Managing NHSS Food Waste

Barriers and opportunities to food waste collection schemes within and across adjacent NHSScotland Board areas.

RESOURCE EFFICIENT SCOTLAND

Growth that doesn't cost the earth

Version 1.0

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A programme from ZERO WASTE SCOTLAND

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Resource Efficient Scotland is a single energy and resource efficiency advisory service for Scottish businesses, third sector and public sector organisations, which aims to reduce overheads through improved energy, material resource and water efficiency. In doing so, it will help cut carbon across public and private sector organisations. This holistic approach to low carbon transition ultimately aims to help more businesses to reduce their emissions, save money and increase their competitiveness.

The programme is funded by the Scottish Government and managed by Zero Waste Scotland.

Executive Summary

In anticipation of the requirement for the National Health Service in Scotland (NHSS) to comply with the requirements of the Waste (Scotland) Regulations 2012 regarding the recycling of food waste in non-rural areas by 1st January 2016, the objective of the work undertaken by the Organic Resource Agency (ORA) on behalf of Zero Waste Scotland was:

> "*To understand food waste service collection requirements of NHSS hospitals at a site, Board and Regional level.*"

The project aimed to determine both the potential impacts and benefits that could result by changing from food waste disposal via in-sink macerators, to a food waste collection scheme, or an on-site treatment and disposal option at hospital sites across a selected number of NHSS Board areas. A survey of 33 hospitals was undertaken, with sites selected in consultation with the NHSS Boards for Ayrshire and Arran, Dumfries and Galloway, Fife, Greater Glasgow and Clyde, Lanarkshire, and Tayside.

A combination of preliminary questions and site visits to the identified hospitals allowed data and qualitative information to be gathered on the management of food, from its reception into store through to the production of meals, their service to patients, and the disposal of any food waste arising. This process helped to identify that there were many different ways in which food is managed by hospitals. However, one of the other key findings was the lack of reliable data on the total amount of food waste produced in hospitals, which is currently mostly disposed of via macerators to sewer or, to a lesser extent, with the general waste.

This report is intended to assist the reader in determining and addressing the key barriers and opportunities to food waste collection within and across adjacent NHSS Board areas, as defined by the title of this project. The report has therefore been structured to assist the reader in determining how to identify potential options, how to proceed to overcome real and perceived barriers, and to realise the opportunities for their own situation. It also briefly sets out the key issues relating to the implementation of the Waste (Scotland) Regulations 2012, including a clarification of the waste management options that will be acceptable under the regulations. This information was derived following consultation with the Scottish Environment Protection Agency (SEPA).

Based on the findings of the hospital surveys, the report proposes a range of food waste management options that would be compliant with the Waste (Scotland) Regulations, but also with HACCP (hazard analysis and critical point control) requirements. This includes proposals for the return of food waste within a hospital to an appropriate central location, typically the main kitchen, using a reverse logistics system. Options that meet these criteria are presented and reviewed, and potential suppliers of suitable technology are identified. A range of key issues that would need to be raised with technology providers are also provided, to allow technologies to be compared effectively and to assist the selection process.

The advantages and disadvantages of treating the food waste within the hospital estate were also considered. Following discussions with the hospitals involved in the study, and with Resource Efficient Scotland, it was determined that the resources available for this project would be better concentrated on other, more widely applicable options for managing food waste, e.g. pre-treatment, off-site treatment, reverse logistics, etc. The reasons for this decision included the relatively high capital and operating costs, in terms of management and labour, of on-site anaerobic digestion (AD) or in-vessel composting (IVC), which were considered to be likely to outweigh any advantages in terms of savings against collection and/or off-site treatment, or any revenue that might be achieved from electricity generation. The location of off-site treatment facilities and their capability to receive and treat food waste from hospitals has also been considered.

However, on-site treatment options have been included in the hospital food waste calculator tool that has been developed in parallel to this report, as there may be situations where these options might be considered more viable, such as in more remote areas distant from off-site treatment facilities, or where exceptionally large amounts of food waste are produced, e.g. from a central production facility. This calculator is intended to illustrate to decision-makers the potential financial impact of implementing different methods of managing waste within the hospital, and the different methods for treating the waste. It compares this with existing food waste management practices, for reference.

The calculator allows the user to take account of the amount of waste produced by a hospital, based on the number of beds and adjusted depending on whether the hospital prepares food on-site using raw ingredients, or whether it receives its food from a Cook and Freeze Production Unit (CFPU). It is also capable of considering the impact of a hospital or a CFPU receiving additional food waste via the introduction of a reverse logistics system. It also takes account of the cost of collecting food waste and the internal management, labour and professional support costs to implementing the new system.

The potential for co-operation within and between NHSS Board areas to introduce a system of reverse logistics for the collection of food waste on the vehicles that deliver food has also been considered. The advantages of such an approach are presented along with the key HACCP issues associated with ensuring that cross-contamination of food waste with meals still to be served does not occur. This forms part of the review of wider management issues that would need to be addressed if such a system was to be trialled or introduced on a large scale, e.g. logistics of vehicle movements, labour requirements, regulatory issues, etc. This assessment includes worked examples of a larger hospital that currently also supplies a number of smaller hospitals and day centres with food, and for a much larger CFPU providing food to a wider range of hospitals.

The practicalities and costs for co-operation with other public sector and commercial organisations for the separate collection of food waste are also considered. It is noted that as many other businesses and organisations will be required to present their waste for separate collection two years before hospitals, there is a potential for hospitals to join an already established food waste collection scheme, rather than start from scratch. A survey of the attitudes of Local Authorities in the same areas as the NHSS Boards participating in this study was undertaken, and this determined that there was potential to co-operate with a range of Local Authorities, both on the collection and treatment of food waste.

The implications of the carbon impact associated with the storage, pre-treatment, collection and treatment of food waste options are also presented.

Having considered a wide range of individual hospital sites and NHSS Board areas, nine barriers have been identified to the introduction of food waste collection and treatment schemes in hospitals. These include:

- The scale and complexity of the NHSS;
- Variation between hospitals within and across adjacent Board areas;
- Variability in the layout and physical structure of hospital sites;
- Variability in the amount of food waste that hospitals generate;
- Location of the hospitals;
- Anticipated working life of a hospital;
- Availability of data on issues relating to the management of food waste;
- Understanding how the costs interrelate for specific sites, or groups of hospitals; and
- The cost associated with the installation and operation of new waste systems

During the undertaking of the study, it became apparent how important it is to engage with hospital staff in each of the catering, estates, domestic, and portering departments, both in selecting the appropriate food waste management system and in preparing properly for its introduction. Engagement with SEPA and Scottish Water will also be essential for the costs and potential benefits to be fully understood and accounted for.

Opportunities for co-operative working within and between NHSS Boards can be summarised as follows:

- Purchasing the waste management technology, e.g. dewatering equipment, etc.;
- Purchasing and co-ordinating waste collection services, including the potential of reverse logistics associated with the delivery of food and collection of food waste;
- Scheduling the installation of the technology to reduce cost and improve timeliness of its introduction;
- Optimising the system as a whole via establishment of a system of reverse logistics to return food waste to the hospital or CFPU that supplied the food, thus minimising the cost of collection paid to waste collection companies, and to achieve some economies of scale at a central waste collection and pre-treatment facility;
- It may also be possible to negotiate on behalf of all of the hospitals involved a lower cost associated with the disposal of trade effluent with Scottish Water (the wholesale company), and the relevant retail water company. This could be a beneficial cost saving as a result of reducing the loading of organic waste into the waste water system following the introduction of a system to divert food waste away from sewer; and
- Sharing of practical experience and knowledge.

The report concludes by drawing the above issues together to propose a series of steps and an iterative process to find an appropriate food waste management system for a hospital, or a group of hospitals within or between adjacent Board areas. The four steps are:

- Information gathering
- A review of the most appropriate option, based on specific needs of the hospital;
- An assessment of the potential benefits of co-operating with other hospitals or organisations, as part of an iterative process; and
- Going out to tender

A set of simple 'Yes or No' questions have also been identified that can be used by hospitals to assist them towards determining the key issues they must address in their particular situation, in order to identify an appropriate system to comply with the Waste (Scotland) Regulations 2012.

1 Introduction

1.1 Objective

The objective of the work undertaken by the Organic Resource Agency (ORA) for Resource Efficient Scotland was:

> "*To understand food waste service collection requirements of NHSScotland hospitals at a site, Board and Regional levels.*"

1.2 Aims

The study aimed to determine both the potential impacts and benefits that could result for hospital sites in a selected number of National Health Service Scotland (NHSS) Board areas by changing the way they manage their food waste, from disposal via maceration to a segregated food waste collection scheme or on-site treatment and disposal.

It is clear that while the Waste (Scotland) Regulations 2012 are developed from a resource and waste management perspective, it is essential that the method of implementation is driven primarily by the needs of those responsible for the delivery of the services within the hospitals, with catering being of particular importance.

This study has therefore involved visiting hospitals to observe current operating practices and food waste provisions, and to take on board the issues identified by the catering managers, with the intention of bringing these issues to the fore when considering the practical steps that need to be taken to meet the requirements of the Waste (Scotland) Regulations 2012.

During the delivery of this study it became apparent that the objective for hospitals and NHSS boards should be a solution that achieved compliance with Waste (Scotland) Regulations 2012, along with:

- No negative impact on the care of patients;
- Minimal change to current working practices for catering, domestic and clinical staff;
- Minimal disruption to the fabric of the buildings;
- Minimal disruption to core services during the installation of the compliant system;
- Minimal cost in terms of capital expenditure (capex), operating costs (opex), and running costs (electricity and water), maintenance and labour cost (also referred to as "revenue" in the NHSS)

This report is intended to assist the reader in determining and addressing the key barriers and opportunities to food waste collection within and across adjacent NHSS boards. The report has therefore been laid out in a format designed to assist the reader in identifying how to proceed, in order to overcome the highlighted barriers and realise the opportunities for their own particular situation.

It is of paramount importance to minimise the production of food waste. However, given the objective of this work the report focuses primarily on addressing the waste that has been generated. While efforts should always continue to minimise waste production, this issue has not been addressed directly in this study.

As stated in the Summary and recommendations of the report, "*Managing food waste in the NHS*" (2005, efm-standards)[1]:

"*The inherent uncertainties and fluctuations in demand for food services mean that waste cannot be eliminated completely. However, with careful planning, consideration for patients' needs and co-operation from all those involved, healthcare providers may reduce food waste whilst still providing a quality service.*"

However, it is important to ensure that the results of on-going achievement of waste minimisation are considered as part of the process of predicting the capacity that will be needed to manage food waste in the future. When determining the suitability of any alternative waste management and treatment system, the following guidance from the same report should be kept in mind:

"*Levels of food waste can be considered acceptable when any attempt to reduce them would compromise quality, patient/client choice and nutritional intake or when the cost of monitoring and addressing exceeds the financial value of waste itself.*"

1.3 The Waste (Scotland) Regulations 2012

The key aspects of the Waste (Scotland) Regulations 2012 (the regulations) relating to hospitals and their management of food waste is summarised below. More information is available on http://www.zerowastescotland.org.uk/category/subject/waste-scotland-regulations

1.3.1 Which hospitals are affected

Once the regulations are implemented, all hospitals in Scotland will fall under its governance, unless:

- The hospital is designated as being in a 'rural' area;
- The hospital produces less than 5kg of food waste per week; or
- Any of the food waste involved is classed as "catering waste that originates from means of transport operating internationally"

For the avoidance of doubt the regulation draws on *Section 108 of the National Health Service (Scotland) Act 1978(b)* for its definition of what a hospital is.

A 'rural' area is defined as a remote small town, accessible rural area or remote rural area as described by reference to postcode units in Table 2 of "*Defining Rural Areas and Non Rural Areas to support Zero Waste Policies*"(c), published by the Scottish Government on 13th March 2012. Information is also available from: www.zerowastescotland.org.uk/RuralPostcodeSearch

[1] http://www.hospitalcaterers.org/documents/foodwst.pdf

1.3.2 Timing of implementation

For Scottish hospitals, implementation of the regulations with respect to food waste will begin on 1st January 2016. The requirements for segregated collection of key dry recyclable materials referred to in the regulations, namely as paper, card, plastics, cans and glass, will apply from 1st January 2014.

1.3.3 Impact on food waste management

The regulations put in place a requirement to take all reasonable steps to ensure the provision of a separate collection of food waste by non-rural hospitals producing more than 5kg of food waste per week. There is an option for the food waste to be combined with other biodegradable waste material, e.g. garden wastes, providing that mixing the materials does not result in less food waste being collected than would occur if the materials were collected separately. This is because the separate collection of food waste has the highest priority, and there is a school of thought that combined collection with other biodegradable wastes can reduce the absolute amount of food waste that is collected, compared with it being collected on its own.

The regulations also put in place a requirement to prohibit the discharge of food waste to public drains or sewers by non-rural hospitals producing more than 5kg food waste per week. Please note, this does not prohibit the use of macerator units or similar technology, but rather constrains the disposal routes.

In order to obtain clarity of what food waste management options would be acceptable under the regulations, the Scottish Environment Protection Agency (SEPA) were contacted and asked specific questions. The questions and SEPAs responses to them are presented in the Appendix 1. This information has been used to inform a brief summary of the generic methods that can be used for food waste collection and treatment (via anaerobic digestion (AD) or in-vessel composting (IVC)) by hospitals and their likely acceptability when the regulations are implemented.

Based on communications with SEPA, Resource Efficient Scotland and ORA understand that while the food waste storage and pre-treatment systems cited in Table 1 i.e.: tank, bins, dewatering, drying and thermal aerobic treatment are acceptable for use prior to separate collection of food waste under the Waste (Scotland) 2012 Regulations, their outputs cannot be used as compost or digestate without treatment in an Animal By Products Regulation (ABPR) compliant and authorised treatment facility, such as a compliant AD or IVC plant. SEPA will be formalising this position with interim regulatory guidance. Queries regarding waste pre and post treatment technology compliance should be sent to Zerowaste@sepa.org.uk.

Please note, the order in which the technologies are listed does not represent any form of hierarchy or infer a preference.

Method of food waste management	Acceptability under the Waste (Scotland) Regulations 2012
On-site Pre-treatment	
Tank – Storage of source segregated food waste in tank for treatment at an AD or IVC facility	**Acceptable**
Bins – Storage of source segregated food waste in bins prior to separate collection for treatment at an AD or IVC facility	**Acceptable**
Dewatering – Disposal of liquid fraction of source segregated food waste to sewer, whilst solid fraction is stored prior to dispatch to an AD or IVC facility. Assumes that dewatering system is 'configured to maximise the capture of organic material for recycling[2].'	**Acceptable**
Drying – Application of heat to evaporate water. This is recondensed and sent to sewer. The remaining solids are collected for disposal via AD or IVC.	**Acceptable**
Thermal aerobic pre-treatment – Heat is applied which evaporates water to the atmosphere. Thermophilic, aerobic bacteria are also added to minimise the mass of solids which are then collected for disposal via AD or IVC.	**Acceptable**
Liquefying – Disposal of food waste to sewer using alternative technology to the macerators, e.g. rapid AD, etc.	**Not Acceptable***
On-site Treatment	
On-site AD or IVC facility – Small-scale AD or IVC facility. Assumes that operation is compliant with Animal By-Products[3] and Waste Management Licensing[4] Regulations	**Acceptable**
Off-site Treatment	
Off-site AD or IVC – Treatment of source segregated food waste at a third party AD or IVC facility. Assumes that operation is compliant with Animal By-Products and Waste Management Licensing Regulations, and that the output results in PAS 100[5] compost or PAS 110[6] digestate.	**Acceptable**
Mechanical and Biological Treatment (MBT) – Disposal of either source segregated or unsegregated food waste to MBT facility for subsequent recovery.	**Not Acceptable***
Incineration – Disposal of either source segregated or unsegregated food waste to an incinerator	**Not Acceptable***
Sewer – Disposal of food waste to sewer via a macerator or other type of liquefier	**Not Acceptable***
Landfill – Disposal of food waste to landfill	**Not Acceptable***

Table 1: Acceptability of food waste management options

* Where exceptions to the requirements of the Waste (Scotland) Regulations are sought, robust evidence must be provided to SEPA for assessment of 'reasonableness'.

[2] Duty of Care – A Code of Practice (Scottish Government)
[3] Animal By-Products (Enforcement) (Scotland) Regulations 2011
[4] Waste Management Licensing (Scotland) Regulations 2011
[5] http://www.wrap.org.uk/content/bsi-pas-100-compost-specification
[6] http://www.wrap.org.uk/content/bsi-pas-110-producing-quality-anaerobic-digestate

2 Survey of hospitals

The first task was to gain a practical understanding of how food waste is managed in a working hospital environment. This involved the following elements:

- Agreement with Resource Efficient Scotland regarding the scope of the survey, the availability of relevant information, and information that should be sought;
- Selection of NHSS Board areas;
- Selection of specific and representative hospitals;
- A questionnaire for hospitals to complete (see questionnaire form in Appendix 2)
- Site visits to a total of 33 hospital sites;
- Follow-up questions at Board and/or hospital level, where appropriate

2.1 Scope of the survey

Following discussion with Zero Waste Scotland, it was decided that the survey of hospitals should be widened to include a greater cross-section of hospitals than was originally envisaged. The survey was therefore extended to include smaller urban hospitals that would also be required to comply with the Waste (Scotland) Regulations 2012.

This approach was adopted to allow a better understanding as to how the management of food waste at these hospitals is currently handled and how it might be adapted and, if possible, co-ordinated with the management of food waste at larger hospitals. It was hoped that this approach would allow these smaller hospitals to benefit from an economy of scale that would not otherwise be possible if they managed their food waste independently.

The surveys were carried out with a view to gaining a practical understanding of the following key issues:

- Current approach and future objectives to food waste management, including waste management strategy;
- Current approach to communication with regard to waste management;
- Any existing issues, e.g. staff engagement, contamination, etc.;
- Availability of data collected regarding waste management, including food waste;
- If waste data is not collected, available or has gaps, to implement a data collection regime and visual observations to allow quantification of non-macerated food waste;
- Other organic waste streams that could be co-collected or treated with food waste, e.g. garden waste, used paper towels, etc.;
- Current waste collection and treatment contracts;

- Availability of information on costs associated with food waste disposal;
- Catering operations in practice, kitchen layouts, and indoor/outdoor storage areas, in restaurants and canteens, to design appropriate food waste collection options;
- Provision of meals to patients on wards, to understand where practices could be changed to separately collect food waste;
- Current waste collection areas and waste transport activities, to understand how segregated food waste collections can be integrated with current services; and
- Potential areas for location of on-site food waste treatment facilities

ORA developed a questionnaire to address what were agreed to be the key issues. The issues discussed and information provided was recorded for each visit, and photographs were taken where appropriate. This additional information has been provided to Resource Efficient Scotland.

2.2 Participating NHSS Board areas

The production and management of food waste was investigated in the following NHSS Board areas:

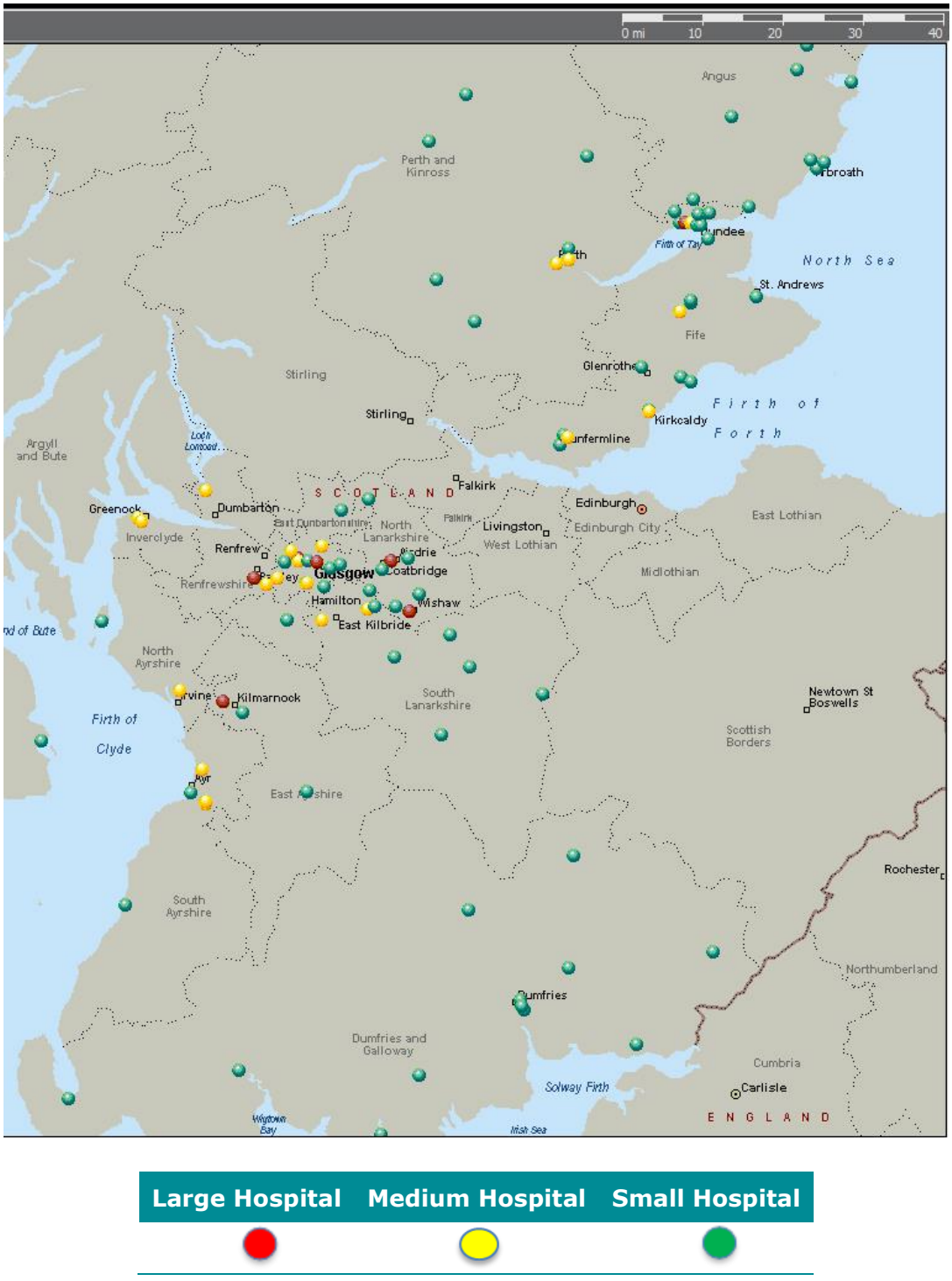
- Ayrshire and Arran
- Dumfries and Galloway
- Fife
- Greater Glasgow and Clyde
- Lanarkshire
- Tayside

Following consultation with Zero Waste Scotland and representatives of each NHSS board, a number of hospitals were selected to provide a cross-section of hospital type, size and location within the Board areas, thus allowing a wide range of food waste management practices to be reviewed.

The NHSS Boards also provided appropriate contact details for each of the hospitals. This level of co-operation was very welcome and assisted greatly with implementation of the study. The people contacted at Board level also provided a useful overview of the key issues that needed to be considered when managing the implementation of requirements to comply with the Waste (Scotland) Regulations 2012.

The locations of the hospitals considered for inclusion in the hospital survey are shown in Figures 1 to 3 respectively. The distribution, from heavily clustered hospitals in Glasgow and Dundee, to the much more widely dispersed and often smaller hospitals in other locations can clearly be seen in these maps.

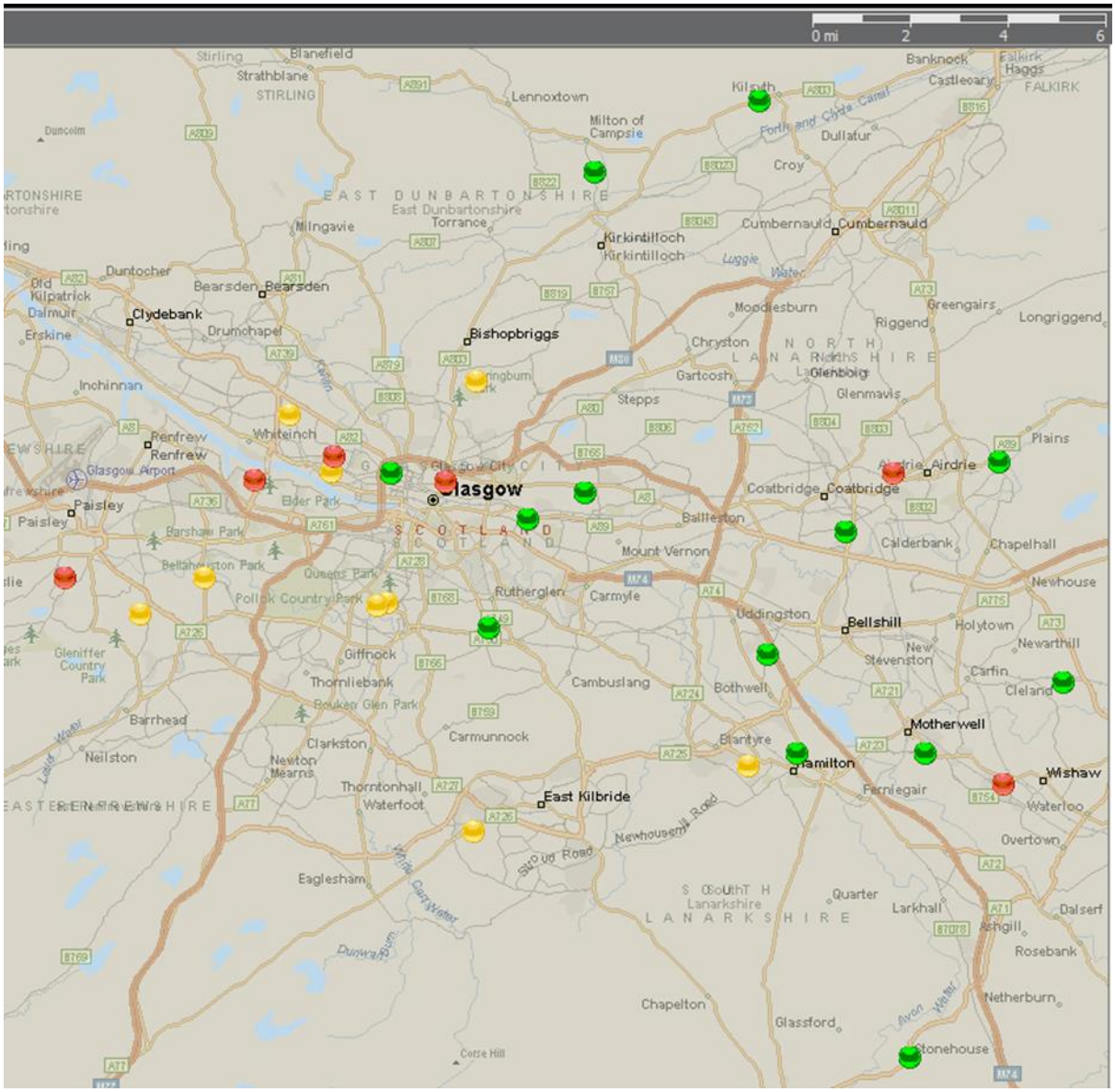
Figure 1: Distribution of hospitals within the surveyed NHSS Board areas



Large Hospital	Medium Hospital	Small Hospital

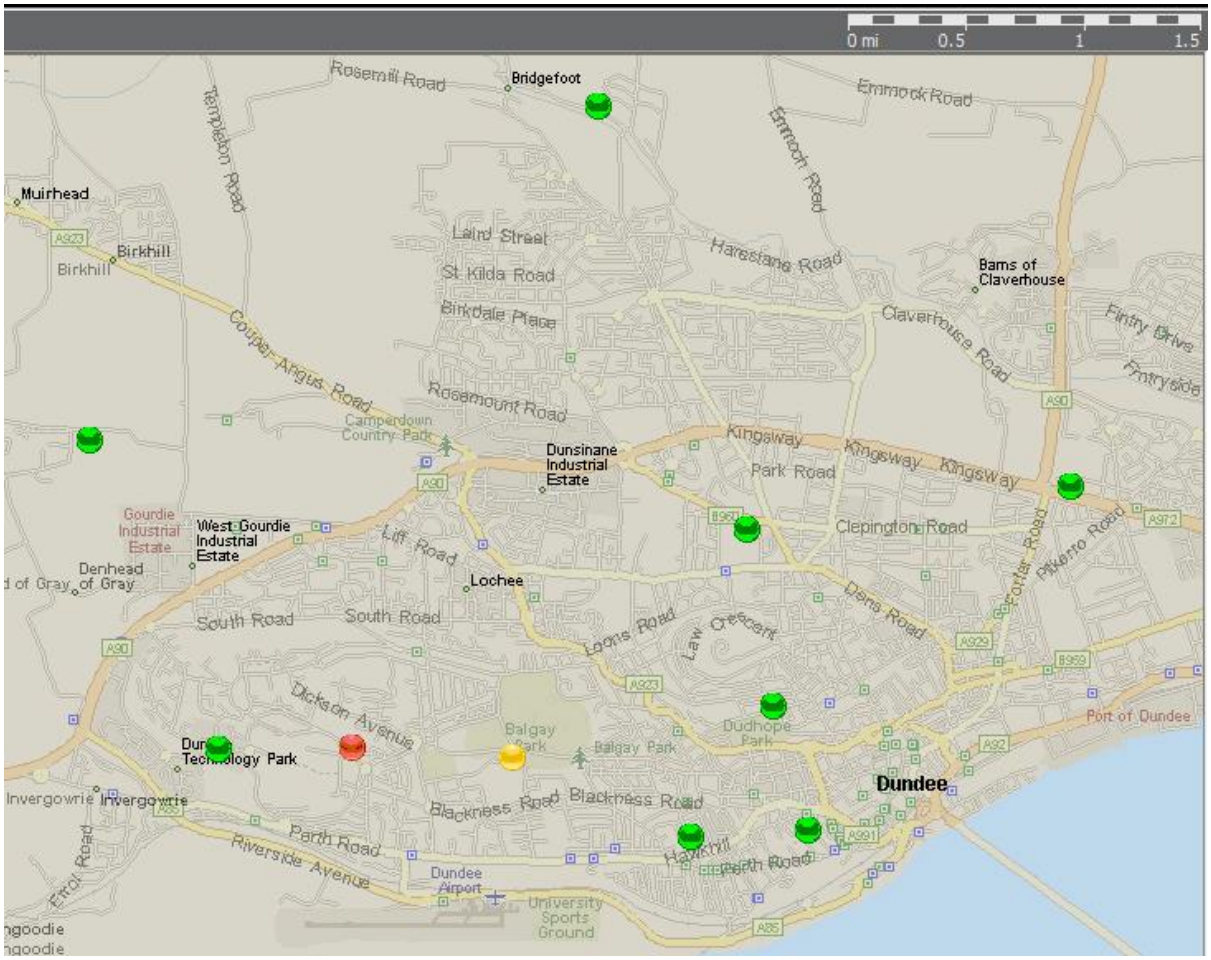
Large hospitals are typically assumed to have more than 500 beds, medium ones have between 100 and 500 beds and small hospitals have less than 100 beds.

Figure 2: Enlarged map showing the distribution of hospitals in NHSS Greater Glasgow and Clyde



Large Hospital	Medium Hospital	Small Hospital

Figure 3: Enlarged map showing the distribution of hospitals in Dundee (NHS Tayside)



Large Hospital	Medium Hospital	Small Hospital

The details of the hospitals visited can be found in Table 2, alongside the key issues that were identified during the study to assist in the selection of the most appropriate methods of complying with the Waste (Scotland) Regulations 2012. This information is summarised as a Food Waste Flow number, which is explained in detail in Section 2.3.

NHSS Board	Hospital	Size	Method of meal preparation	Current food disposal method	Food Waste Flow
Ayrshire & Arran	University Hospital Crosshouse (UHC)	Large	From raw on site	Main kitchen macerators (x3)	1.1
	Biggart Hospital	Medium	Hot box from UHA. Chips, fish and egg cooked on-site	Main kitchen macerator for breakfast & dining room waste. Ward waste returned to UHA	1.2
	Ailsa Hospital	Medium	From raw on site	Main kitchen macerator	1.1
	Kirklandside Hospital	Small	Hot plate from UHC	Three macerators – Dining Room, Ward 1 and Day Hospital	2.2
	University Hospital Ayr (UHA)	Medium	From raw on site	Main kitchen macerator plus one in trolley emptying area	1.1
Dumfries & Galloway	Dumfries & Galloway Royal Infirmary	Medium	From raw on site	Main kitchen macerator (x2) Bones to landfill	1.1
	Midpark Hospital	Small	Delivered from DGRI	Two macerators in wash-up areas	1.2
Fife	Queen Margaret Hospital	Medium	From raw on site (60%) Cook-freeze (40%)	Main kitchen macerators (x2)	1.1
	Victoria Hospital	Medium	Cook-freeze Some fresh fruit & veg.	Main kitchen macerators (x4)	1.2
	Stratheden Hospital	Medium	From raw on site	Ward level maceration Two other macerators	2.1
Greater Glasgow & Clyde	Southern General	Large	Cook-freeze Fresh cooked for staff/visitors	Zonal kitchen maceration	2.1
	Glasgow Royal Infirmary	Large	Cook-freeze	Double bagged, taken by Shanks	1.2
	Royal Alexandra Hospital	Large	Cook-freeze (with CFPU)	Ward-level maceration	2.2
	Inverclyde Hospital	Medium	Cook-freeze (with CFPU)	Main kitchen Waste2O System	1.2
	Stobhill Hospital	Medium	Cook-freeze	Ward-level maceration (x7) Some double bagged, taken by Shanks	2.2

NHSS Board	Hospital	Size	Method of meal preparation	Current food disposal method	Food Waste Flow
Greater Glasgow & Clyde	Vale of Leven District General Hospital	Medium	Cook-freeze	Main kitchen macerator	1.2
	Gartnavel General Hospital	Medium	Cook-freeze	Main kitchen macerator	1.2
	Leverndale Hospital	Medium	Cook-freeze	Double bagged, taken by Shanks	3.2
	New Victoria Hospital	Medium	Cook-freeze	Ward-level maceration	2.2
	Dykebar Hospital	Medium	Cook-freeze	Ward-level maceration	2.2
	Lightburn Hospital	Small	Cook-freeze	Double bagged, taken by Glasgow City Council	3.2
	Parkhead Hospital	Small	Cook-freeze	Double bagged, disposed of with residual waste (MBT)	3.2
Lanarkshire	Monklands Hospital	Large	Cook-freeze	Main kitchen Meiko System	4.2
	Hairmyres Hospital	Medium	Cook-freeze	Ward-level maceration Main kitchen macerator	2.2
	Udston Hospital	Medium	Cook-freeze	Ward-level maceration	2.2
	Wester Moffat Hospital	Small	Cook-freeze	Ward-level maceration	2.2
	Coathill Hospital	Small	Cook-freeze	Ward-level maceration	2.2
Tayside	Ninewells Hospital	Large	From raw on site	Main kitchen macerator Some general waste	1.1
	Perth Royal Infirmary	Medium	From raw on site	Main kitchen macerator	1.1
	Murray Royal Hospital	Medium	Ready made from PRI	Ward-level maceration	2.2
	Royal Victoria Hospital	Medium	From raw on site	Ward-level maceration (x9)	2.1

Table 2: Summary of hospitals surveyed and visited

The appropriate person in the catering or domestic department of each of the hospitals visited was contacted by telephone to arrange and agree a date and time for a visit to their facility. These hospital visits were completed during March 2013. A survey was also undertaken as part of the same telephone call, as appropriate.

During the site visit, an ORA team member was taken on an escorted tour of the hospital, to observe the movement of food through the hospital; specifically the:

- Reception of food on site;
- Storage of food;
- Preparation of food in kitchens or regenerated on wards;
- Serving of food on wards or via serveries near wards;
- Management of food waste either in main kitchen, on wards or kitchenettes near wards; and
- Storage and collection point for food waste on site

During the site visits information was collected via face-to-face discussions, and photographs were taken of the equipment and potential storage areas for waste on site.

2.3 Current methods of food waste management

During the site visits to the hospitals, it became apparent that one of the biggest barriers to finding an optimal solution to the management of food waste was the fact that the hospitals varied considerably in the way that food waste was both generated and managed. It is therefore unlikely that there is a single optimal solution that will suit all situations.

There were also many subtle differences between the hospitals. However, there were sufficient similarities between food waste management methods to determine four generic types (Food Waste Flows) and their associated sub-types. These are described in Table 3, with the key differences between the Food Waste Flows indicated with bold text.

Food Waste Flow 1 Segregated food waste disposed of in main kitchen to sewer	
1.1 Raw Ingredients • Food waste from preparation is disposed of in main kitchen via a macerator to sewer • Return of plates with food scrapings, unserved meals or bulk service trays containing food waste to the main kitchen • Food waste is disposed of via macerator to a sewer in the main kitchen	**1.2 Cook-freeze or Cook-chill** • Return of plates with food scrapings and bulk service trays containing food waste to the main kitchen • Food waste is disposed of via macerator to sewer in main kitchens • Plates are washed in the main kitchen
Food Waste Flow 2 Segregated food waste disposed of to sewer in kitchenette near Wards	
2.1 Raw Ingredients • Food waste from preparation is disposed of in main kitchen via a macerator to sewer • Plates with food scrapings, unserved meals or bulk service trays containing food waste taken to kitchenette • Food waste is disposed of via a macerator to sewer in kitchenette • Plates washed in kitchenette	**2.2 Cook-freeze or Cook-chill** • Plates with food scrapings, unserved meals or bulk service trays containing food waste taken to kitchenette • Food waste is disposed of via a macerator to sewer in kitchenette • Plates washed in kitchenette
Food Waste Flow 3 Food waste mixed with general waste, disposed of in central general waste area	
3.1 Raw Ingredients • Food waste from preparation is disposed of in kitchen. Food waste is put into double wrapped black bags along with other general waste • Return of plates with food scrapings, unserved meals or bulk service trays containing food waste to the main kitchen or kitchenette • Food waste is put into double wrapped black bags along with other general waste • Black bags are taken to a central general waste collection point where it is taken for treatment via an MBT/MRF, landfill or energy from waste facility	**3.3 Cook-freeze or Cook-chill** • Return of plates with food scrapings, unserved meals or bulk service trays containing food waste to the main kitchen or kitchenette • Food waste is put into double wrapped black bags along with other general waste • Black bags are taken to a central general waste collection point where it is taken for treatment via an MBT/MRF, landfill or energy from waste facility
Food Waste Flow 4 Segregated food waste disposed of in main kitchen, then sent to a storage tank	
4.1 Raw Ingredients • Food waste from preparation is disposed of in the kitchen and sent via positive or negative pressure to a storage tank which is emptied and taken to IVC or AD • Return of plates with food scrapings, unserved meals or bulk service trays containing food waste to the main kitchen • Food waste is disposed of in the main kitchen and sent via positive or negative pressure to a storage tank which is emptied and taken to IVC or AD	**4.2 Cook-freeze or Cook-chill** • Serving on wards as bulk service • Return of plates with food scrapings and bulk service trays containing food waste to the main kitchen • Food waste is disposed of in the main kitchen and sent via positive or negative pressure to a storage tank which is emptied and taken to IVC or AD

Table 3: Description of Food Waste Flows used in this report

2.4 Current food waste arisings

The measurement of food waste arising from unserved plated meals and servings from bulk service is performed routinely. However, this data is not expressed in terms of mass (kg) or volume (litres), and it does not include plate scrapings, food preparation waste or any other sources of food waste generation at the hospital. Therefore, although the data is available, it is of little direct use when equating the scale and cost of waste management technology and associated logistics, as these typically require a knowledge of the total mass and volume of waste that requires treatment over a given period.

During the site visits, catering staff were found to be aware of this limitation in knowledge. They typically cited the audit data compiled by the Health Facilities Scotland (HFS) Catering Services Advisory Group (CAG) as the main source of mass and volume information. Where Resource Efficient Scotland had previously undertaken an independent audit of food waste volumes and disposal routes, this was also referred to.

It was also noted that, as the CAG data was typically collected on a single day, it can only provide a "snap shot" of the waste produced at each hospital. It is not possible to quantify how representative these values are over a full year. However, because the samples were taken over a large number of hospitals, there is a large data set to work with to indicate inter-hospital variation – but not intra-hospital variation – over time.

Resource Efficient Scotland had previously obtained information on the disposal of food waste via in-sink macerators across the NHSS estate, as part of project SUP002-006 Macerated Food Waste Disposal. The data gathered used a more comprehensive method of measurement and was clearly reported. However, it did not cover all of the hospitals surveyed.

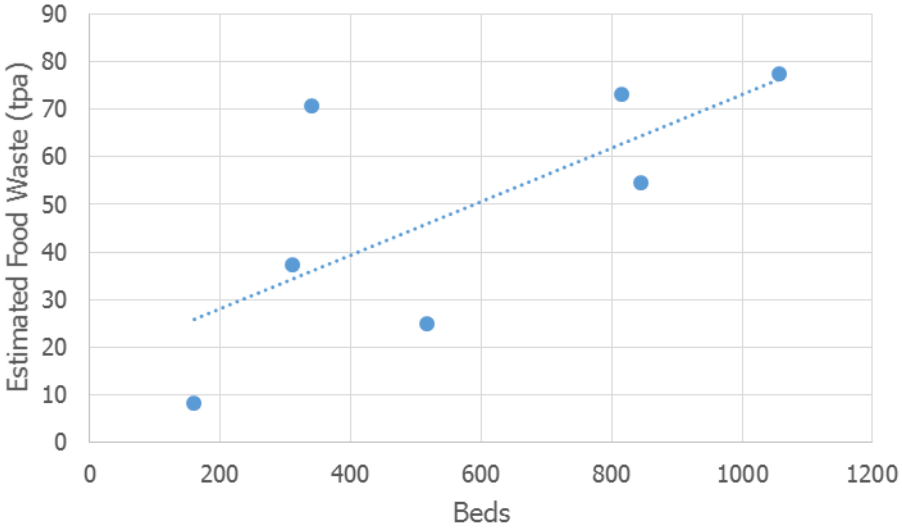
In order to illustrate the variability of the data that was available two sources of data have been presented in Table 4 for the Victoria Infirmary in Glasgow.

Source of data	Food waste (tpa)
HFS CAG Survey 2013	70.6
SUP002-006 Macerated food waste disposal	41.6

Table 4: Variations in food waste data estimations, Victoria Infirmary (Glasgow)

Variability in the CAG data in terms of the amount of waste that is produced relative to the size of the hospital, expressed by the number of beds, can be seen in Figure 4. This shows the amount of waste that was estimated to have been produced by seven general acute hospitals in the Greater Glasgow and Clyde Board area.

Figure 4: Estimated food waste production, NHSS Greater Glasgow & Clyde (HFS CAG Survey 2013)



It is apparent from Figure 4, and from conversations with individuals in the surveyed hospitals, that there is a need for more reliable data on food waste production in order to make accurate predictions on the required food waste treatment capacity for individual hospitals and across the NHSS board areas as a whole. Routine waste auditing will also allow the effect of these changes to be measured and assist in the improvement of the waste management system as whole.

In many situations where there is need to establish waste arisings for a population of people over the long term, such as in Local Authority collection schemes for household waste, quarterly sampling is carried out to account for seasonal variation. Any audit period used by the NHSS should cover a period over which variation could occur, such as weekends, and should be carried out for a minimum of one week (and possibly over one menu cycle) to determine whether the type of food offered also affects the amount of waste produced.

3 Food waste management options

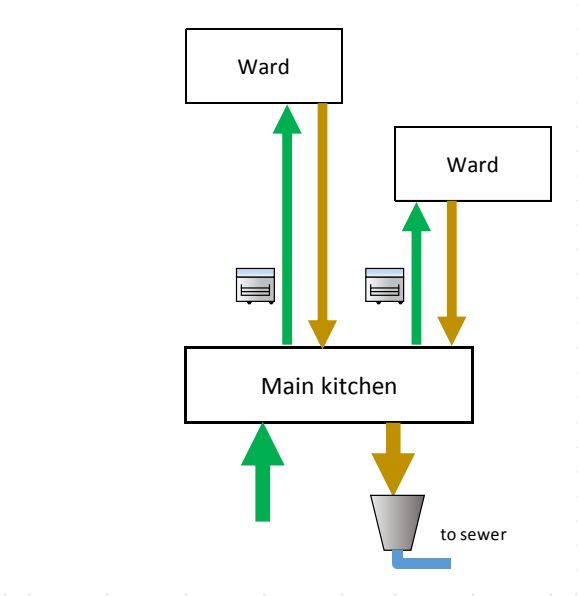
3.1 Return of food waste to an acceptable disposal point

Depending on which Food Waste Flow scenario a hospital is currently using, changes may need to be made to the flow of food waste internally in order to bring it back to a central location, such as a main kitchen, for disposal. One way that this can be achieved is through reverse logistics, which is where the method to deliver the food to patients – usually a trolley system – is used to return the food waste to the identified central location.

This method of reverse logistics is already in place for Food Waste Flows 1 and 4, as the food waste is already returned to the main kitchen. This is illustrated in Figure 5, using Food Waste Flow 1 as an example. For Food Waste Flow 4, the final stage disposal to sewer would be replaced with disposal to a storage tank.

No change needs to be made for the movement of food waste from the wards, whether the system utilises raw food preparation or a Cook-freeze/Cook-chill arrangement.

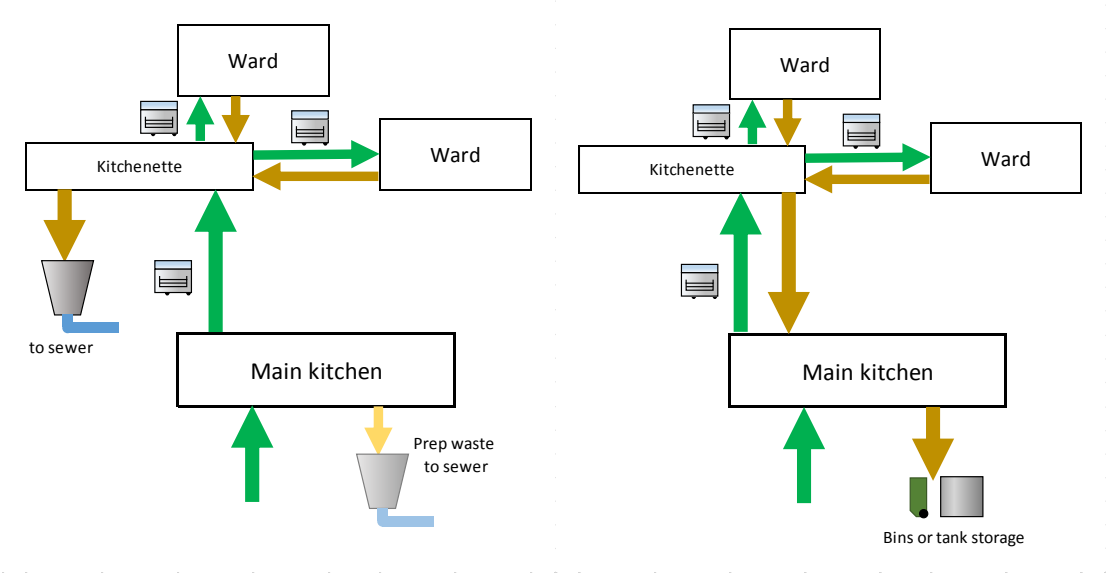
Figure 5: Return of food waste to main kitchen using reverse logistics*



* The flow of food is indicated by green arrows and food waste with brown arrows.

In order to implement reverse logistics within hospitals who dispose of food waste to a sewer via macerator located in kitchenettes (Food Waste Flow 2) or with the general waste (Food Waste Flow 3), the flow of food waste would need to be altered to return it using reverse logistics to a central disposal location (e.g. the main kitchen), as shown in Figure 6.

Figure 6: Food Waste Flow 2 before (left) and after (right) the implementation of reverse logistics



Examples of where this approach has already been implemented are Monklands, Ayrshire Central and Girvan hospitals which now return the food waste to the main kitchen in buckets or caddies, from where it is then sent to a food waste storage tank. There are also examples of hospitals who still dispose of food waste to sewer, but who also already have a reverse logistics system in place that would allow the food to be returned to the main kitchen, e.g. Midpark (Dumfries and Galloway) and Victoria (Fife) hospitals. They use food waste caddies carried with the regeneration and serving trolleys.

This form of reverse logistics is, therefore, already proven in practice and is also compliant with HACCP requirements. The buckets or caddies (typically 20-30 litres capacity) are clean when they go out with the food on the trolleys, and are returned full with the empty trolleys to be taken to the wash up area where other food waste is present. The buckets are then emptied and put through the dishwasher, ready for sending out again with the food trolleys.

Figure 7: Clean, empty food waste buckets on trolleys at Monklands Hospital

Figure 8: Vacuum and tank system, Ayrshire Central (left) and food waste bucket being emptied (right)

3.2 On-site food waste pre-treatment technology and storage options

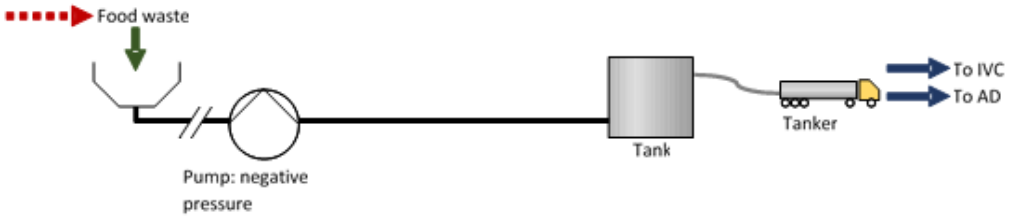
ORA undertook a survey of companies that supply technology that has the potential to be appropriate for use in hospitals, in order to be compliant with the introduction of the Waste (Scotland) Regulations 2012.

The following primary options are considered from a technical viewpoint and are labelled as Options A-G for further reference. For regulatory issues, please see Section 1.3.

In the following pre-treatment options, the red arrows show when man-power is required. In all of the options that take source segregated food waste to in-vessel composting (IVC) or anaerobic digestion (AD), collection using road vehicles can be excluded and on-site treatment technology considered in its place.

3.2.1 Option A – Vacuum pump plus tank

This option utilises a vacuum pump to move source segregated food waste to a central tank, which can then be accessed by a tanker for off-site treatment. Additional water is not required for the main operation of the technology, but is typically used to wash the system through at the end of the day.

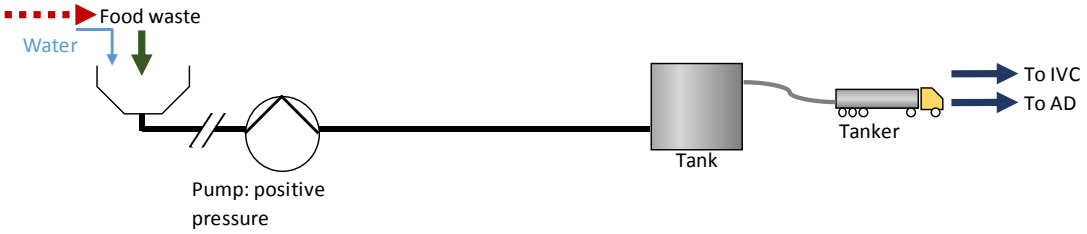


Man power is required to feed waste to the system.

This method has been trialled at Ayrshire Central and Girvan hospitals. The system has proven to be a practical option at both sites, with the contents of the tank collected when it is around 70% full. The frequency of collection depends on the rate of production of food waste and any addition of water, e.g. the tank is emptied typically once every four weeks at Ayrshire Central.

3.2.2 Option B – Positive pressure pump plus tank

This option utilises a positive pressure pump to move source segregated food waste and added water to a central tank, which can be accessed by a tanker for off-site treatment.

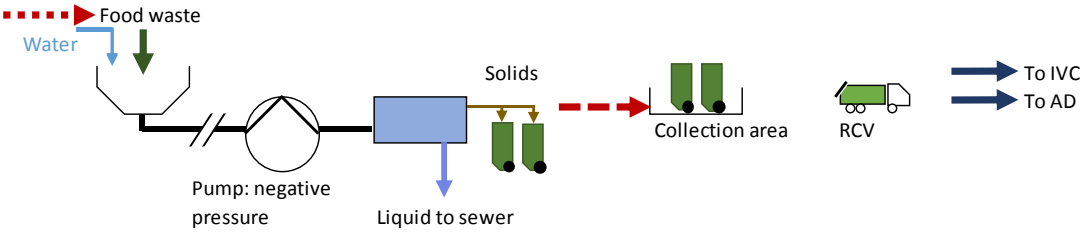


Man power is required to feed waste to the system.

This system has also proved to be a practical option at Monklands. The contents of the tank are also collected when the tank is around 70% full.

3.2.3 Option C – Combined vacuum pump and dewatering plus bins

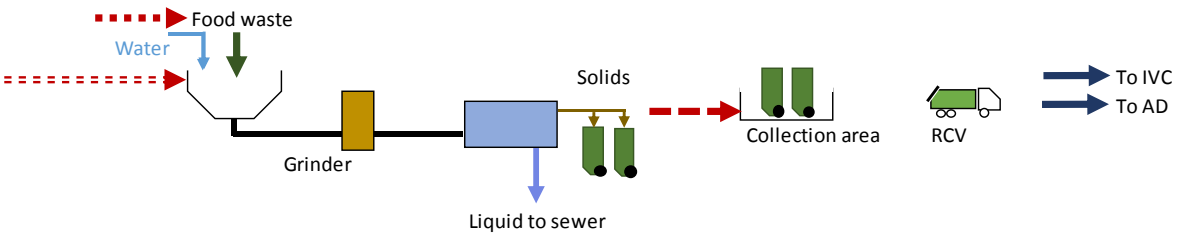
This option utilises a vacuum pump to move food waste and added water to a central dewatering plant. The dewatering plant outputs liquids to sewer and solids to bins. The bins can be left for collection by a refuse collection vehicle (RCV), which takes the solid fraction of the source segregated waste for off-site treatment.



Man power is required to feed waste to the system and to move bins from the dewatering plant to the collection area.

3.2.4 Option D – Dewatering plus bins

In this option, the food waste and added water are fed into a grinder and dewatering plant. The dewatering plant outputs liquids to sewer and solids to bins. The bins can be left for collection by an RCV, which takes the solid fraction of the source segregated waste for off-site treatment.

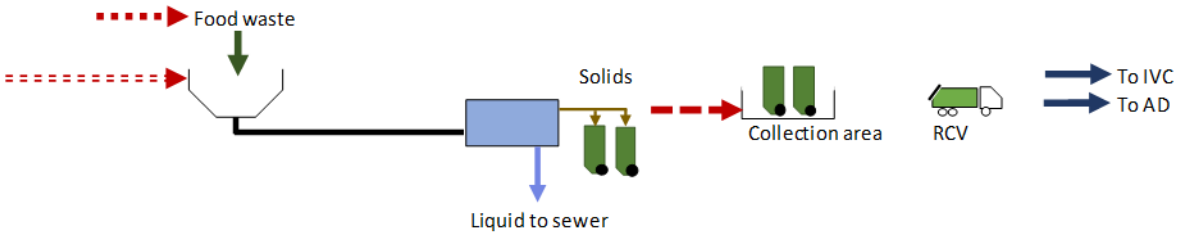


Man power is required to move waste from source to the dewatering system, but only if this has not been co-located. It is also required to feed waste into the system, and to move bins from the dewatering plant to the collection area.

None of the hospitals visited during this study had a dewatering system installed. However, a dewatering system has been installed by Imperial College London.

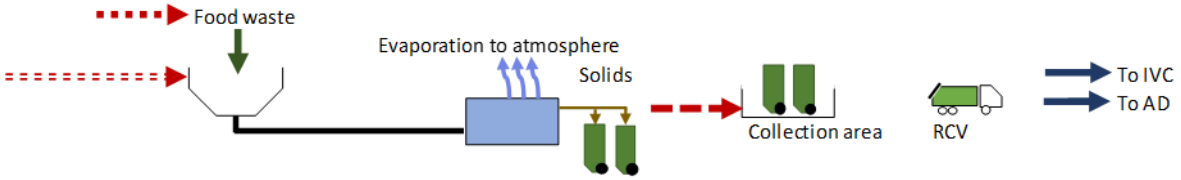
3.2.5 Option E – Drying, plus bins

In this option the food waste is fed directly to the drying plant. The drying plant evaporates water which is then recondensed and put to sewer. The remaining solids are output to bins. The bins can be left for collection by an RCV which takes the solid fraction of the source segregated waste for off-site treatment.



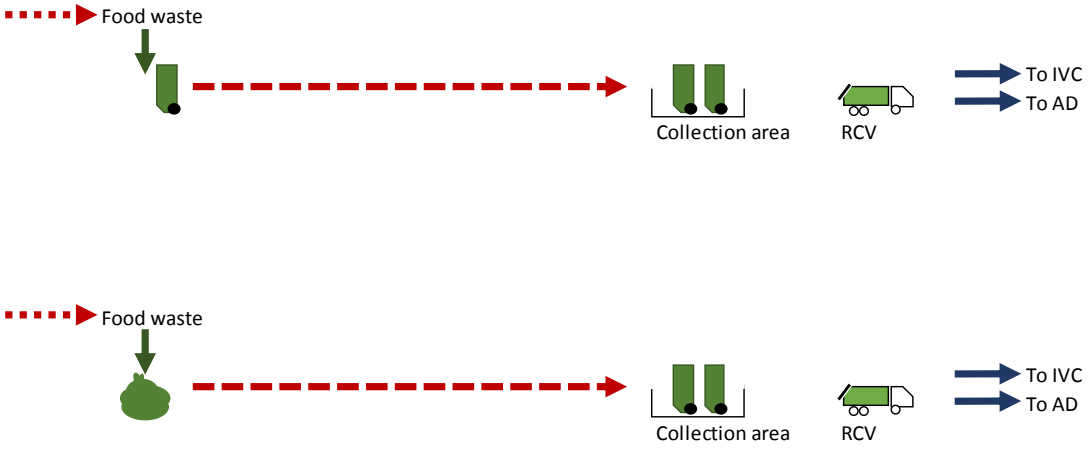
3.2.6 Option F – Thermal aerobic pre-treatment, plus bins

In this option the food waste is fed to the pre-treatment plant. At this stage biological additives may be added. The pre-treatment plant outputs water to atmosphere and solids to bins. The bins can be left for collection by an RCV which takes the solid fraction of the source segregated waste for off-site treatment.



3.2.7 Option G – No pre-treatment, plus bins

In this option the food waste is put into bags or bins at source. The food waste is then transported by porters, either in bags or bins, to the waste collection point within the hospital. When bags are used, they are put into the bins at the collection point. From there the bins are collected by an RCV or via bin replacement service using a low loader lorry, which takes the source segregated food waste for off-site treatment.



Man power is required to put food waste into the bins and/or bags, and to move bins/bags from the source to the collection area. There is no pre-treatment technology required.

The storage of food waste in bins for separate collection is a proven method in commercial situations such as supermarkets[7] and commercial kitchens. This is a flexible system in terms of the size and location of the bins that can be tailored to an individual situation. The bins are durable; they have lids, can be washed to maintain hygienic conditions and can either be emptied on site by a refuse collection vehicle (RCV) or removed and replaced with cleaned bins with a low loader vehicle that is fitted with a tail lift.

None of the hospitals surveyed operated a system where the waste food was collected in bins. However, Resource Efficient Scotland is aware that Midlothian Community Hospital (NHS Lothian) and Stirling Community Hospital (NHS Forth Valley) do use bins for source segregated food waste.

When this option was considered, concerns were raised by operational staff regarding the need for frequent collection to avoid problems with vermin and flies, the need for clean bins to comply with HACCP procedures, and the time and effort associated with manual handling. However, the hospitals that operate this system did not report having any of these problems to Resource Efficient Scotland.

[7] Zero waste to landfill, Katie Hague, The Co-operative, RWM Exhibition London, 11th September 2013

3.2.8 Examples of pre-treatment technology provision

The key issues that will need to be determined as part of the procurement of the pre-treatment technology include but are not necessarily limited to:

- Capital cost;
- Lifecycle replacement costs of major components of the system;
- Operating costs:
    - Labour
    - Electricity
    - In some cases, gas
    - Water
    - Spare parts in store
- Performance guarantees;
- Acceptance tests;
- Handover procedures from the technology provider to the hospital staff;
- Warranties; and
- Ongoing technical support including:
    - Servicing
    - Call out in the event of unplanned maintenance and repair
    - Help line and remote telemetry

Please note that neither Resource Efficient Scotland nor ORA can vouch for the accuracy of the claims made by the technology providers regarding the technical and financial aspects. These issues can only be determined via a formal tendering process that considers these issues for a particular situation.

Table 5**Error! Reference source not found.** provides a summary of the key technical information and costs provided by a range of on-site technology providers in response to a standard set of questions. It is interesting to note the wide range of answers received, in terms of the units used – this reflects the different ways in which different technology providers present the performance of their technology. In procurement, it will be necessary to ask more direct questions that allow the tenders to be compared more efficiently on a like-for-like basis.

The key issues the technology providers would require that are likely to be specific to an individual hospital's particular circumstances include:

- The required throughput per hour (rather than the daily or annual quantity);
- The proposed operating hours;
- Location of the unit within the hospital;
- The preferred form of the output; and
- The method of output handling and disposal

Indicative Treatment Type	Pre-treatment type	Throughput	Water Use	Power Rating	Solid Fraction Yield	Capex
Vacuum pump, plus tank	A	Entry unit 1,500kg/hr. (single station)	10-15 l/d	20 kW	N/A	£138,500
Positive pressure pump, plus tank	B	1,620 kg/hr. (single macerator)	78 l/hr.	3.7 kW	N/A	£50,000
Combined vacuum pump and dewatering, plus bins	C	2100 kg/hr. (covering three macerator units)	840 l/hr.	100 kW	20-40 kg	£179,100
Combined vacuum pump and dewatering, plus bins	C	750 kg/hr.	156 l/hr.	20 kW	50kg	£76,000
Dewatering, plus bins	D	Entry unit 200 kg/hr. Larger unit 900 kg/hr.	600 l/hr.	2.2 kW 5.1 kW	40-60 kg	£9,888 £13,475
Dewatering, plus bins	D	600 kg/hr.	300 l/hr.	3.5 kW	70 kg	£12,700
Drying plus bins	E	Entry unit 50 kg/day Largest unit 2000 kg/day	0	1.0kW 11.5kW	10 kg	£12,125 £132,050
Drying plus bins	E	Entry unit 30 kg/day Largest unit approx 700 kg/day	0	4kW 25kW	10-15kg	£10,775 £58,675
Thermal aerobic pre-treatment plus bins	F	Entry unit 20 kg/day Largest unit 200 kg/day	0	0.94kW 4.0kW	5kg	Not disclosed

Table 5: Indicative information for different treatment types

Treatment type is described in section 3.2, which explains the different on-site food waste pre-treatment technology and storage options.

Water consumption is based on data supplied by the manufactures that regarding what they would expect under recommended operating conditions.

Power rating is the maximum power that the equipment will safely consume. Please note that this should not be confused with its actual energy consumption, which will be dependent on how the machine is used in practice.

Solid fraction yield is the expected yield of solid output from 100kg of waste input. Capex is the manufacturer's estimate of the capital cost of a unit installed at a typical location. Treatment type is described in section 3.2, which explains the different on-site food waste pre-treatment technology and storage options.

Water consumption is based on data supplied by the manufacturers as to what they would expect under recommended operating conditions.

Power rating is the maximum power that the equipment will safely consume. Please note that this should not be confused with its actual energy consumption, which will be dependent on how the machine is used in practice.

Solid fraction yield is the expected yield of solid output from 100kg of waste input. Capex is the manufacturer's estimate of the capital cost of a unit including installation at a typical location.

3.3 On-site food waste treatment

When considering whether it is appropriate to treat the waste on site within the hospital's grounds, a number of issues need to be considered. The advantages and disadvantages of this option are outlined below:

Advantages:

- Potential for cost avoidance, by removing the the need for a dedicated waste haulage service for food waste from the hopital to an off-site treatment facility
- Potential for renewable energy (heat and power) production on-site via AD
- Potential to improve sustainability by directly demonstrating sustainable recycling/recovery of biodegradable wastes
- Potential public relations benefits if on-site operations are successful and efficient

Disadvantages:

- New responsibility for estates team in terms of management and labour time
- New skill set required to operate both IVC and AD, but especially for AD
- New environmental legislative framework to understand and comply with – non compliance can lead to serious consequences including fines and convictions
- Potential impact on sensitive receptors. The risk of bioaerosols (fungi, bacteria and viruses) would be of particular concern, particularly given the proximity to vulnerable patient groups such as those with a weakened or supressed immune system.
- The operation of the plant requires constant attention 7 days per week, particularly for AD, therefore operator holiday andsickness cover will be essential
- The need to find long term end uses for the compost from IVC or digetate from AD

- Potential risk of negative public relations for the hospital staff, patients and those surrounding the hospital if the facility was badly managed or ran into technical difficulty at no fault of the hospital.

During the visits to the hospitals, concerns were expressed from the catering and domestic staff in terms of who would be responsible for the preparation of the on-site treatment and where it would be located within the hospital grounds.

Given the potential significance of some of the above disadvantages, the concerns raised during the hospital visits and the relatively high cost of the on-site treatment, it was decided in consultation with Zero Waste Scotland that the time would be better devoted in this report to matters such as the management of the food waste within the hospital, pre-treatment technologies and off site treatment.

3.4 Off-site food waste treatment facilities

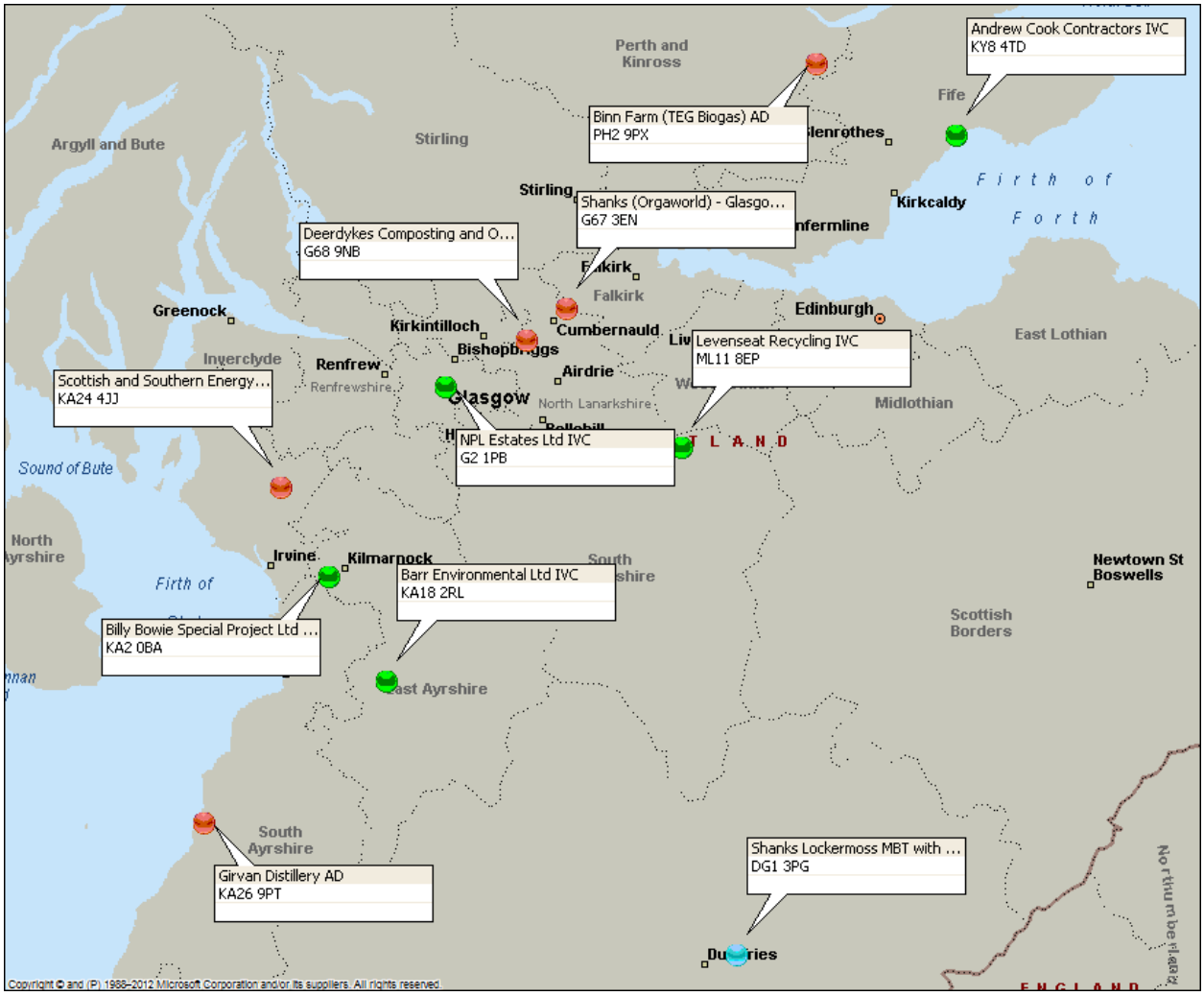
A survey was undertaken of the waste treatment facilities that had the potential to receive source segregated food waste across the area covered by the selected NHSS Boards within the scope of this study. Summary details for each site are provided in Table 6, while the location of the facilities is indicated on the map in Figure 9.

Name	Location	Facility Type	Annual Capacity	Postcode	Map
Binn Farm (TEG Biogas)	Glenfarg, Perthshire	AD	16,000t	PH2 9PX	
Deerdykes Composting & Organics Recycling Facility	Deerdykes, Cumbernauld	AD	30,000t	G68 9NB	
Girvan Distillery*	Girvan, Ayrshire	AD	730,000t	KA26 9PT	
Scottish & Southern Energy (SSE) Barkip Biogas	Ayrshire	AD	75,000t	KA24 4JJ	
Shanks (Orgaworld), Glasgow*	Cumbernauld, North Lanarkshire	AD	60,000t	G67 3EN	
Andrew Cook Contractors*	Fife	IVC	<5,000t	KY8 4TD	
NPL Estates Ltd.*	Glasgow	IVC	<5,000t	G2 1PB	
Barr Environmental Ltd.	Ayrshire	IVC	5-20,000t	KA18 2RL	
Billy Bowie Special Project Ltd.	Ayrshire	IVC	10,000t	KA2 0BA	
Levenseat Recycling*	Lanarkshire	IVC	5-20,000t	ML11 8EP	
Shanks Lockermoss	Dumfries	MBT with IVC	65,000t	DG1 3PG	

Table 6: List of off-site waste treatment facilities for food waste across selected NHSS Board areas

* These facilities received a questionnaire from ORA; however, no response was provided.

Figure 9: Map of facilities noted in Table 6



AD	IVC	MBT with IVC

For more detailed information regarding the type of services provided at these facilities, please refer to Appendix 3.

4 Co-operation in the collection of food waste

4.1 Between hospitals using reverse logistics

Within a Board area, it is often the case that a larger hospital prepares food from raw ingredients and then supplies cooked food to smaller hospitals and day centres in the surrounding area. These hospitals have previously been defined in this report as having Food Waste Flows 1.1, 2.1, 3.1 and 4.1. In this situation there is the potential for the food waste to be returned to the hospital that supplied the food in the first place. A Waste Carriers Licence from SEPA would be required for this to take place, but this is not necessarily a barrier to change as the NHSS have successfully obtained such licences in the past, in order to carry other types of waste.

The food waste could then be disposed of at the larger hospital. This form of "reverse logistics," which is now widely adopted by supermarkets in the UK, results in food waste being returned to a central distribution centre.

Different methods are used to maintain hygienic conditions and to avoid the risk of cross-contamination of food with food waste. This includes using sealed bins, which are then washed before being returned to the hospitals; the use of a split-bodied vehicles to provide an internal barrier between the food waste bins and the food delivery trolleys; and arranging vehicle movements to allow all of the food to be delivered first, and the food waste bins to be collected on the return journey, thereby avoiding food and food waste being in the vehicle at the same time.

With all these methods, the principles of HACCP must be applied to ensure that the system is hygienic and the risk of cross-contamination or by-pass of any systems is avoided.

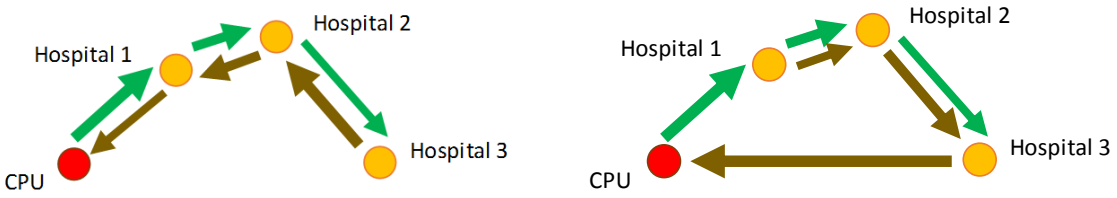
The NHSS could benefit from implementation of this service in the following ways:

- There are no extra vehicle movements associated with a dedicated waste collection service to individual hospitals by a waste collection company;
- Reduced transport cost incurred to waste collection companies;
- Reduced carbon impact associated with transportation of food waste;
- It avoids the requirement and associated cost of installing new waste management technologies at smaller hospitals and day centres;
- It improves the economy of scale associated with the technology for the management of the food waste at the larger hospitals;
- It may also reduce the cost of collection by having a larger tonnage concentrated in one place as a result of a more efficient food waste collection service; and
- There is less disruption caused in the smaller hospitals in terms of operation and installation of the new system

There are two potential options for a reverse logistics system. One option is for the vehicle to deliver the food to each hospital and then on the return journey collect the waste food from each of the hospital to which it had previously delivered food at the same time as collecting the empty food trolleys, as illustrated in Figure 10. This method would avoid the need for the food delivery vehicle to carry food prior to consumption and waste food in the same vehicle at the same time.

The alternative would be for the food delivery vehicle to collect the food waste at the same time as delivering the food and then go onto the next hospital and ultimately return the CPU directly with the food waste. This option would involve carrying food prior to consumption in the same vehicle with waste food at the same time. In this case it would be necessary to be particularly careful to avoid the risk of any cross contamination via the use of sealed bins and/or a split vehicle.

Figure 10: Movement of food (green) and food waste (brown) [Option 1 on left; Option 2 on right]



By way of example, the Royal Victoria Hospital in Dundee currently supplies two other hospitals and two day centres with food. It would be possible to consider a reverse logistics system where the food waste from each of these sites is returned to the Royal Victoria Hospital, from where it could be pre-treated and stored, thus acting as central collection point. An example of how this could be achieved is illustrated in Figure 11 and Figure 12.

Figure 11: Reverse logistics for the management of food waste between larger and smaller hospitals

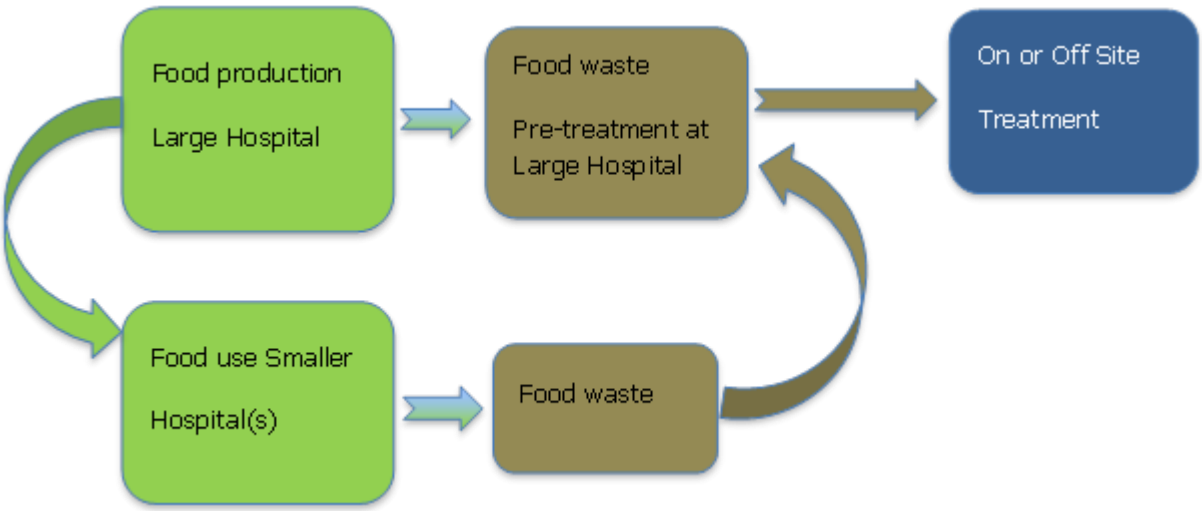
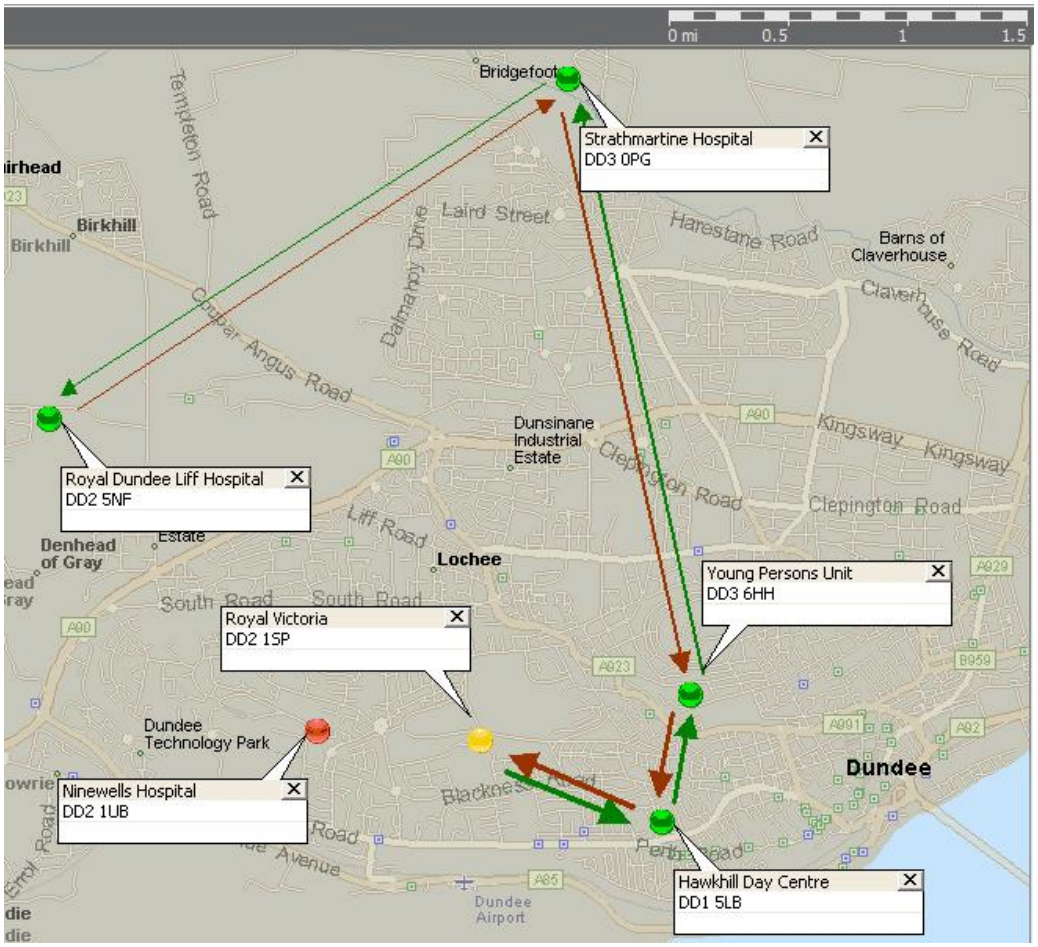


Figure 12: Example of reverse logistics arrangement between Dundee hospitals (NHS Tayside)

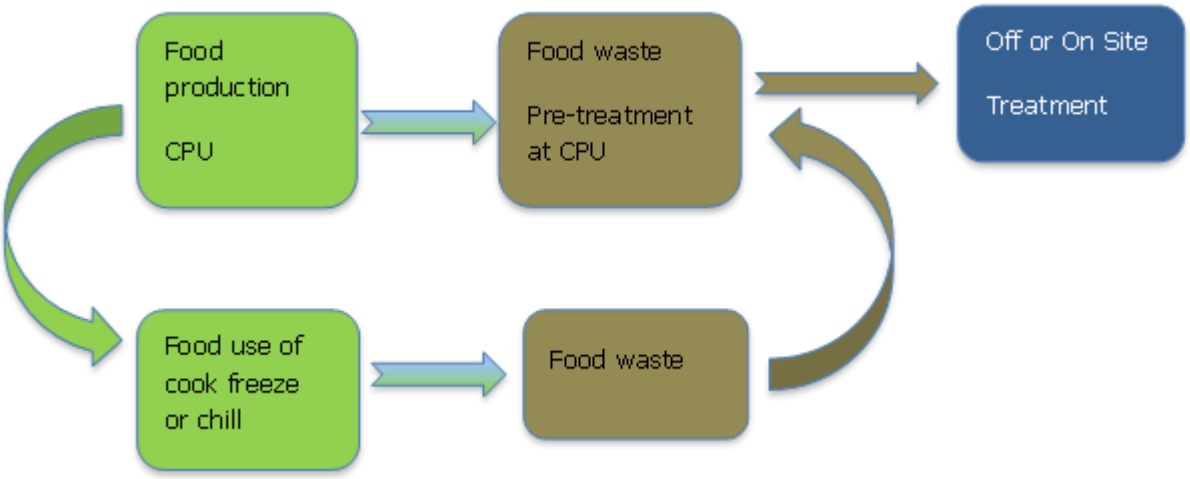


Food Delivery → Food Waste Collection →

It should be noted that while this is an example schematic, it does represent the current practice whereby the delivery vehicle retraces its steps by picking up the empty food trolleys from each of the hospitals to which it had earlier delivered food. Therefore, there is no additional traveling involved with the collection of the food waste on this return journey.

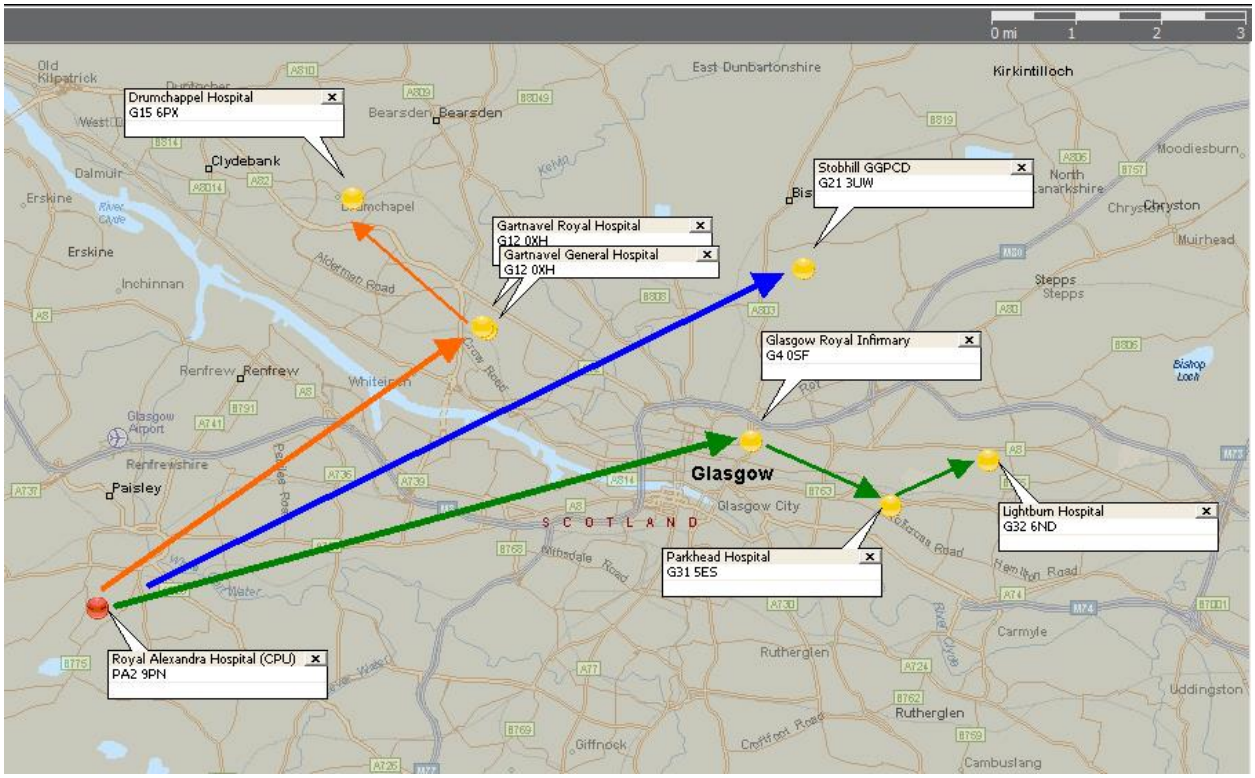
The same system could also work for hospitals that receive Cook-freeze or Cook-chill food from a central production unit (CPU). The hospitals have previously been defined in this report as having Food Waste Flows 1.2, 2.2, 3.2 and 4.2. In this case the CPU would receive the food waste from the hospitals it supplies with food. An example of how this could be achieved is illustrated in Figure 13.

Figure 13: Reverse logistics for the management of food waste between CFPU and serviced hospitals



An example of this approach is provided in Figure 14, for the delivery of food from the Cook and Freeze Production Unit (CFPU) at Inverclyde hospital.

Figure 14: Possible routing of food delivery from Inverclyde CFPU (routes in different colours)



While these reverse logistics options do offer potential savings in terms of capex and opex within – and potentially between adjacent – NHSS Board areas, these should be balanced against some very real concerns that were expressed when this issue was discussed at Board and hospital levels during this study.

The following issues would need to be considered in detail before any trial or larger scale system could be introduced:

- HACCP to ensure the avoidance of cross contamination of food prior to consumption with waste food. This could be of particular concern with food waste from regenerated food.

- The design and size of the vehicle would have to be evaluated especially if there was a requirement for a split vehicle for Option 2 to be HACCP compliant.

- The frequency required for the collection of the waste food would have to coincide with the delivery of the food, e.g. the CPUs deliver food to larger hospital six days per week, and to smaller ones only two or three times per week.

- The labour requirements and training required to include the additional task of managing the handling of waste as well as delivering food.

- There would be requirement for additional interface between the catering and the transport staff and management staff to ensure that the management of food waste did not adversely affect the essential service of delivering the food to the hospitals.

4.2 With commercial or other public sector waste collection services

There is potential for the food waste from hospitals to be integrated with the collection of other source segregated food wastes from commercial or other public sector organisations.

The way in which waste is presented should allow the same vehicle to be used as would be the case for neighbouring organisations. This would allow hospitals to be on the same collection round and thus achieve an economy of scale through a sufficiently high density of collection points that would provide a more competitive collection price. For example, if a hospital indicated that they would want their waste to be collected as part of an existing food waste collection service, it could be co-ordinated with collections of source segregated food waste from commercial businesses. Any commercial target would be adjusted to achieve a number of lifts (i.e. emptied 120 litre bins) per day from the hospital, combined with other premises visited on the same waste collection round. This waste would then be taken for treatment via AD or IVC.

The hospital would therefore have to consider the following issues:

- **Frequency of collection** – this would need to tie in with the collection rounds so that it complements the collection of waste from other organisations.

- **Time of collection** – this would have to be co-ordinated with the collection time from other organisations on the same collection round on any given day.

- **Type of bins** – the bins would have to be compatible with the vehicle that collects the waste. The bins are likely to be supplied by the waste collection contractor, which will ensure that this is the case.

- **Method of collection** – this would have to be compatible with the collection of food waste from other organisations on the same collection round, i.e. the waste could be tipped directly into the refuse collection vehicle (RCV) or full bins could be removed and replaced with clean bins on a low loader type of vehicle.

- **Use of bin liners and waste bags** – some waste treatment facilities have sophisticated pre-treatment technologies which allow them to receive waste in bags which is then removed to avoid causing problems in their treatment process. A waste collection contractor may be willing to accept wrapped waste and this in turn may allow less frequent, and thus less costly, collection. It may have the advantage of keeping the bins cleaner. However, if the waste treatment contractor will not accept waste in this form then this option is not possible. Biodegradable bags are often cited as a potential solution.

However, biodegradable bags typically do not degrade effectively in AD facilities and can cause both operational problems and problems with PAS 110 due to the presence of the plastic in the digestate. In-vessel composting (IVC) is less likely to have operational problems, but can cause issues with PAS 100 compliance due to presence of plastic in the compost. It is important therefore to consider these issues with the waste contractor and to find solutions that suit the hospital, the contractor, the other organisations on the same collection round and the operator of the AD or IVC facility.

The bin collection method could be offered in two forms:

A dedicated refuse collection vehicle (RCV), typically offered as split-body vehicle that could co-collect dry recyclable materials or general waste. This co-collection system has been found to allow the food waste from businesses to be collected at a similar cost to general mixed waste. In order to maintain clean and hygienic conditions in the hospitals, it would be necessary to obtain a bin cleaning service, either via the contractor or a third party sub-contractor.

Figure 15: Split-bodied RCV for co-collection of food waste and glass (Sita)

A bin replacement system is the alternative method, where the full bins that are being uplifted are simply replaced with equivalent empty and clean bins.

The cost of collection – even if offered on a daily basis – was suggested to be between £9-12 per uplift of a 120 litre wheeled bin. Assuming a bulk density of between 0.5–0.7 kg/litre, this is equivalent to approximately £107-£200 per tonne (£146 per tonne if we

assume 0.6 kg/litre and £10.50 per lift). This cost includes bin rental and any replacement bins. However, it excludes the cost of plastic bags, which if used would be an ongoing additional cost to the hospital.

It is likely that if the collection of waste from a hospital can be co-ordinated with from other hospitals, businesses and public sector organisations, such as schools, universities or prisons, then the cost will be at the lower end of the spectrum. However, the actual cost will only be known when a specific contract is offered for tender.

In both of these systems, it is reported that the waste need only be collected once per week if the food waste is first put into clear plastic bags. This assumes that the AD facility to which the waste is taken has effective depackaging technology in place. However, many of the hospitals visited indicated that they would want the food waste to be collected on a daily basis during the week.

Collection of waste with a tanker is more of a stand-alone operation as it would typically take half a day to travel to and remove food waste from a single site. The cost of this operation was considered to be approximately £80 per tonne collected, assuming a tank held 12,000 litres. In this case there is less likely to be savings associated with co-ordination of food waste collections from other sites.

4.3 With Local Authorities for collection and treatment of food waste

The NHSS has an opportunity to benefit from the fact that most businesses in Scotland will be required to present their food waste for separate collection from 1st January 2014. Waste collection companies have recognised this as an opportunity and are establishing collection systems to meet this demand. Therefore, by the time hospitals in urban areas of Scotland are required to separate their waste in 2016, it is likely that collection systems will be in place for both the commercial sector as well as public sector organisations.

ORA have contacted the Local Authorities where the hospitals visited during this study are located. The results of this survey are included in Appendix 4. It is clear from the responses received that a large number of the Local Authorities are considering or intending to introduce the collection of food waste in bins. Those responsible for the management of food waste at hospitals can use the information in Appendix 4 to see if the applicable Local Authority for the hospital, or cluster of hospitals, currently provides a food waste collection service, or is intending to offer one in the future.

As indicated in Section 4.2, the private sector also offers this type of service. Therefore, there is considerable scope for competition for the provision of food waste collections in bins by the time the requirements come into effect for hospitals on 1st January 2016. They are not, however, intending to establish systems for the collection of food waste from tanks, although some might possibly consider doing so if approached by the NHSS, as opposed to single, individual hospital sites.

5 Potential carbon impact of the different options

Accurately establishing the potential carbon savings or additional carbon emissions that could result from moving away from disposal of food waste to sewer to other alternative disposal options is complex, and relies on a comprehensive set of relevant data on current and potential future practice. This includes water companies and industry bodies, such as Water UK, for information regarding the impact of food entering sewers, and DEFRA, for the impact from transportation of waste and treatment using IVC and AD.

It is not possible to undertake such a detailed analysis as part of this study. However, the potential implications of different food waste management options, in terms of carbon savings and emissions, are illustrated in a simple flow chart (Figure 16).

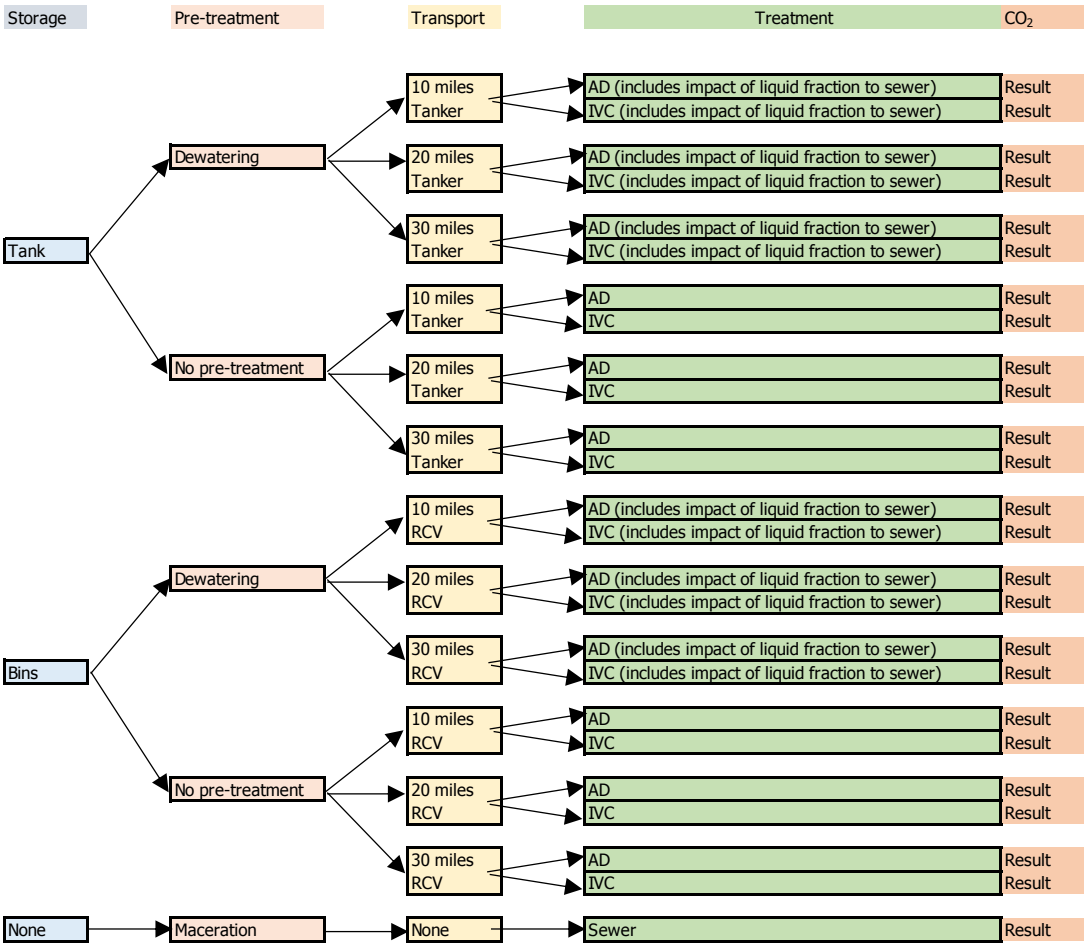
The flow chart is split into four sections regarding the management of the food waste:

- Food waste storage
- Pre-treatment
- Transport
- Treatment

If developed further, and with more accurate data, the flow chart could provide a simple basis for estimating the carbon impact of each of the four sections, based on simple choices. A sum of the scores would obtain a total score for a scenario, relating back to the Food Waste Flows described in Section 2.3, and the on-site pre-treatment and off-site treatments described in Sections 3.2 and 3.4 respectively.

It could also be adapted to accommodate alternative waste management scenarios that may be considered appropriate by the NHSS Boards.

Figure 16: Example method to determine potential carbon savings and emissions, different options



5.1 Storage

The use of a tank to store the waste has the advantage that it needs to be collected less frequently than would be the case with bins. However, bins will have a lower level of embedded energy involved in their production; while there will be a greater amount in the tank and the associated equipment to get the waste to the tank. The carbon impact of the collection of the waste could be reduced if the food waste is collected as part of a collection round with food waste from other sites, if this allows the collection vehicle to be operated at its full carrying capacity.

5.2 Pre-treatment

The type of pre-treatment used will affect the likely carbon benefit; for example, a system that diverts food waste to a storage tank for collection by a tanker will incur the carbon impacts associated with road transport. If the pre-treatment involves a dewatering process that separates the solids from the liquid, then the carbon impact associated with road transport will be lower by comparison, as the mass of waste that has to be collected has been reduced. However, it should be remembered that the liquid fraction would incur the environmental impact associated with disposal to sewer.

The energy involved in the pre-treatment of the waste will result in carbon emissions. This will be particularly true in the case of dehydration where the waste is heated. This impact could be lessened if gas is used for heating rather than electricity, but the additional emissions must be accounted for regardless. This impact will be balanced to some degree by the additional reduction in mass that could be achieved by lowering the moisture content of the food waste to what is claimed by manufacturers to be 10%.

5.3 Collection and transport

The proximity principle applies to this part of the food waste management process in that the carbon impact will be lower if the distance to the treatment facility is short.

The carbon impact will be reduced further if the collection of food waste can be integrated into the collection of food waste from other nearby sites, and the vehicle is therefore able to carry its full capacity.

5.4 Treatment

Both AD and IVC produce carbon savings compared to disposal to landfill because the diverted waste does not produce landfill gas. This includes a high proportion of methane (CH_4), which is approximately 20 times more damaging as a greenhouse gas than carbon dioxide (CO_2).

AD is generally considered to be marginally better in terms of carbon savings than IVC because it can obtain useful energy from the food waste, typically in the form of electricity and heat via a combined heat and power (CHP) engine. However, it is often the case that this system is not fully optimised because the heat is not fully utilised. There is also the option to "clean up" the biogas to produce biomethane, which can be injected into the gas grid and/or used as transport fuel. There is also the option to simply produce heat.

IVC is generally considered to be less beneficial than AD in terms of carbon savings because it does not produce energy that can be used outside of the facility. However, it does benefit from the production of compost, which has a total mass of around 50% of the input mass; by comparison, AD produces a digestate with a typical mass close to that of the original input mass. This results in the transport and application carbon impact of the compost being less than that of digestate for a given input tonnage.

6 Summary of barriers and opportunities

During the course of this study, the following key barriers to the separate collection of food waste across and between board areas were identified:

- Scale and complexity of the NHSS;
- Variation between sites within and across adjacent Board areas;
- Variability in layout and physical structure of hospitals;
- Variability in amount of food waste that hospitals generate;
- Location of hospitals;
- Anticipated working life of the hospital;
- Availability of data on management of food waste;
- Understanding how costs interrelate for specific sites or groups of hospitals; and
- Cost of installing and operating new waste management systems

6.1 Scale and complexity of the NHSS

The scale and complexity of the NHSS is a barrier in itself. However, by taking a step-wise approach to addressing food waste as indicated in Section 9, initially on a hospital-by-hospital basis, it should be possible to identify food waste management solutions that meet the specific requirements of each hospital. At this point, it is also prudent to consider the potential to co-operate within and between adjacent NHSS board areas, so as to optimise the system as a whole.

This study also highlighted the importance of good communications within and between hospitals and the NHSS Boards, to ensure that new waste management systems are developed that meet the needs of those working in each hospital and are compliant with the requirements of both the Waste (Scotland) Regulations 2012 and HACCP. It also important that for the new system to work effectively, information training and ongoing guidance and support is provided to all those involved in its installation and ongoing operation.

6.2 Variation between sites within and across adjacent Board areas

During the visits to 33 hospitals it became very apparent that one of the barriers to finding an optimal solution to the management of food waste was the fact that the different hospitals varied considerably in the way that food waste was both generated and managed. It is therefore unlikely that a single optimal solution will exist that suits all situations and which could be introduced as a blanket measure across the NHSS estate.

This report has taken the complex range of food waste management systems found during the hospital visits and broken them down into four generic Food Waste Flow types described in Section 2.3.

6.3 Variability in layout and physical structure of hospitals

Every hospital visited had a different layout, including a lot of variation in the following key issues, which affect the selection of an appropriate food waste management system:

- Proximity of the main kitchen to the wards where the food is served;
- Proximity of the main kitchen to a suitable location of food waste storage tank or food waste bin storage area;
- The use of macerators in kitchenettes close to the wards, as well as in the main kitchen; and
- The availability of a suitable on-site location for a tank for the collection of food waste or where bins could be placed ready for collection, which is also accessible for collection vehicles.

In order to address this issue, the relative merits of systems that move waste via a piped system using positive or negative pressure should be considered alongside systems using food waste buckets and caddies and wheeled bins, either following pre-treatment using dewatering technology or with no pre-treatment.

6.4 Variability in amount of food waste that hospitals generate

The amount of food waste generated is also variable, depending on the size of the hospital, i.e. the number of patients that are catered for at the hospital and patient type. This variation is increased further by other factors, such as whether food is prepared from raw ingredients, where food waste is generated from, as well as unserved meals and uneaten food on the plates. It was also widely reported that additional waste is generated when food is taken from the kitchen as bulk service rather than as plated meals[8].

This study addresses this issue by summarising which of the different systems a visited hospital operates. It also provides an indication of where data on waste arisings needs to be improved, in order to improve the planning of the capacity and cost of an appropriate food waste management system.

6.5 Location of hospitals

The hospitals are located over a wide geographic area. Some are clustered in urban areas, while others are more remote. This makes it a complex task to operate an efficient waste collection system for hospitals within a single NHSS Board area, or with adjacent areas.

This report highlights ways in which a system of reverse logistics within or between adjacent NHSS Board areas may be established to allow larger hospitals that supply smaller ones with cooked food from central production units (CPUs) to receive food waste as part of the return journey for equipment and trollies. It also highlights the fact that, as most businesses and other public sector organisations are required to have their food waste collected separately from 1st January 2014, there is likely to be scope for linking hospitals into these collection rounds when hospitals are required to comply with the Waste (Scotland) Regulations 2012 from 1st January 2016.

[8] http://www.hospitalcaterers.org/documents/foodwst.pdf

6.6 Anticipated working life of the hospital

Some of the hospitals visited are due to close within the next 10 years. In these situations, a short-term or interim solution is required, as it would be difficult to justify the capital cost and disruption involved in installing a new system. The use of bins may be appropriate in these situations as it is likely to have a lower capital cost. Any higher operating costs would only be incurred for a short period of time.

6.7 Availability of data on management of food waste

There are a number of barriers relating to the availability of data:

- Waste arisings data for food waste across the different hospitals over time;
- Cost information capex and opex of existing macerators; and
- Man-hour information relating to the current handling and movement of waste within the hospitals

The study highlighted the fact that data is available via a Catering Advisory Group (CAG) survey. However, there are concerns relating to the fact that the data only represents a single day and many of the hospitals visited indicated that the data did not necessarily represent "normal" operations. The data was also taken by people in the kitchens who do not normally undertake waste audits. Waste audits were carried out by Resource Efficient Scotland for some of the hospitals, which is likely to be more reliable given the standard methodology that was used. It would make the data collected during the CAG survey more robust if the catering staff were to undertake more waste audits over time.

It would also be worth investigating whether a system of capturing extensive data which is recorded on "unserved meals" on a plated service or "unserved portions" on a bulk service could be related to the mass and volume of food. If so, this may provide a useful dataset to which plate scrapings and any food preparation waste arisings could be added.

Many of the catering managers were not aware of the cost per unit of water or electricity, as this is not part of their budgetary responsibilities. There was also considerable variation in the assumed amount of working hours for the macerators. In some cases, even for larger hospitals, it was estimated to be only one hour after each of the three main meals. In other cases, it was assumed that the water was running all day. Data was obtained at Board level and from Estates Departments where available, and this has been used in the development of a hospital food waste disposal calculator, specifically for hospital sites in Scotland.

There is a lack of data on the man hours required to undertake existing tasks such as plate scraping or the movement of wastes. This data would be useful in predicting the additional cost or savings associated with the introduction of a new waste management system. Several hospitals operate different elements of the handling of waste that are likely to be relevant to the introduction of a new waste management system. For example, the scraping of food waste into a caddy or bucket and sending it back to the main kitchen for disposal to a tank in the case of Monklands Hospital and Ayrshire Central Hospital.

There are currently very few examples of the labour associated with the movement of waste in bins to a central collection point.

6.8 Understanding how costs interrelate for specific sites or groups of hospitals

Even if all of the data was available to determine the costs and benefits of the different waste management treatment systems, it is a complex job to bring this all together in a comprehensive way. As part of this study, a food waste disposal calculator has been developed to assist decision makers in identification of the key financial issues associated with different methods of food waste management, in relation to their particular situation.

6.9 Cost of installing and operating new waste management systems

A major concern for the catering managers surveyed was which department would be responsible for the cost of installation and ongoing operation of the new waste management system. It was generally assumed that the cost of purchasing and installing the technology would come from the Estates Department budget. However, it was less clear where the potentially more significant ongoing operating cost would be drawn from. This issue needs to be addressed, to allow the departments to work together effectively to find the best solution in terms of both the operation and costs.

7 Engagement and provision of information

7.1 Internal engagement and information

As indicated in the introduction, it is essential that the business case and method of implementation is driven primarily by the needs of those responsible for the delivery of the services within the hospitals, with catering being of particular importance. For the reasons indicated below, the solutions need to work effectively for all of the following members of the NHSS team within the hospitals:

- **Catering management teams** need to be consulted to ensure that the selected food waste management systems allows – as far as possible – business as usual to take place. They should also be consulted to allow the selected infrastructure to be put in place with minimum disruption to the receipt, preparation and serving of food.

- **Estates management and staff** need to be consulted with to ensure that the selection of the technology is affordable and compliant with the wider opportunities and constraints of the site. They need to be confident that the waste management, maintenance and support contracts are sufficiently robust to meet the operational needs of the hospitals. They also need to be consulted to allow the procurement and budgeting process to be undertaken in good time.

- **Domestic Services management and staff** need to be consulted as they are frequently involved in the serving of the food and the collection of food waste at source, through scraping of food waste into the waste containers.

- **Porters and their managers** need to be consulted to ensure that the system for taking the waste to a central disposal or transfer point is properly integrated into standard operating procedures and practices. This may in some circumstances result in the driving of vehicles carrying food waste within a hospital's grounds or between hospitals. This may also involve gaining a Waste Carriers Licence from SEPA for this purpose, and training staff directly involved in transporting the waste.

- **Nursing staff** often share the role of serving food to patients and they must be made aware of the new systems for managing the food waste and ensuring the principles of HACCP are applied effectively.

- **The Infection Control Team** must be satisfied that any new system of food waste management meets the requirement of HACCP and that any risk of by-pass which could result in the cross-contamination of food with food waste from patients, visitors or hospital staff is completely avoided.

Having decided on the preferred option, it is essential that training and appropriate on-site information and guidance is provided to all staff and contractors involved. The training and information should not only explain what needs to be done but also why it needs to be done in terms of the environment and the ongoing effective operation the individual hospital and the NHSS as a whole. For example, it is essential that the colour coding, symbols and terms be compliant with standard practice for all other waste within the NHSS.

7.2 External consultation

7.2.1 Scottish Environment Protection Agency (SEPA)

The requirements of the Waste (Scotland) Regulations 2012 are summarised in section 1.3. SEPA has the responsibility to oversee implementation of the regulation, and their position on key issues relating to the management of food waste from hospitals has been provided to ORA as part of this study (summarised previously in Section 1.3 and in more detail in Appendix 1).

If an NHSS Board decides to implement a reverse logistics system to ensure the return of food waste to the hospital or CPU that supplied the food originally, then there will be a requirement for a Waste Carriers Licence to be issued by SEPA. It is understood the NHSS currently hold similar licences for carrying other waste; therefore this should not be considered a significant barrier to this option being implemented.

7.2.2 Scottish Water

Scottish Water will need to be consulted with reference to the Trade Effluent Certificate (TEC) for the hospital waste. Further to these discussions, in situations where food waste is currently macerated and put to sewer, there may the potential to reduce costs associated with a potential reduced loading of the water from the kitchen in terms of chemical oxygen demand (COD) and total suspended solids (TSS), as well as reduction in the volume of waste water produced. There may also be the potential to reduce the fixed cost element of Trade Effluent charges for sites which can reduce the portion of the sewerage network reserved for their use. The potential value of these benefits has not been calculated as part of this study, but should be investigated further in specific instances. It should also be noted that for sites which currently do not dispose of food waste to sewer, then in situations where dewatering systems are installed the load on the sewerage network will be increased, and could incur extra cost.

8 Opportunities for co-operation within and between Board areas

Having consulted with the NHSS Boards and catering managers at individual hospitals, it has become apparent that there are considerable opportunities for co-operation between individual hospitals within the same Board area and, to a similar extent, between hospital sites in adjacent Board areas.

However, prior to this approach being considered, it is important to ensure that the following issues have been discussed by potential partner organisations:

- Clarification of the regulatory position with SEPA regarding which particular food waste management systems are acceptable in terms of compliance with Waste (Scotland) Regulations 2012.
- Purchasing the waste management technology.
- Purchasing and coordinating waste collection services including the potential of reverse logistics associated with the delivery of food and collection of food waste.
- Scheduling the installation of the technology to reduce cost and improve timeliness of its introduction.
- Optimise the system as whole via establishing a system of reverse logistics to return food waste to the hospital or CPU that supplied the food thus minimising the cost of collection paid to waste collection companies and to achieve some economies of scale at a central waste collection and pre-treatment facility.
- It may be possible to negotiate on behalf of all of the hospitals a lower cost associated with the disposal of trade effluent with Scottish Water and the relevant retail water company. This could be a beneficial cost saving as a result of reducing the loading of organic waste into the waste water system following the introduction of systems which divert food waste away from the sewer.
- Sharing of experience and knowledge.

9 Key steps to implementing a food waste collection scheme

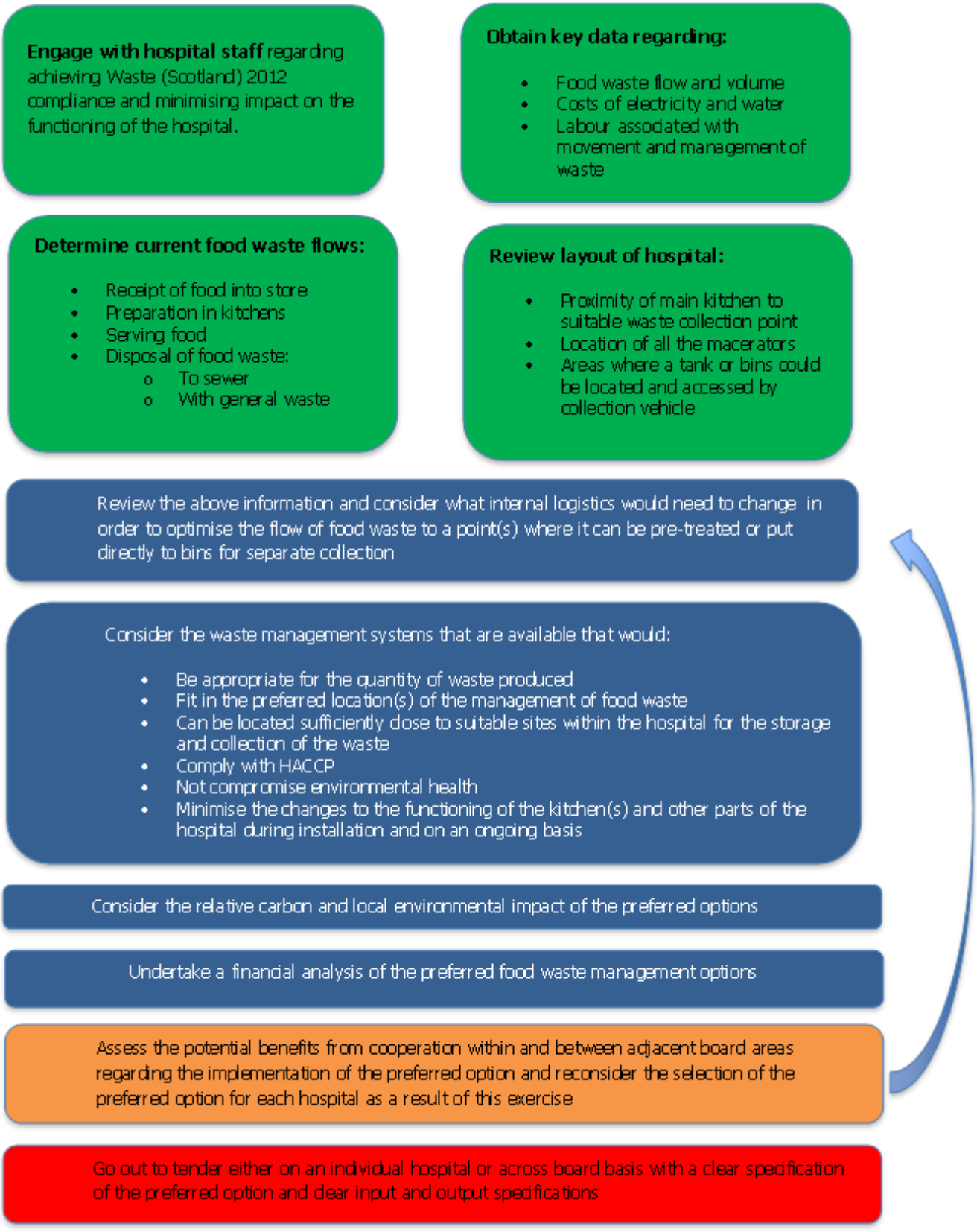
It is apparent that the situation for every hospital differs in terms of the amount of food waste that is produced, how it is currently managed and how it could best be managed in the future. However, there are some common steps that need to be carried out for every hospital which, if followed, could lead to an optimal situation for that hospital or group of hospitals, whether they are in the same Board area or across adjacent Board areas boundaries. These steps are summarised in the flow chart in Figure 17.

The first stage is to gather the required information, as indicated by the green boxes in the flow chart. This information can then be used to determine the best approach for an individual hospital by undertaking the tasks in the blue boxes. Having completed these tasks, the opportunities for co-operation could be investigated further, to determine if the selected approach could be achieved more effectively and at lower cost by working co-operatively within the Board area and/or with adjacent Boards via an iterative process.

Having identified the most appropriate method of food waste management for a single or cluster group of hospitals, the next step is to go out to tender.

There are a wide range of potential outcomes that could result from undertaking the above exercise. A number of these outcomes are presented in Table 7, where a decision tree type approach is employed to address specific key issues on a 'yes or no basis' that leads one to a particular waste management system. The options selected are considered to be relatively common scenarios based on the surveyed hospitals.

Figure 17: Key steps to making a decision - optimising food waste management systems



A – Is food waste returned to a central point in the hospital?

B – Is the kitchen close to a nearby space for a storage tank?

C – Is the outside space big enough for storage tanks and accessible to a waste collection vehicle?

D – Is a commercially viable quantity of food waste generated, collected or returned to site?

Scenario	A	B	C	D	Potentially appropriate method for food waste management
One	Yes	Yes	Yes	Yes	• No need to change movement of food waste to disposal point. • All potential options for waste pre-treatment and transport to storage. • Storage of food waste in bins or tank.
Two	Yes	No	Yes	Yes	• No need to change movement of food waste to disposal point. • Any of the potential options for the pre-treatment could be used. A positive or negative pressure system to transport waste to a tank over a longer distance will be more complex with longer pipe runs through hospital, additional pumping stations and more costly than Scenario One. • Use of wheeled bins may be more appropriate but there would be an increase in labour required to take the waste to the bin collection point. Dewatering of the waste in the kitchen would reduce the volume of waste and thus reduce this labour cost. • Storage of food waste in bins or tank depending on the selected method of pre-treating the waste.

Scenario	A	B	C	D	Potentially appropriate method for food waste management
Three	No	Yes	Yes	Yes	• The current system for the movement of food waste to disposal point will need to be changed. The waste which may currently be disposed of in kitchenettes close to the wards will need to be returned to the main kitchen. This may not require any extra labour as the food would be scraped into caddies of buckets, rather than into the macerator in the kitchenette. The food waste will then be returned to the kitchen with the trolley which brought the food to the ward. Reverse logistics of this nature are explained in section 4.1. • The food waste from the caddies or buckets can then be emptied into any of the potential options (A-G) for the pre-treatment (section 3.2). A positive or negative pressure system to transport waste to a tank over a longer distance will be more complex with longer pipe runs through hospital, additional pumping stations and more costly than Scenario One. • Use of wheeled bins may be more appropriate but there would be an increase in labour required to take the waste to the bin collection point. Dewatering of the waste in the kitchen would reduce the volume of waste and thus reduce this labour cost. • Storage of food waste in bins or tank depending on the selected method of pre-treating the waste.
Four	Yes	Yes or No	Yes or No	No	• No need to change movement of food waste to disposal point. • It may not be cost effective to install a system for the pre-treatment and transport of the waste via vacuum or positive pressure to a central collection point. If this is the case it would be better to consider a simple bin based system for the transport and storage of non-pre-treated food waste (see section 3.2.5, technology E). • If the site is remote from other organisations that produce food waste it is also unlikely to be cost effective for a waste collection company to collect the food waste. • The food waste could be returned via reverse logistics by NHSS to the hospital or CPU which supplied the food (see section 4.1). • Storage of food waste in bins or tank at the hospital or CPU where the food waste was sent to.

Table 7: Summary of key factors affecting waste management option scenarios

10 Calculation of the cost of food waste disposal

It became apparent during the course of the study that there was a need to determine the financial implications of moving from existing food waste management practices to practices that would be acceptable when the Waste (Scotland) Regulations 2012 are implemented on the 1st January 2016. Therefore, as part of this work a "Hospital food waste disposal calculator" has been developed. It is intended to illustrate to decision makers the potential financial impact of implementing different methods of managing waste within the hospital and the different methods of treating the waste. It compares this with the existing food waste management practices at the hospitals.

The calculator allows the user to:

- Take account of the amount of waste a hospital of a given number of beds is likely to produce in a year;
- Adjust the assumed amount of food waste by taking into account whether the hospital prepares food on site from raw ingredients, or whether it receives its food from a CFPU or similar;
- Consider the impact of a hospital or CFPU receiving additional food waste via the introduction of reverse logistics for food waste;
- Consider the range of waste pre-treatment options that are described in section 3.2 alongside the range of off-site treatment options described in section 3.4
- Take account of the cost of collecting the food waste and the internal management and labour costs and professional support to implement and run the new system.

The outputs for the model are the estimated capital expenditure, operating costs, income and total cost over 10 years. The calculator provides the user with default values based on working assumptions and also allows the user to override these values with site specific information where it is available.

11 Glossary of terms and acronyms

ABPR	Animal by-products regulations
AD	Anaerobic digestion
Bulk food service systems	Food delivered to inpatient areas in bulk, ready for plating in the ward or dining area.
Bulk food service waste	The number of remaining main course meals (based on a visual inspection) at the end of the mealtime, expressed as a percentage of the total number of main course meals provided and available at the start of the mealtime.
Capex	Capital expenditure, the cost associated with equipment purchase and installation.
CAG	Catering advisory group of Health Facilities Scotland
Catering waste	All waste food, including used cooking oils.
CBA	Cost benefit analysis
CPU	Central production unit
FiT	Feed in tariff for renewable electricity
Food loss	Those parts of food that cannot be eaten for any reason, for example bones or fruit peel.
Food waste	Food purchased, prepared, delivered and intended to be eaten by patients but that remains un-served or uneaten at the end of the meal service. The distinction between food loss and food waste is important if food waste is determined by weight at the end of meal service.
HACCP	Hazard analysis and critical control point
HFS	Heath Facilities Scotland
IVC	In vessel composting
Opex	Operational expenditure, the cost associated with the operation of the equipment including running cost in terms of power and water, maintenance and repairs and labour costs to operate the equipment (also referred to as "revenue" within the NHSS).
MBT	Mechanical and biological treatment
Meal	For the purposes of food wastage analysis, this is defined as one of the following: • a protein dish served with complementary potatoes, rice or bread and/or vegetables; • a main course salad served with a protein; • a round of sandwiches.
MRF	Material recycling facility

NHSS	National Health Service Scotland
PAS 100	Publically Available Specification 100 (BSI PAS 100) for composted materials.
PAS 110	Publically Available Specification 110 (BSI PAS 110) for whole digestate, separated fibre derived from the anaerobic digestion of source-segregated biodegradable material
Plated meal systems	Food plated away from the ward or dining area.
Plated meal waste	The number of untouched/unserved patient/client meals remaining at the end of the meal service period, expressed as a percentage of the total number of meals provided and available at the start of the mealtime.
Plate waste	Food served to a patient/client but left uneaten on the plate. Expressed as a percentage of the meal served to that particular patient/client.
RCV	Refuse collection vehicle
tpa	Tonnes per annum
WML	Waste management licence