service configuration. However, current food waste yields are low when compared to other authorities operating comparable services to Newcastle's preferred service configuration. NuLBC is currently running a pilot scheme to providing householders with plastic bags to line their food caddies to determine if this will increase participation and capture. We have therefore explored the impact of increased food waste yields should participation and recognition increase.

Figure 10 shows the results of the effect of increased food capture on the different service configurations and the impact of high food waste captures combined with high dry recycling yields and set out. As discussed previously, generally volume (notably of cardboard), determines when to tip rather than weight. Also, food set-out rates will almost always be lower than set-out rates for dry recycling. Therefore the additional food collected is generally not a constraint and does not significantly affect the resources required to deliver the service.

Figure 10: Vehicle requirements for increased food collection combined with increased yield and set out of dry recycling



3.3.7 Summary

Table 7 presents a summary of the changes in vehicle numbers required for different sensitivities. A lower average and maximum additional vehicle requirement suggests a configuration that is more resilient to the all sensitivities tested i.e. the sensitivities tested will have less impact upon resources required. Accepting that more sensitivity tests were undertaken for certain service configurations, the results suggest that a service configuration with 75% of vehicles having a driver plus two loaders is least sensitive to changes in participation, yield and loading times, followed by one in which 50% have a driver plus two loaders.

When 100% of vehicles have two loaders only 12 vehicles are required. When 75% or fewer vehicles have two loaders, 14 vehicles are required. Therefore in total capital investment costs a driver plus two loaders on all vehicles represents the lowest cost. As described around Figure 3, costs might reasonably be managed by starting with a smaller number of vehicles having two loaders initially and increasing loader numbers as either yields increase or if collections take longer than have been modelled.

Table 7: Summary of sensitivities

	Proportion of vehicles with 2 loaders			
	25%	50%	75%	100%
Number of vehicles for basic preferred option configuration	13.7	13.7	13.3	11.5
Average **additional** vehicles required above the basic configuration across sensitivities	0.94	0.54	0.44	0.66
Maximum **additional** vehicles required above the basic configuration across sensitivities	3.22	2.13	1.62	2.21

4 Operational considerations

4.1 Working patterns

The modelling inputs are all based on having a five-day working week rather than the four-day week currently operated by NuLBC as the Council anticipates the introduction of this change in working pattern with the roll out of its preferred service configuration. Whilst a detailed analysis of the relative merits of working patterns is outside the scope of this work, it's important to be clear that such a change can influence both resource requirements and operational costs of the collection service.

We have seen a number of local authorities in the past switch to a four-day working week similar to that currently operated in NuLBC in order to mitigate the impact of bank holidays on collection services. Whilst this can have some benefits in eliminating the disruption to services following bank holidays, the greatest benefits of operating under a four-day week are seen if it results in a higher proportion of full, or close to full, vehicle tips thus increasing resource efficiencies. However, in the case of NuLBC, vehicles are already tipping when full at the end of the day. Therefore a four-day week with a longer day will result in additional vehicle tips of only partially full vehicles creating inefficiencies, as the time available for collection is not fully utilised. It is also unlikely to reduce the overall vehicle requirements. In addition, there may be operational health and safety considerations that should be taken into account in operating an increased working day (usually approximately 10 hours). There are also obvious impacts on staff productivity at the end of a very long working day and more of the day is likely to be worked in the dark in the winter months. It should also be noted that the benefits of operating a four day week can be achieved through other mechanisms, most notable in the drafting of staff terms and conditions and the use of overtime payment for bank holiday working.

4.2 Routing Considerations

The number of tips will depend primarily on how quickly the recycling vehicle fills up and the efficiency of the utilisation of the compartments as the need to tip shown within this modelling is based on volume rather than tonnage. Detailed route planning will help to identify where two tips are possible, but also adjustments to routes will be required once the service is operational and the volume of different materials on different rounds is identified. It has been found on other services using the types of stillage vehicle proposed by NuLBC that card is the limiting factor. However the proportion of card will vary between rounds and, on those rounds where the proportion of card is lower, it may be possible to increase the round size and still only tip once. It may be prudent for NuLBC to retain at least one of the smaller stillage vehicles to provide a back-up service, particularly when the new service is initially rolled out in order to cover for rounds that are taking longer than anticipated to complete. In addition, NuLBC should consider optimising routes as part of its round planning process; this may result in additional resource savings over and above what has been shown by the results of this work.

Under NuLBC's preferred service configuration, fortnightly collections will continue for both residual and garden waste collections. It is sensible to consider how these services will be structured across the fortnight, for example operating refuse collection across the whole borough one week then garden collections the next or a 50/50 split system alternation the services in each half of the borough as is currently operated. It is unlikely that this will have any significant impact on the resource requirements of the service however there may be some operational benefits to maintaining the current 50/50 split structure of these services e.g. collecting missed bins etc. It is likely that this system has benefits for depot operatives as finish time between services will be staggered, reducing the number of vehicles queuing to tip at the end of the day. It also allows greater flexibility to use resources from each service to manage variations in yields across the two services.

5 Conclusions and recommendations

KAT calculates optimised numbers of vehicles and tips given the amount of time available in the day for loading, tipping and driving. This, in turn, is dependent on the amount of material to collect, the number of properties to serve and the size of the vehicles. Given these factors, most collections consist of one tip, which determines the number of vehicles required.

If the overall loader contribution is increased and the available time for collection is increased marginally then it is possible for a second tip to be undertaken. Consequently KAT calculates that the overall fleet requirement is slightly lower if all vehicles have a driver plus two or if the available time for collection can be increased. However, as the service is quite sensitive to these timings, small fluctuations have the potential to lead to a requirement for more vehicles. Therefore our modelling initially indicates that NuLBC will require either a fleet of 14 vehicles, with a driver plus two on 50% of the vehicles, or a fleet of 12 vehicles, but with a driver plus two on all vehicles.

However, although a smaller fleet with more loaders may be able to service the authority, small reductions in available collection time (e.g. longer loading and unloading times or longer travel times), may quickly require additional vehicles or leave no spare capacity for breakdowns, delays or population growth. Likewise a fleet of 14 vehicles with only 50% of vehicles with two loaders is operating optimally and provides no spare capacity for growth or spare vehicles using that crew configuration.

The sensitivity analysis suggests that a service in which more vehicles have a driver plus two loaders is more resilient to change in material yields than where fewer vehicles have two loaders. The recommended service configuration is therefore:

- A fleet of 14 vehicles comprising 13 operational vehicles and one spare;
- A minimum of 23 loaders which would enable an average round of 800 properties to be serviced per round and minimise the number of rounds where more than one tip is required.
- Additional capacity can be met by increasing the proportion of vehicles with two loaders and, in the longer term utilising the spare vehicle on standard rounds.

This configuration ensures that the service will accommodate increases in yield and set-out due to improved performance, increases in the number of households served and increases in travel time or tipping time.

In the short term it is recommended that the stillage vehicles used under the existing contract be retained in order to provide services to harder to reach properties or provide a back-up to existing rounds.

Given that some of the rounds require two loads of which one is only a partial load it is recommended that rounds closest to the depot are designed for two tips and others further for one tip.

In our view the authority would benefit from the development of detailed route planning to support this service roll-out and to maximise efficiency.

It is recommended that staggered start times are considered to overcome the issue of the majority of vehicles only tipping once and most likely at similar times at the end of the day. Alternatively, full vehicles could be parked on their return to depot at the end of the day and depot operatives could be employed to work a later shift pattern in order to unload the vehicle fleet.

Appendix 1: Modelling results

Table 8: Working day and crew configuration sensitivity results

Configuration	Vehicles		Tips		Average round size	
	6.5hr day	7hr day	6.5hr day	7hr day	6.5hr day	7hr day
50% 2 loaders	13.7	12.9	1.0	1.1	736	792
100% 2 loaders	11.5	10.4	1.2	1.3	858	936
75% 2 loaders	13.3	11.9	1.0	1.1	736	858
25% 2 loaders	13.7	13.7	1.0	1.0	736	736

Table 9: Vehicle loading time sensitivity results

Configuration		Vehicles		Tips		Additional vehicles required		Average round size	
		6.5hr day	7hr day	6.5hr day	7hr day	6.5hr day	7hr day	6.5hr day	7hr day
50% Two Loaders	10s to set-out	13.7	13.7	1.0	1.0	0.00	0.00	736	736
	Extra 5 s to load	13.7	13.7	1.0	1.0	0.00	0.00	736	736
	10s to set-out, extra 5s to load	14.5	13.7	0.9	1.0	0.81	0.00	687	736
	10s to set-out, extra 10s to load	13.7	14.4	1.0	1.0	2.21	0.67	736	687
100% Two Loaders	10s to set-out & 2 trips	12.6	11.4	1.1	1.2	1.08	-0.12	792	858
	Extra 5s to load & 2 trips	12.6	11.4	1.1	1.2	1.08	-0.12	792	858
	10s to set-out, extra 5s to load & 2 trips	13.7	12.4	1.0	1.1	2.16	0.85	736	792
	10s to set-out, extra 10s to load & 2 trips	13.7	13.3	1.0	1.0	2.21	1.83	736	736
25% Two Loaders	10s to set-out & 1.25 trips	14.7	13.7	0.9	1.0	0.98	0.00	687	736

	10s to set-out, extra 5s to load & 1.25 trips	15.9	14.6	0.9	0.9	2.24	0.93	644	687

Table 10: Tipping time sensitivity results

Configuration		Vehicles		Tips		Additional vehicles required		Average round size	
		6.5hr day	7hr day	6.5hr day	7hr day	6.5hr day	7hr day	6.5hr day	7hr day
50% Two Loaders	15 min tipping time	13.7	12.6	1.0	1.1	0.00	-0.32	736	792
	30 min tipping time	13.7	13.7	1.0	1.0	0.00	0.78	736	736
	40 min tipping time	13.7	13.7	1.0	1.0	0.00	0.78	736	736
100% Two Loaders	15 min tipping time	11.1	10.0	1.2	1.4	-0.39	-0.41	858	1030
	30 min tipping time	12.4	11.0	1.1	1.2	0.87	0.59	792	936
	40 min tipping time	13.4	11.8	1.0	1.2	1.88	1.39	736	858
25% Two Loaders	15 min tipping time		13.7		1.0		0.00		736
	30 min tipping time		13.7		1.0		0.00		736
	40 min tipping time	14.3	13.7	1.0	1.0	0.57	0.00	687	736

Table 11: Increasing yield sensitivity results

Configuration		Vehicles		Tips		Additional vehicles required		Average round size	
		180kg/hh/yr	190kg/hh/yr	180kg/hh/yr	190kg/hh/yr	180kg/hh/yr	190kg/hh/yr	180kg/hh/yr	190kg/hh/yr
50% Two Loaders	70% ppn	13.7	13.7	1.0	1.0			736	736
	81% ppn	14.4	15.3	1.0	1.0	0.67	1.55	687	644
	+80 set-out	14.6	15.3	1.0	1.0	0.92	1.60	687	644
100% Two Loaders	70% ppn	11.5	11.5	1.2	1.2			858	858
	81% ppn	11.5	12.0	1.3	1.3	0.00	0.49	858	858
	+80 set-out	12.2	12.9	1.2	1.2	0.70	1.40	792	792
25% Two	70% ppn	13.3	13.3	1.0	1.0			736	736

Loaders	81% ppn	13.3	13.8	1.1	1.1	0.00	0.57	736	736
	+80 set-out	13.9	14.9	1.1	1.0	0.66	1.62	736	687

Table 12: Food waste sensitivity results

Service configuration		No additional food		Additional food	
		Vehicles	No. of tips	Vehicles	No. of tips
65% ppn on food	50% two loaders	13.7	1.0	13.9	1.0
	100% two loaders	11.5	1.2	11.5	1.3
	75% two loaders	13.3	1.0	13.3	1.1
	25% two loaders	13.7	1.0	13.9	0.9
190 kg and high set-out on dry 65% ppn & 56% recog	50% two loaders	15.3	1.0	15.6	1.0
	100% two loaders	12.9	1.2	12.9	1.3
	75% two loaders	14.9	1.0	14.9	1.1
	25% two loaders	15.3	1.0	15.6	0.9
190 kg and high set-out on dry 65% ppn & 56% recog 7 hour day	50% two loaders	14.6	1.0	14.6	1.1
	100% two loaders	11.5	1.3	11.7	1.3
	75% two loaders	13.5	1.1	13.5	1.2
	25% two loaders	15.3	1.0	15.6	1.0

Table 13: Dry recycling and food waste yields

	Dry recycling yield			Additional food	
	168 kg/hh/yr	180 kg/hh/yr	190 kg/hh/yr	65% ppn	65% ppn + 56% recognition
News & magazines	3,027	3,259	3,420	3,027	3,420
Corrugated card	568	611	641	568	641
Non-corrugated card	896	965	1,013	896	1,013
Plastic bottles	795	848	889	795	889
Glass flint	1,285	1,371	1,439	1,285	1,439

Glass green	275	293	308	275	308
Glass brown	1,050	1,120	1,176	1,050	1,176
Steel cans	509	548	575	509	575
Aluminium cans	157	169	177	157	177
Textiles	78	101	106	78	106
Total dry	***8,640***	***9,285***	***9,744***	***8,640***	***9,744***
Food	2,812	2,812	2,812	3,323	3,649
TOTAL kerbside	***11,452***	***12,097***	***12,556***	***11,963***	***13,393***

Table 14: Average crew loading contribution

	Proportion of vehicles with two loaders			
	25%	**50%**	**75%**	**100%**
Driver contribution				
Driver plus one	25%	25%	25%	25%
Driver plus two	10%	10%	10%	10%
Loader contribution	100%	100%	100%	100%
Average crew loading contribution	**1.53**	**1.68**	**1.82**	**2.1**

Appendix 2: Assumptions

1 Introduction

The assumptions used in options modelling undertaken for Newcastle under Lyme Borough Council (NuLBC) are outlines in the following appendices. The aim of this appendices is to present assumptions in a clear and concise manor. The majority of assumptions were discussed with Council officers during on-site data collection and baseline modelling. The performance assumptions are based on benchmarking of similar authorities with similar schemes. Full details of the benchmarking exercise are presenting in section 2.

Assumptions are presented in table format detailing the source of assumption with short descriptions for how the data has used in the modelling process.

2 Current kerbside performance

Waste composition for NuLBC was not available, therefore KAT default figures have been applied. Collections tonnages have been based on 2013/14 WDF returns.

	KAT default	Collected tonnage	Breakdown	Assumed participation rate	Households served	Recognition rate[6]	Capture rate[7]	Yield (kg/hhd)
Newspapers and magazines	11.4%	2,800	2,800	70%	55,000	81%	56%	50.9
Other paper	4.7%							
Corrugated card	2.1%	1,354	525	70%	55,000	81%	57%	9.5
Non-corrugated card	3.4%		829	70%	55,000	81%	57%	15.1
Plastic film	4.7%							
Plastic bottles	1.8%	750	750	70%	55,000	139%	98%	13.6
Plastic - other dense	4.5%							
Glass flint	3.0%	2,459	1,211	70%	55,000	133%	93%	22.0
Glass brown	0.6%		259	70%	55,000	133%	93%	4.7

[6] Recognition Rate is the percentage of material diverted by a participating household

[7] Capture Rate is percentage of material diverted from the total waste stream

Glass green	2.4%		989	70%	55,000	133%	93%	18.0
Steel cans	1.8%	617	472	70%	55,000	84%	59%	8.6
Aluminium cans	0.6%		145	70%	55,000	84%	59%	2.6
Foil containers	0.1%							
Textiles	2.8%	41	41	70%	55,000	5%	3%	0.7
Soil and other organic	2.5%							
Food waste	24.6%	2,728	2,728	50%	51,000	51%	25%	53.5
Compostable garden waste	12.4%	10,201	10,201	90%	48,000	210%	189%	212.5
Other	16.6%							
Total	*100.00%*	*20,950*	*20,950*					
Household waste		22,633	22,633		55,000			
TOTAL		**43,583**	**43,583**		**55,000**			**792.4**

3 Baseline Assumptions

Operational Assumptions

Table 15: Baseline Operational Assumptions

Term	Dry	Garden	Food	Refuse	NOTES
Service Assumption					
Number of households served (street level)	51,800	48,000 (875 with additional bin(s)	51,800	51,800	
Number of flats	3,200	0	1,000	3,200	Majority of properties integrated into normal rounds
Collection frequency	Fortnightly	Fortnightly	Weekly	Fortnightly	
Number of collection days per week	4	4	4	4	

Term	Dry	Garden	Food	Refuse	NOTES
Average round size per day	Kerbsider - 1,180 Split RCV - 3,165	1,490	1,770	1,380	Based on data in RouteSmart summaries
Average number of loads/tips per day	2	2	2	2	
Staff Assumptions					
Number of loaders	Kerbsider: 2 Split body: 3 Stillage: 1	26t: 2 15t: 1	Link Tip: 1	26t: 2 15t: 1	
Driver contribution to loading.	Stillages 80%	15t – 25%	Link Tip: 60%	15t – 25%	
Vehicle Assumptions					
Number of collection vehicles	5 x 24t kerbsiders (paper, glass, cans & food) 2 x 7.5t stillages (paper, glass, cans & food) 2 x 26t split body RCV 30/70 split (plastic/card)	3 x 26t RCV 1 x 15t	Green week: 4 x 6.5t Link Tip Blue week: pod on kerbsider	4 x 26t RCV 1 x 15t RCV	24t RCV for trade waste provides support to refuse and garden as required 18t vehicle as spare
Volume of Vehicle	Kerbsider: 28 m^3 Split body: 21 m^3 Stillage: 10 m^3	26 t – 22m^3 15 t – 15 m^3	Link Tip: 4 m^3	26 t – 22m^3 15 t – 15 m^3	Estimated volumes based on payload data provided.
Maximum vehicle payload (kg)	Split RCV: 9,940 Kerbsider: 6,720 Stillage: 3,120	26t – 10,900 15t – 4,100	6.5t – 1,900	26t – 10,900 15t – 4,100	
Average maximum	Split RCV: 5,000				

Term	Dry	Garden	Food	Refuse	NOTES
actual payload (kg)	Kerbsider: 6,000 Stillage: 2,800				
Are slave bins used?	Yes for cardboard (7 bags per slave)	No	Yes for green week (15 caddies per slave)	No	
Time Assumptions					
Average distance driven per vehicle each week (miles)	Kerbsider – 166 Split RCV - 164	202	207	208	Used for the calculation of fuel costs Based on data in RouteSmart summaries
Average time taken to drive from starting depot to beginning of round.	Kerbsider - 17 min Split RCV – 15 min	15 min	15 min	15 min	Based on data in RouteSmart summaries
Average time taken to drive from round to unloading point (one-way)	Kerbsider 17 min Split RCV 15 min	15 min	15 min	15 min	Based on data in RouteSmart summaries
Average time taken to unload	20 min	10 min	10 min	20 min	This is an average time between arriving at the treatment facility and leaving the facility. This includes waiting time.
Average time taken to drive from unloading point to the finish depot	5 min (same location)	20 min	20 min	20 min	
Average hours worked by each collection crew per day	Split RCV - 7:40 Kerbsiders – 9:25	7:00	7:10	7:38	This is the time from leaving the depot in the morning and returning after the final unloading in the afternoon. Based on data in RouteSmart summaries
Performance Assumptions					

Term	Dry	Garden	Food	Refuse	NOTES
Average set-out rate (%)	60 – paper, glass, cans 70 – plastic & card	90 (summer) 25 (winter)	50 – green week 40 – blue week	95	Estimates: no surveys have been undertaken.
Average participation rate (%)	70	90	50	n/a	Estimates: no surveys have been undertaken.
Average % level of contamination	0.5%	1.0%	0%	n/a	Non-suitable material collected by collection vehicle and carried on the round.

Financial Assumptions

Note that the KAT model calculates and presents costs automatically . However the costs produced will not form part of the final report as NuL will transfer the operational requirements in to their own financial models. The costs that will be used in KAT are presented below for information only.

Table 16: Baseline Financial Assumptions

Term	Dry	Garden	Food	Refuse	NOTES
Containers					
Average unit cost for kerbside container	Blue Box – £2.10 Reusable bag – £1.30 Single use bag – £0.055 (KAT default)	240 l wheeled bin - £18.00	Food caddy & bin - £2.50	180 l wheeled bin £17.50	Assumes includes distribution costs.
Number and type of containers per household	Blue Box – tins / glass/ WEEE / batteries Green Reusable bag – cardboard Blue Reusable bag – Paper Red single use bag – Plastic (30 bags per year)	240l brown lidded bin – garden waste only. Additional bins at £36 per year	25l external caddy & 7l kitchen caddy Food Waste in plastic liner (not provided)	Standard policy is 180l bin 240l bin for families 6 or over. 75% of residents still have 240l and about 500 have 360l	

Term	Dry	Garden	Food	Refuse	NOTES
Annual container replacement rate (%)	Blue Box – 2500 (4.5%) Green Reusable bag – 3000 (5.5%) Blue Reusable bag –unknown: assume same as green bag Red single use bag – 30 liners per household	1500 (3.1%)	2000 (3.9%)	3000 (5.5%)	Replacement due to loss or damage
Are containers bought outright or lease purchase?	Outright – supplied through contract	outright	outright	outright	
Vehicles					
Are vehicles typically bought outright, by lease purchase or hire?	Lease (through contract)	outright	outright	outright	
Purchase cost per vehicle	Kerbsider - £112,000 (KAT default) Split RCV - £150,000 Stillage - £38,000 (KAT default)	26 t - £150,000 15 t - £130,000	Link tip - £50,000	26t - £150,000 15t - £130,000	
Depreciation period/planned lifespan (years)	7 years	7 years	7 years	7 years	If no financing cost included a straight line depreciation assumed.
Annual vehicle running costs per vehicle	Split RCV – 10% of capital costs Kerbsider - 7.5% of capital costs Stillage - 7.5% of capital costs	10% of capital costs	7.5% of capital costs	10% of capital costs	The running costs include oil and maintenance. These are KAT default figures based on vehicle size.

Term	Dry	Garden	Food	Refuse	NOTES
Annual vehicle standing costs per vehicle	5% of capital costs				The standing costs include MOTs and Road Tax. These are KAT default figures based on vehicle size.
Fuel cost (£/litre)	£1.01				
Staff					
Driver unit cost	£28,250				Based on NuL budgets it reflects basic salary, NI, pension and selected on-costs.
Loader unit cost	£25,000				Based on NuL budgets it reflects basic salary, NI, pension and selected on-costs.
Supervision cost	9% of the total crew costs (i.e. drivers + loaders)				KAT default figure
Material					
Material income	Paper - £91.77 Glass - £12.50 Cans - £115.50 Card - £55.50 Plastic bottles - £40.50				
Gate fee	Garden waste - £25.14 Food - £56.58				
Recycling credit	£47.30 (3% annual increase)				
Other					
Overheads cost	12% of the total operating costs (i.e. labour, vehicle standing and running costs).				This is KAT default figure

4 Preferred Option Assumptions

All assumptions for garden waste and refuse collection services will remain the same as the baseline assumptions with the exception for the number of collection days in a week that will switch from four days to five days. Table 17 and Table 18 therefore show assumptions for dry recycling and food waste collection serviced. Sensitivities to be tested are also detailed. Participation, recognition and set-out rates are relative increases on the rates used in the baseline; they do not necessarily represent actual figures that will be obtained.

Operational Assumption

Table 17: Preferred option operational assumptions

Term	Dry & food	Sensitivity	NOTES
Service Assumption			
Number of households served (street level)	51,500		KAT will model service to these properties only.
Number of flats	3,200		Properties served by bins. Separate round not considered by this exercise.
Collection frequency	Weekly		
No. of collection days per week	5		
Staff Assumptions			
Number of loaders	50% of vehicles 1 loader 50% of vehicles 2 loaders	a) 100% vehicles with 2 loaders b) 75% vehicles with 2 loaders, 25% with 1 loader c) 25% vehicles with two loaders, 75% of vehicles with one loader	
Driver contribution to loading.	10% with two loaders 25% with one loader		
Vehicle Assumptions			

Term	Dry & food	Sensitivity	NOTES
Vehicle	Resource Recovery Vehicle (RRV) Stream 1 – Paper Stream 2 – Card Stream 3 – Glass Stream 4 – Cans & plastic Stream 5 – food Stream 6 – Textiles, small WEEE		
Volume of Vehicle	32 m^3		Based on Romaquip vehicle
Maximum vehicle payload (kg)	4,000		Based on Romaquip vehicle
Time Assumptions			
Average distance driven per vehicle each week (miles)	120		Used for the calculation of fuel costs.
Average time taken to drive from starting depot to beginning of round.	15 min		Assumes similar to existing services
Average time taken to drive from round to unloading point (one-way)	15 min		Assumes similar to existing services
Average time taken to unload	20 min	30 minutes 40 minutes	This is an average time between arriving at the treatment facility and leaving the facility. This includes waiting time.
Average time taken to drive from unloading point to the finish depot	5 min (same location)		

<table>
<tr><th>Term</th><th colspan="2">Dry & food</th><th>Sensitivity</th><th>NOTES</th></tr>
<tr><td>Average hours worked by each collection crew per day</td><td colspan="2">6:30</td><td>7:00 hours</td><td>This is the time from leaving the depot in the morning and returning after the final unloading in the afternoon.</td></tr>
<tr><td colspan="5">Performance Assumptions</td></tr>
<tr><td>Overall dry yield</td><td colspan="2">167 kg/hh/yr (dry only)
55 kg/hh/yr (food)</td><td>180 kg/hh/yr (dry)
190 kg/hh/yr (dry)</td><td>Higher figures represent higher and top performing similar authorities. Based on benchmarking</td></tr>
<tr><td>Average participation rate (%)</td><td>Dry
10% increase on existing rates for dry recycling = 77%</td><td>Food
5 percentage point increase in participation for food waste = 55%</td><td rowspan="2">Recognition and participation will be adjusted to produce higher yields shown above.</td><td>Based on benchmarking work.
5% increase due to frequency change
5% increase due to new scheme introduction.</td></tr>
<tr><td>Average recognition (%)</td><td colspan="2">5%increase on existing rates for each dry material (See Section 3 for existing rates)</td><td>Increase due to frequency change.</td></tr>
<tr><td>Average set-out rate (%)</td><td colspan="2">As existing service</td><td>+10%
+20%</td><td></td></tr>
<tr><td>Average % level of contamination</td><td colspan="2">0.1%</td><td></td><td>Non-suitable material collected and carried on the round.</td></tr>
</table>

Financial Assumptions

Note that the KAT model will be used to review costs for the sensitivity analysis as they are automatically calculated and presented in KAT. However the costs produced will not form part of the final report as NuL will transfer the operational requirements in to their own financial models. The costs that will be used in KAT are presented below for information only.

Table 18: Preferred option financial assumptions

Term	Dry	Sensitivity	NOTES
Containers			
Average unit cost for kerbside container	Blue Box – £2.10 Single use bag – £0.055 (KAT default)		Assumes includes distribution costs.
Number and type of containers per household	Box 1 – paper & card Box 2 – glass Box 3 – cans & plastic Kitchen bin – food User supplied bags – textiles, small WEEE		
Annual container replacement rate (%)	Boxes – 4.5% Kitchen bins - 3.9%		Based on existing rates
Are containers bought outright or lease purchase?	Outright		
Vehicles			
Vehicles bought outright, by lease purchase or hire?	Outright		
Purchase cost per vehicle	£110,000		NuL estimate
Depreciation period/planned lifespan (years)	7 years		If no financing cost included a straight line depreciation assumed.
Annual vehicle running costs per vehicle	£5,000		Based on figures provided by Conwy
Annual vehicle standing costs per vehicle	£1,600		Based on figures provided by Conwy
Fuel cost (£/litre)	£1.01		

Term	Dry	Sensitivity	NOTES
Staff			
Driver unit cost	£28,250		
Loader unit cost	£25,000		
Supervision cost	9% of total driver & loader costs		KAT default
Material			
Material income	Paper - £91.77 Glass - £12.50 Cans - £115.50 Card - £55.50 Plastic bottles - £40.50	To follow	Variations in material income for the sensitivity will be based on benchmarking
Gate fee	Garden waste - £25.14 Food - £56.58	To follow	Variations in material income for the sensitivity will be based based on benchmarking
Recycling credit	£47.30 (3% annual increase)		
Other			
Overheads cost	12% of the total operating costs (i.e. labour, vehicle standing and running costs).		KAT default

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