Guidance on applying the waste hierarchy

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Content

Glossary

Term	Description
Closed-loop recycling	Where a product is used, discarded, captured, and then the component materials are recycled into a new product of similar functionality which is then itself used, discarded and captured, to be recycled again, continuously cycling the material resource though the supply chain.
Co-mingled waste	Co-mingled collections are where some, or all, of the key dry recyclables are collected together in the same container and later sorted at a Materials Recycling Facility.
Environmental indicators	A series of parameters applied to each waste management option to judge the total environmental impact associated with management of waste materials and for subsequently comparing the relative benefits associated with each option. In the case of the development of the waste hierarchy guidance, four indicators were chosen: climate change (measured by comparative CO_{2eq} savings); air quality (measured by a combination of ozone creation, acidification, human and aquatic toxicity); water quality (measured by aquatic pollution including substances known to contribute to eutrophication of controlled waters); and resource depletion (measured by a – typically – qualitative assessment of the decreasing availability of natural resources).
Open-loop recycling	Where material is recycled in an open loop process the product is not the same as the material recycled (e.g. glass container to glass fibre insulation or to aggregate). The material is made into a substantially different product with different properties. The product is often non-recyclable or has degraded recycling capabilities.
Source segregated	Each distinct waste stream (including the key dry recyclables and food/garden waste) collected in separate containers or compartments within a vehicle.
Mixed municipal waste	The waste left after source segregation measures have been implemented – this is sometimes referred to as ‘black bag’, ‘general’ or ‘non-recyclable’ waste.
Waste hierarchy	The priority order available for managing wastes, ranked in descending order of preference, based on the best environmental outcome across the lifecycle of the material.

Introduction

Average commodity prices are higher today than at any time in the past century, and this trend looks set to continue as consumer preferences heighten global demand and competition for a range of resources. For some materials such as copper, indium and rare earth elements supply chain risks are already emerging.

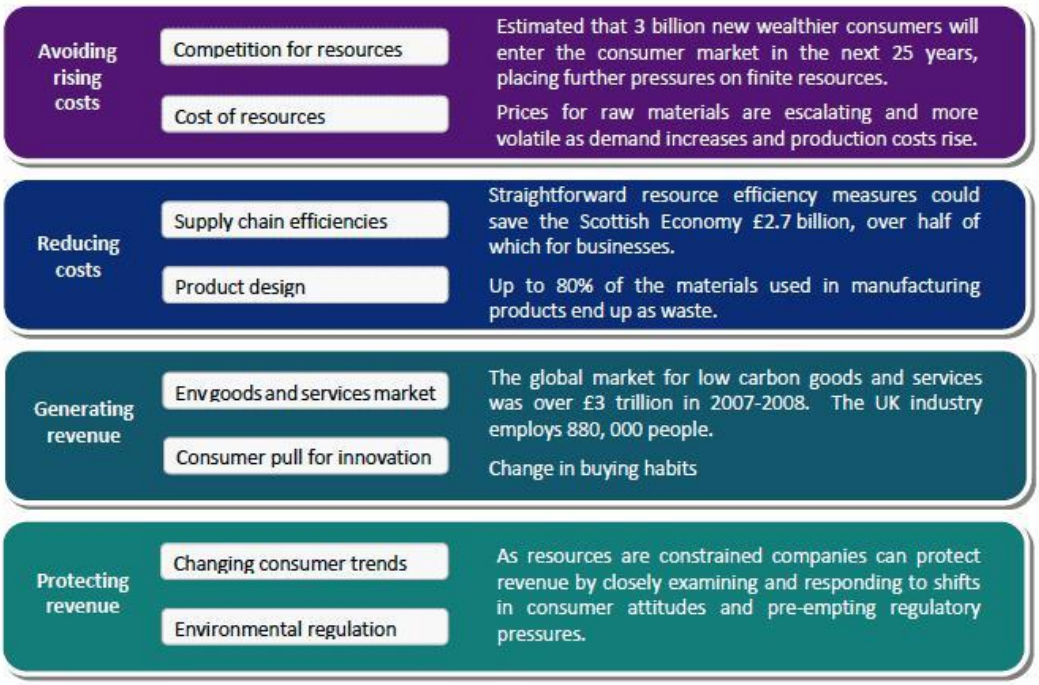
In addition to price rises and increasing market volatility, the environmental costs of resource extraction are likely to increase. For instance, where new supplies of diminishing materials are needed, more energy intensive mining and refining may be necessary, with resultant higher greenhouse gas emissions, detrimental impacts to ecosystems and increased demands on water supplies.

Reliable access to a sustainable pool of high quality resources is essential for our economy to prosper. This means finding new and innovative strategies to conserve materials while also finding ways to cycle materials efficiently back into supply chains.

The Zero Waste agenda is an ambitious programme of change that aims to create an environment where: **goods and materials are continually cycled to support the sustainable growth of the Scottish economy, and waste is progressively designed out.**

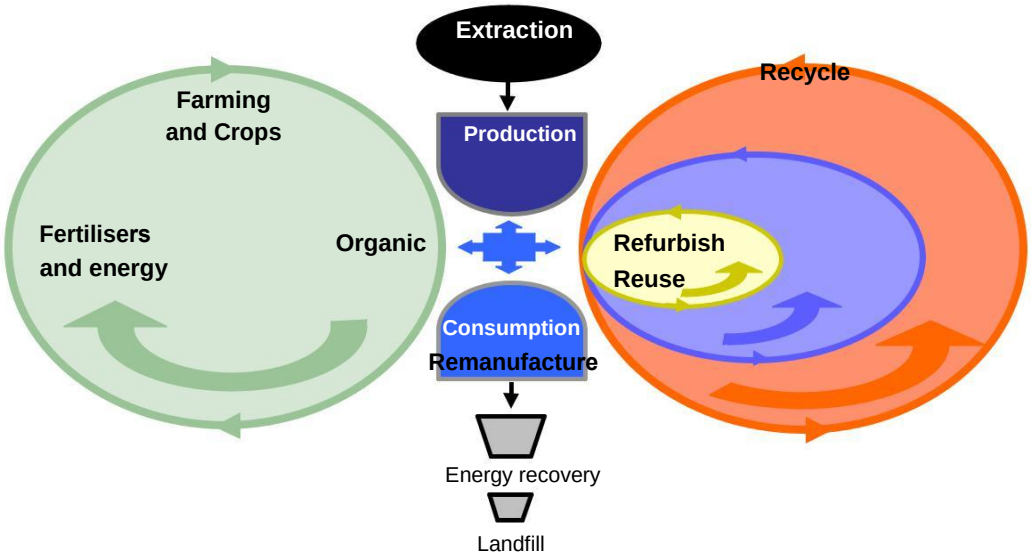
The waste hierarchy forms part of the blueprint to achieving this vision and moving our economy away from a linear model of production, consumption and disposal towards an economy that maximises the economic potential creating cycles for materials to flow continually through our economy, without the need to rely on new raw materials that are becoming increasingly costly, both financially and environmentally (Figure 1).

Figure 1: Economic opportunities from treating waste as a resource



This is about much more than simply getting better at end of life recycling. The less a product has to be changed in reuse, refurbishment and remanufacturing and the faster it returns to use, the higher the potential savings on the shares of material, labour, energy, and capital embedded in the product and on the associated mix of environmental impacts.

Figure 2: The Circular Economy



Applying the waste hierarchy is therefore not simply about limiting impacts to our climate and environment, it can help save businesses money and create new opportunities for our economy to grow. A recent UK study estimated around 2.3% of Gross Domestic Product (GDP) could be saved through straightforward action to use goods and materials more efficiently and generating less waste. In 2010 that would have meant more than £ 2.7bn of potential savings to the Scottish economy. Over half of these savings (£1.4bn) could be made by businesses.

Further information on the Scottish Government's actions to prevent waste and use our resources more efficiently can be found in our consultation on *Safeguarding Scotland's Resources: A Programme for the Efficient Use of Our Materials*.

PART 1

Context and Background

1.1 Purpose of guidance

Section 34 of the Environmental Protection Act 1990 (as amended) makes it the duty of everyone (with the exception of occupiers of domestic properties as respects the household waste produced at those properties) who produces, keeps or manages controlled waste, or as a broker or dealer has control of such waste, to:

- "take all such measures available to that person as are reasonable in the circumstances to apply the waste hierarchy set out in Article 4(1) of the Waste Directive".
- "take all reasonable steps to ensure that the waste is managed in manner which promotes high quality recycling".

This document provides guidance on the discharge of these duties and on the circumstances in which the duty may be departed from.

1. 2 What is the Waste Hierarchy?

The waste hierarchy ranks waste management options according to the best environmental outcome taking into consideration the lifecycle of the material. The lifecycle of a material is an environmental assessment of all the stages of a product's life from-cradle-to-grave (i.e. from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

In its simplest form, the waste hierarchy gives top priority to preventing waste. When waste is created, it gives priority to preparing it for reuse, then recycling, then other recovery, and last of all disposal (i.e. landfill).

With the exception of tyres, the waste hierarchy ranking applies, almost universally, as described in Figure 3.

Figure 3: Waste Hierarchy

By way of example, one tonne of food waste in landfill produces 450kg CO_{2eq} (equivalents) whereas preventing one tonne of food waste saves 3590kg CO_{2eq}. The benefits of selecting options higher up the hierarchy extend beyond carbon savings and include reduced water consumption, protection of important raw materials, creation of jobs and other economic opportunities.

In some circumstances there is justification to deviate from the waste hierarchy based on life cycle thinking. The approach taken compares the environmental impacts of managing the wastes according to different options in the waste hierarchy.

The ranking of the various waste management options in Part 2 is based on **current scientific research** on how the options impact on the environment in terms of ecological foot-printing, climate change, air quality, water quality and resource depletion. ANNEX 1 provides more details on the environmental indicators. Over time, new technologies may emerge, and the comparative efficiency of waste management options may change. Likewise, new research is published all the time.

To take account of such changes, this guidance and the evidence informing it will be periodically reviewed.

1.3 What is "High Quality Recycling"?

Evidence shows there are more benefits to closed loop recycling where a product is used, discarded, captured, and then the component materials recycled into a new product of similar functionality which can itself be used, discarded, captured and recycled again, continuously cycling the material resource though the supply chain. Examples include:

- the use of recovered glass cullet in re-melt applications to create new glass products rather than for aggregate in construction;

- the use of recovered plastic to produce, for example, new food and drinks containers rather than construction products;
- the use of recovered paper for the production of new paper products rather than other uses such as animal bedding and insulation.

These closed loop applications generally represent the Scottish Government's interpretation of 'high quality recycling' and waste management systems must be designed and operated to prioritise these preferred outcomes. Part 2 of this guidance makes a clear distinction between high quality recycling and other forms of recycling or recovery to help the waste industry understand their duty under Section 34(2L) of the 1990 Regulations.

The 'high quality' outcomes described later in this guidance require high quality materials in order to be viable. Supply chains, from producer onwards, must therefore work together to maximise the delivery of high quality material capable of meeting the standards required by those that reprocess materials in high quality outcomes.

Even if markets exist for lower quality material (e.g. through open loop recycling or energy recovery) it is essential that the quality of materials is maintained in order to stimulate the development of high quality markets and recycling infrastructure in Scotland.

1.4 Relevant legislation and guidance

This Waste Hierarchy Guidance forms part of a suite of documents produced to support the implementation of the revised Waste Framework Directive (rWFD), the Zero Waste Plan and the Waste (Scotland) Regulations 2012.

The Waste (Scotland) Regulations 2012

The Waste (Scotland) Regulations 2012 transpose Articles 11 and 22 of the rWFD and deals with the practical implementation of provisions such as the separate collection of recyclable materials and processing and management of waste and the promotion of 'high quality' recycling.

Specific measures introduced by the regulations include:

- a requirement on all waste holders to take reasonable steps to promote high quality recycling;
- a requirement for businesses to take reasonable steps to present dry recyclables (metals, plastics, paper, card and glass) (2014) and food waste for collection (2014 and 2016 for businesses producing between 5kg and 50kg of food waste);
- a requirement on local authorities to provide householders with a collection service for dry recyclables (2014) and food waste (2016);
- a ban on materials collected separately for recycling going to landfill or incineration (2014);
- a ban on biodegradable municipal waste going to landfill, thus helping to substantially reduce harmful emissions of methane (2021).

Code of Practice on Duty of Care

The Duty of Care requirements are laid out in Section 34 of the Environmental Protection Act 1990 (as amended). Waste must be managed correctly by storing it properly, only transferring it to the appropriate persons and ensuring that when it is transferred it is sufficiently well described to enable its safe recovery or disposal without harming the environment.

As described above, the Waste (Scotland) Regulations 2012 amended Section 34 to implement a number of actions of the Scottish Government's Zero Waste Plan, including measures to increase the quantity and quality of recyclable materials collected in Scotland.

The "Duty of Care: A Code of Practice" (the "Code") explains these duties which apply to anyone who produces, keeps, imports or manages controlled waste in Scotland. It provides advice on the design and operation of waste management systems with respect to the segregation of key waste streams at source and promoting the 'high quality' recycling outcomes set out in Part 2 of this guidance. The Code can be downloaded from the Scottish Government's web site at http://www.scotland.gov.uk/Resource/0040/00404095.pdf.

Kerbside Good Practice Guide (for Local Authorities)

Zero Waste Scotland (ZWS) has produced a **Kerbside Good Practice Guide** which provides Local Authorities with guidance and good practice examples when operating kerbside collection services. The guide explains that recycling collection services and subsequent materials management routes should be designed to maximise the capture of the key waste streams and prioritise 'high quality' recycling.

In the Kerbside Good Practice Guide the benchmarks for high quality recycling are described for the key recyclable materials that Scottish local authorities will be required by the regulations to collect separately: food waste, glass, metals, plastics, paper and card. These aim to ensure that materials are collected in a way which provides the potential for 'high quality' recycling. The Kerbside Good Practice Guide can be downloaded from the Zero Waste Scotland web site[1].

1.5 Applying the hierarchy

The **Tables in Part 2** illustrate how the hierarchy applies for a range of common waste streams. It includes departures from the standard Article 4 hierarchy where, in the opinion of the Scottish Government, this is justified on the basis of life cycle thinking. **The list is not exhaustive, and will be expanded in future years.** The evidence base used by the Scottish Government to form its opinion on the departures is provided in a separate document[2].

If your organisation produces, keeps or manages waste, you need to take all such measures as are reasonable in the circumstances to apply the waste hierarchy to prevent

1 http://www.zerowastescotland.org.uk/sites/default/files/Household%20Recycling%20COP%20v2.pdf.
2 Supporting Evidence Base for Scottish Government Guidance on applying the Waste Hierarchy, Scottish Government, 2012.

waste. You must apply the hierarchy as a priority order when making decisions about the management of waste.

You must endeavour to first prevent the waste arising and then take steps to prepare the waste for reuse and engage in ‘high quality’ recycling before other recycling and recovery activities are considered.

For each waste stream you handle, you should consult the tables in Part 2 to ensure that you are taking the necessary steps to apply the waste hierarchy. Some further guidance on action that can be taken to prevent waste or increase rates of reuse and recycling is provided in Part 3. This includes links to other relevant sources of information, support and guidance.

To help waste holders understand how to comply with the duty to promote ‘high quality’ recycling, the tables in Part 2 provide details of the recycling outcomes which, in the view of the Scottish Government, constitute ‘high quality’. These outcomes are shown in the green boxes and must be prioritised over other forms of recycling.

The tables in Part 2 also provide the outcomes which, in the view of Scottish Government, should be avoided where possible and only used where opportunities to use options higher up the hierarchy have been exhausted. These outcomes are shown in the red boxes. It is anticipated that these outcomes will be largely phased out, either by the markets, through the incineration and landfill bans or through other policy interventions such as the split in producer responsibility targets for glass recycling.

If you are making decisions on waste management, **you must be able to justify them**. It is good practice therefore to keep a record of your decisions.

PART 2

Material guidance sheets

2.1 Using this guidance

Adoption of measures in accordance with the waste hierarchy involves making decisions and choices about how waste is prevented, re-used, recycled, recovered or disposed. In all cases, **prevention** is better than other options because it prevents the waste arising and therefore negates the requirement to manage it. To a certain extent **re-use** (e.g. the sale of second-hand clothing) does too – the functionality and use of a serviceable article, product or item can be conferred to another user without it actually being managed as a waste material. Therefore correct application of the hierarchy is to seek to prevent waste first and then if this is not possible enable the re-use by either direct (without alteration or repair) or indirect (with repair or modification) means. This applies to all materials but particularly to those materials that carry a high value, are resource intensive, have a re-use value or have large water and carbon footprints – examples include electronics and electrical equipment, clothing and textiles, furnishings and furniture as well as paints.

Within the category of **recycling** there are specific distinctions such as closed loop (where the waste material is recycled into new products of similar characteristics with equal or greater value) and open loop (where waste is recycled into something else that makes the materials non-recyclable in future- commonly referred to as down-cycling) . Both options confer greater benefits (in most cases) than energy recovery. The actual level of environmental benefit is highly dependent on what virgin material is displaced by the recyclate. For this reason, closed loop typically ranks higher in the hierarchy than open loop because the benefit is greater in most cases. As outlined in Section 4, the duty to promote high quality recycling means that for most recyclable wastes closed loop recycling must be prioritised over open loop recycling such as manufacturing aggregate from container glass.

Energy **recovery** has a role to play in recovering the energy value from certain wastes (such as wood, tyres and certain plastics) as well for those wastes left after recycling. The Waste (Scotland) Regulations 2012 ban separately collected materials capable of being recycled from energy from waste and require treatment of mixed municipal waste to remove rigid plastics and non-ferrous metals before energy recovery.

Disposal to landfill is typically ranked as the least favourable option because it confers the least environmental benefit – resource and value is effectively lost, although in some cases methane generated from decomposition can be harnessed for productive energy generation.

2.2 General principles

Whilst this section of the guidance deals with the priority order and principles by which specific materials should be managed to offset the environmental impact and deliver the greatest benefit, there are some general principles that those producing, collecting or processing waste should be aware of when selecting options for management of wastes.

Waste producers

- Take action to prevent waste arising in the first place. Actions that you can take include:
  - Think carefully about what you buy to avoid unwanted items becoming waste – perishable food items are a particular waste hotspot that can be avoided by simple planning. There are lots of resources available to help make the change on the Zero Waste Scotland website.
  - Sell or swap unwanted items (textiles, furniture, electrical and electronic equipment, toys or leisure equipment etc) or support charitable re-use through donation to high street charities or to local third sector refurbishment schemes.
  - Retain and use electrical and electronic equipment, textiles or furniture for longer. Could you refurbish or repair them instead of buying new ones?
  - Hire or lease arrangements are generally a more efficient way of accessing a product or service than outright purchase and buying or re-using second hand equipment prevents products entering the waste stream.
- Use of more durable products can extend packaging lifetimes - discuss options with your suppliers on returnable packaging and take-back schemes.
- Work with your waste collection agent to find a recycling service that is tailored to **your** needs and preserves material quality.
- Whenever possible segregate wastes and avoid contamination or mixing them with other recyclables.
- Stipulate high quality recycling as a contractual standard when negotiating new recycling collection contracts, where practicable. Seek evidence from your appointed service provider as to the end destination and use of materials collected for recycling.

Waste collectors

- Priority should be given to establishing high quality recycling contracts with reprocessors and manufacturers over less defined open loop recycling, which generally doesn't bring the same environmental benefit. Seek evidence from your appointed service provider as to the end destination and use of materials collected for recycling.
- Separate collection is likely to yield the higher quality materials which the market seeks, and in a competitive market these higher quality materials may command a higher price. When collected as a co-mingled stream, particular care must be taken to minimise contamination from other non- target and non-recyclable wastes and separation must result in materials of sufficient quality to enable high quality recycling.
- Encourage waste producers to recycle more by highlighting options for direct reuse, preparation for reuse and high quality recycling services within collection or recycling information.
- Provide sufficient information to the customer to help them meet their obligations, including information on end destination of materials, carbon emission savings and particularly any benefits directly relevant to them.

- Where possible offer waste audits, advice or training to customers on actions they can take to prevent waste, reuse items or deliver high quality materials for recycling.

- Work with Scotland's knowledge hubs as well as waste producers and continue to actively contribute to the dissemination, publication and advocacy of best practice in material segregation, collection and processing.

Processing and sorting facilities

- Once segregated, recyclables cannot be mixed with other waste materials where such mixing would impact on material quality.

- Where practicable, promote and implement high quality recycling practices to deliver high quality materials to market thereby delivering greatest environmental benefits, generating a positive return for Scotland's economy and society and encouraging investment in Scotland's recycling industry.

- Work with waste collectors and producers to ensure collected recyclables can meet the specifications for high quality recycling routes – this may require active engagement, clear communication and strong guidelines to be set to encourage positive recycling behaviours.

- Work in partnership with government programmes, brands and the material remanufacturers to help design for increased recyclability – the recycling and reprocessing industry are vital stakeholders in creating a strong and stable Scottish recycling industry that encourages inward investment. Ultimately, making materials and products easier to recycle means less time and resource at the processing stage.

- Incentivise contracts to encourage waste producers and collectors to maintain a stream of recyclable wastes that meet high quality specifications.

- Work in partnership with waste collectors to improve quality of input materials through auditing incoming loads and sampling.

- Meet published standards and specifications for recyclable outputs – this is a priority across all material streams to build and maintain confidence in the ability of recycled materials to deliver greater or equal function to virgin equivalent.

- Invest in the right technology – this is crucial to the supporting the growth and long-term viability of Scotland's recycling and reprocessing industry. Funding and support may be available to help.

- Provide customers with the information they need to demonstrate they are complying with the waste hierarchy, which could include end destination reports, information on carbon savings etc.

2.3 Interpreting the options

This guidance provides a clear indication of the priority order that the Scottish Government believes waste producers, collectors and processors should be following in respect of materials commonly collected at the kerbside or via business waste collections.

The structure of the guidance is material-specific and, in addition to the priority order, each option is presented in one of three categories as shown in **Figure 4**: “high quality”, “acceptable” and “avoid”. **Table 1** presents the options in summary form.

Figure 4: How to interpret the options for preventing and managing wastes

”HIGH QUALITY”	These options typically focus on preventing waste, re-using it or recycling it where the inherent value in the waste material is fully preserved – typically this includes remanufacturing and closed-loop recycling. In regard to energy recovery via anaerobic digestion, it is only considered recycling where PAS 110 digestate is produced. These options must be prioritised.
“ACCEPTABLE”	These options do not deliver as great an environmental benefit across the life-cycle as those considered “high quality”. Options in this category include open-loop recycling and recovery of energy (for AD and composting where PAS standards are not met). Choosing management options in this category should be considered only after exhausting the outcomes further up the hierarchy
“AVOID”	These options are generally not compatible with longer-term ambitions for Zero Waste, are banned under the Waste (Scotland) Regulations 2012 or deliver little environmental benefit. Landfill and incineration without energy recovery typically fall within this category. Producers, collectors and processors of waste should seek to avoid these options.

Table 1: Overview of the options for managing recyclable materials according to the Waste Hierarchy

Food Waste	Garden Waste	Glass	Metals	Paper and Card	Plastic Films
HIGH QUALITY **Prevention:** Being less wasteful, better storage, preparation, production and use of food. Redistribution of unwanted food. Home composting of certain food wastes. **Recycling:** Anaerobic digestion of source segregated food waste with energy recovery and production of outputs compliant with PAS110 & SEPA quality standards. In vessel composting (IVC) of food waste Where PAS100 & SEPA quality standards are met.	**HIGH QUALITY** Home composting. **Recycling:** Windrow composting of source segregated garden waste where PAS100 standard are met. Anaerobic digestion of co-collected food and garden waste with energy recovery and production of PAS110 compliant products. In vessel composting (IVC) of co-collected food and garden waste where PAS100 standards are met.	**HIGH QUALITY** **Prevention:** Containers can be specified as returnable or re-usable, lightweight packaging. **Reuse:** Re-usable packaging systems avoid glass waste and bring high environmental benefits. **Closed loop** **Recycling:** Re-melt into new packaging or flat glass provides greater and ongoing environmental benefits over open-loop.	**HIGH QUALITY** **Prevention:** Eco-design, lightweight packaging, optimised manufacture, smart design (designed for deconstruction and greater recyclability). Metal goods can be traded and re-sold or donated to charitable organisations. **Reuse:** Metal household goods can be reused through community recycling centres. **Closed loop recycling:** All metals into re-melt (various end applications).	**HIGH QUALITY** **Prevention:** Better storage, using less, e-communications and marketing, procurement and technological solutions. **Closed loop recycling:** Recycling used paper and card as a paper mill feedstock for production of new pulp using recovered and recycled fibres.	**HIGH QUALITY** **Prevention:** Minimisation of film use (e.g. shrink-wrap in secondary packaging) and using packaging systems that optimise recovery potential. **Reuse:** Carrier bags and some plastic film packaging can be re-used. **Recycling:** High value – recycling of plastic film into new packaging applications.

Food Waste	Garden Waste	Glass	Metals	Paper and Card	Plastic Films
ACCEPTABLE **Recovery:** Anaerobic digestion or IVC of food waste with energy recovery but with outputs not compliant with PAS110 or PAS100 standards, which limits beneficial application on land. **High Efficiency Incineration:** Suitable for separately collected food waste which can not be recycled e.g. due to contamination.	**ACCEPTABLE** **Recovery:** Windrow composting of source segregated garden waste where PAS100 standards are not met. Anaerobic digestion of co-collected food and garden waste with energy recovery where PAS110 compliant products are not produced. IVC of co-collected food and garden waste where PAS100 standards are not met. **High Efficiency Incineration:** Incineration of garden waste which can not be recycled e.g. contaminated or oversize material.	**ACCEPTABLE** **Open loop recycling (high value):** Less environmental benefits than closed loop as glass production is energy intensive. Glass fibre production or similar applications, where similar carbon emission savings to closed-loop are achieved.	**ACCEPTABLE** **Recovery:** **Open loop recycling:** There are very limited applications.	**ACCEPTABLE** **Open loop recycling:** into other fibre-based products (e.g. where PAS or paper mill specifications cannot be met). **High Efficiency Incineration:** Suitable for separately collected paper and card which cannot be recycled e.g. due to contamination or short/damaged fibres.	**ACCEPTABLE** **Recycling:** Lower value – recycling of plastic film into non-packaging products (e.g. for mixed polymers). **High Efficiency Incineration or conversion into liquid fuels:** Suitable for separately collected plastic film which cannot be recycled e.g. due to contamination.

Food Waste	Garden Waste	Glass	Metals	Paper and Card	Plastic Films
AVOID **Incineration:** Not suitable for separately collected food waste capable of recycling as this will be banned from 2014. **Landfill:** Not suitable for separately collected food waste - this will be banned from 2014.	**AVOID** **Landfill:** Not suitable for separately collected garden waste.	**AVOID** **Open loop recycling (low value):** Glass being used as an aggregate substitute has negligible carbon benefits and removes glass from the resource cycle. **Landfill:** Not suitable for separately collected glass - this will be banned from 2014.	**AVOID** **Landfill:** Not suitable for separately collected metals - this will be banned from 2014.	**AVOID** **Incineration:** Not suitable for separately collected paper and card capable of recycling - this will be banned from 2014. **Landfill:** Not suitable for separately collected paper and card - this will be banned from 2014.	**AVOID** **Incineration:** Not suitable for separately collected plastic film capable of recycling - this will be banned from 2014. **Landfill:** Not suitable for separately collected plastic film - this will be banned from 2014.

Rigid Plastics	Textiles	Tyres	Mixed Municipal Waste	WEEE	Wood
HIGH QUALITY **Prevention:** Behaviour change through changes to product design and manufacturing practice. **Reuse:** Reuse of rigid bulk plastic packaging (e.g. IBCs and drums). **Recycling:** Recycling of plastics into pellets and flakes for manufacture of new plastic products that can be readily recycled again.	**HIGH QUALITY** **Prevention:** Eco-design, extended service life, design for repair and reuse. **Reuse:** Reuse without the need for repair or alteration (e.g. on-line auction, donated to charities). **Fibre Recycling:** Recycling textiles into yarn. Recycling textiles into filling materials (e.g. insulation).	**HIGH QUALITY** **Reuse:** Reuse by retreading tyres. **Recycling:** Recovery of rubber for use in road surfaces, displacing the use asphalt. Recovery of metals for recycling. Using recycled tyre crumb in place of virgin rubber. **Energy Recovery:** Use of tyres in cement kilns as a substitute for conventional fossil fuels. Treatment by pyrolysis to produce steel, carbon, oil and in some cases heat and power.	**HIGH QUALITY** **Prevention:** Segregation of recyclable materials at source. **Treatment:** Reclamation of recyclable materials. High Efficiency Incineration: After treatment to capture remaining recyclables, incineration with a high degree of efficiency.	**HIGH QUALITY** **Prevention:** Product design to facilitate increased lifetime expectancy, durability, upgrading and reconditioning. Development of new business models such as product leasing to facilitate product and material reclamation and reconditioning. **Preparation for reuse:** Reconditioning of products for resale and reuse. Extraction of re-usable components. **Recycling:** Recycling of materials (particularly, metals, plastics, glass and rare-earth metals).	**HIGH QUALITY** **Prevention:** Behavioural change such as better material storage, accurate material ordering and good planning and design. **Reuse:** Reuse of wood e.g. pallets and structural wood. **Open loop recycling:** Recycling of wood into other wood products.

Rigid Plastics	Textiles	Tyres	Mixed Municipal Waste	WEEE	Wood
ACCEPTABLE **Recycling:** Recycling of plastics into pellets and flakes for manufacture of lower grade plastic products which lose the ability to be recycled in the future (down-cycling). **High Efficiency Incineration:** Suitable for separately collected plastic which can not be recycled e.g. due to contamination.	**ACCEPTABLE** **Recycling:** Converting textiles into usable products (e.g. wipers/rags). **High Efficiency Incineration:** The energy within fibres can be recovered – this may be an option for unusable or heavily contaminated textiles.	**ACCEPTABLE** **Recycling:** Sea defences or drainage fill, replacing materials such as gravel.	**ACCEPTABLE** No options in this category.	**ACCEPTABLE** **High Efficiency Incineration:** Suitable for residual WEEE following recovery of recyclable materials.	**ACCEPTABLE** **High Efficiency Incineration:** Particularly for non-recyclable wood where high efficiency energy recovery is available.
AVOID **Incineration:** Not suitable for separately collected plastic capable of recycling - this will be banned from 2014. **Landfill:** Not suitable for separately collected plastic - this will be banned from 2014.	**AVOID** **Landfill:** Not suitable for separately collected textiles.	**AVOID** **Landfill:** The disposal of tyres in landfill is prohibited.	**AVOID** **Incineration:** Low efficiency incineration is not permitted by the PPC Regulations. **Landfill:** Biodegradable municipal waste will be banned from landfill from 2021	**AVOID** **Landfill:** Not suitable for separately collected WEEE.	**AVOID** **Landfill:** Not suitable for separately collected wood.

2.4 Material-specific guidance

This section of the guidance outlines the specific options associated with 12 commonly collected recyclable materials. Each section is presented in a common format dealing with general principles to adhere to when selecting the option for managing the waste, a short summary of the main points of evidence associated with the best environmental options and key points for waste producers, collectors and processors to look to for managing their wastes so as to reduce the overall life-cycle impact.

To be taken direct to the relevant page, click on the material title.

1. **Food Waste**
2. **Garden Waste**
3. **Glass**
4. **Metals**
5. **Paper & Card**
6. **Plastic Films**
7. **Rigid Plastics**
8. **Textiles**
9. **Tyres**
10. **Mixed Municipal Waste**
11. **Waste Electrical and Electronic Equipment**
12. **Waste Wood**

Food Waste

HIGH QUALITY

Prevention:
Being less wasteful, better storage, preparation, production and use of food.

Redistribution of unwanted food.

Home composting for certain food wastes.

Recycling : Anaerobic digestion of source segregated food waste with energy recovery and production of PAS110 compliant outputs.

In vessel composting (IVC) of food waste where PAS100 standards are met.

ACCEPTABLE

Recovery:
Anaerobic digestion or IVC of food waste with energy recovery but with outputs not compliant with PAS110 or PAS100 standards, which limits beneficial application on land.

High Efficiency Incineration:
Suitable for separately collected food waste which can not be recycled e.g. due to contamination.

Guiding principle

A considerable amount of food waste can be avoided through waste prevention measures resulting in avoided environmental impacts in both the food supply chain and food waste management process. Food waste prevention can be achieved largely through changing the behaviour of businesses and households in the purchasing, storage and use of food; there is a large body of research and guidance in this area.

Businesses preparing, retailing, distributing or wholesaling food must present food waste separately for collection and local authorities must make provision for separate food waste collection from households. This will facilitate recycling and recovery of food waste and reduce environmental impact.

The evidence

Avoiding food waste results in significant reductions in carbon emissions, on average equating to four tonnes for every tonne of food waste avoided.

Overall, the greatest environmental benefits in food waste recycling are achieved through anaerobic digestion.

Composting brings fewer benefits overall but is a better option than incineration based on the environmental indicators.

Anaerobic digestion is considered as recycling rather than recovery only where the PAS110 standard for digestate is achieved and for IVC only where PAS 100 standard for compost is achieved.

Further management options for food waste include rendering and biofuel production however, the evidence base of environmental benefits has yet to be established for these routes.

What this means for waste producers

Ensuring activities requiring food production, retail, preparation and wholesale prevent food waste generation as much as practicable through behaviour change and subsequently, segregating food waste for collection.

Avoiding contamination of residual waste with food waste and participating in separate food waste collections.

Discussing options with suppliers regarding the return of out of date and unwanted food or participation in charitable donation of unwanted food fit for human consumption.

AVOID	
Incineration: Not suitable for separately collected food waste capable of recycling - will be banned from Jan 2014. **Landfill:** Not suitable for separately collected food waste - will be banned from Jan 2014. **Disposal to Sewer**: Not suitable for food waste – will be banned in certain areas from 2016.	**What this means for waste collections** Provision of a separate food waste collection service to businesses and households (household food waste can however be co-mingled with garden waste) with reprocessing via anaerobic digestion to achieve the lowest environmental impact for food waste. Encouraging householders to participate in home composting and separate food waste collection rounds to optimise food waste capture and minimise food waste arisings in residual waste streams. **What this means for processing and sorting waste** A focus on anaerobic digestion that meets PAS110 over composting. No incineration or landfilling of separately collected food waste.

Garden Waste

HIGH QUALITY

Home composting.

Recycling:
Windrow composting of source segregated garden waste where PAS100 standard is achieved.

If co-collected with food waste, anaerobic digestion of co -collected garden and food waste with energy recovery and production of PAS110 compliant products.

In vessel composting (IVC) of co-collected garden and food waste where PAS100 standards are met.

ACCEPTABLE

Recovery:
Windrow composting of source segregated garden waste where PAS100 standards are not met.

Anaerobic digestion of co-collected food and garden waste with energy recovery where-PAS110 compliant products are not produced.

IVC of co-collected food and garden waste where PAS100 standards are not met.

High Efficiency Incineration:
Incineration of garden waste which can not be recycled e.g. contaminated or oversize material.

AVOID

Landfill:
Not suitable for separately collected garden waste.

Guiding principle

Garden waste arises as a result of domestic and commercial maintenance of gardens and grounds, which includes ground clearance, landscaping and tree pruning and felling. Source segregation of biodegradable garden waste allows a range of management options, the most environmentally beneficial being separate collection for windrow composting and then dry anaerobic digestion where PAS110 standard for digestate is met.

The evidence

Meeting the PAS 100 (compost) or PAS 110 (digestate) is important in managing garden waste because it enables the by-products to be beneficially applied to land; bringing additional environmental benefits such as displacing use of virgin agricultural fertilisers. Therefore, waste management options that meet the PAS standards are considered the best environmental option according to the waste hierarchy. Whilst dry anaerobic digestion of garden waste can deliver the greatest benefits, options such as in-vessel composting are more prevalent and can deliver greater environmental benefits than other options such as windrow composting and incineration.

The evidence suggests that home composting of green and garden waste (as with food waste) brings less environmental benefit than anaerobic digestion (with energy recovery) because much of the imbedded energy released during decomposition is lost; however, home composting displaces use of virgin top soil and peat in gardening and landscaping and can be considered as a complimentary option. Shredding garden waste and spreading on land is an option although the research suggests fewer environmental benefits when compared to other options.

Where garden waste is incinerated with energy recovery, the evidence is clear that recovery of the energy using combined heat and power technology brings significant additional environmental benefits (e.g. avoided CO_2).

What this means for waste producers

Waste producers should take all practicable steps to ensure that garden waste is processed in dry anaerobic digestion facilities. This will ensure that the energy and end-use potential of such waste is fully captured. If dry AD is not an option then processing in IVC facilities or windrow composting should be prioritised over incineration.

What this means for waste collections

Collection of garden waste either segregated or co-collected with food waste; both options enable significant benefits over landfill and incineration when using processes that meet PAS110 and PAS100 standards.

Ensure the treatment option selected meets the PAS 100 or 110 standards as only those facilities that do count towards recycling targets.

	What this means for processing and sorting waste The lack of capacity for treatment of garden waste in Scotland using dry anaerobic digestion is restrictive, particularly to those seeking to manage source segregated garden waste. Development of long-term contracts with local authorities and commercial landscapers for supply of source segregated garden waste will support development of PAS 110-compliant dry anaerobic digestion facilities. Meeting the PAS 100 and 110 standards is important in demonstrating effective recycling and to realise the greatest environmental benefits. Work towards accreditation of anaerobic digestion and composting facilities to the standards.

Glass

HIGH QUALITY

Prevent:
Containers can be specified as returnable or re-usable, lightweight packaging.

Reuse:
Re-usable packaging systems avoid glass waste and bring high environmental benefits.

Closed loop recycling:
Re-melt into new packaging or flat glass is the preferable recycling option with greater and ongoing environmental benefits over open-loop.

ACCEPTABLE

Open loop recycling (high value):
Less environmental benefits than closed loop as glass production is energy intensive.

Glass fibre production or similar applications where similar carbon emission savings to closed-loop are achieved.

AVOID

Open loop recycling (low value):
Glass being used as an aggregate substitute has negligible carbon benefits and removes glass from the resource cycle.

Landfill:
Not suitable for separately collected glass - will be banned from 2014.

Guiding principle

Glass can be recycled an infinite number of times avoiding significant carbon and other energy related emissions and associated environmental impacts. Where glass waste can not be prevented or reused, it should be recycled in a closed loop through remelt.

Some open loop recycling outcomes can result in avoided carbon emissions similar to that achieved for closed loop recycling; examples include recycled glass being used for fibre production and loft insulation products.

The evidence

Avoiding the loss of glass from the resource cycle through closed loop recycling is a key principle in waste glass management. Systems are available that enable multiple reuse of glass packaging (e.g. milk and beverage bottles) which avoid the impacts of glass manufacture and remelt.

The highest prices for glass are obtained for single colour glass cullet (for packaging glass) and uncontaminated glass (for architectural glass).

Transportation of glass for recycling has very little impact on greenhouse gas emissions hence the location of recycling plant is not a significant aspect in waste glass management.

Open loop recycling to glass fibre avoids carbon emissions similar (but lower) to that achieved for closed loop recycling. Other open loop recycling options include industrial uses and use as an aggregate substitute. Environmental benefits of recycling glass in these applications are much reduced (for aggregates, carbon impact benefits are negligible) and should be avoided.

No energy can be recovered from incineration of glass and although inert, landfilling glass should be avoided as the material is lost from the resource cycle and occupies landfill space.

What this means for waste producers

For product manufacturers, develop reusable glass packaging and supporting distribution and collection systems to enable reuse. For glass product users, source returnable or reusable packaging, or lightweight products made from recycled cullet.

Segregate different coloured glass for collection and avoid contamination with other materials to maximise opportunities for closed loop recycling. Seek assurance from your waste contractor that the end destination for your glass is as far up the hierarchy as possible, prioritising closed loop recycling whenever possible.

What this means for waste collections

Ideally collecting glass separately, with kerbside colour separation to obtain clean, uncontaminated material, suitable for closed loop recycling and the potential to attract the best market price.

	Where glass is not colour separated at kerbside, collecting it mixed with other dry recyclables that will not be readily contaminated by the inclusion of glass and ensuring that sorting facilities have optical sorting infrastructure with a high degree of sorting capability to enable capture of the glass for remelt applications. Using bring sites with segregated collection as part of the collection strategy (with careful attention to total capture rates). Co-mingled systems which result in the loss of significant tonnages to low quality end uses should be avoided. Encouraging householders and businesses to participate in recycling collections optimises glass collection and waste diverted from residual waste streams and potentially landfill. **What this means for processing and sorting waste** Where glass is not colour separated at kerbside, colour sorting technology should be employed to ensure that glass is able to go to closed loop recycling, where there is market demand for this. Where glass is going to an open loop recycling process, e.g. to glass fibre, efforts should be made to ensure that the carbon emissions savings that will be achieved are similar to those achieved from closed loop recycling. For open loop recycling, to optimise environmental benefits recycling into glass fibre rather than industrial uses and the substitution of aggregate is preferred. Although the difference in carbon impacts between use of glass in aggregate and disposal to landfill are negligible, landfill should be avoided to minimise the loss of landfill space.

Metals

HIGH QUALITY

Prevention:
Eco-design, lightweight packaging, optimised manufacture, smart design (designed for deconstruction and greater recyclability).

Metal goods can be traded and re-sold or donated to charitable organisations.

Reuse:
Metal household goods can be reused through community recycling centres.

Closed loop recycling:
All metals into re-melt (various end applications).

ACCEPTABLE

Open loop recycling:
There are very limited applications.

AVOID

Landfill:

Not suitable for separately collected metals - will be banned from 2014.

Guiding principle

Metal cans and packaging are 100% recyclable and endlessly recyclable. Metal products (e.g. garden furniture) can be re-sold through community groups, on-line auctions or prepared for reuse through community recycling centres.

Closed loop recycling (re-melt into new metal products) is the benchmark to achieve where quality requirements for the metal recycling market can be consistently met. Even recycling small amounts is beneficial.

Collected non-ferrous and steel attract different prices and the materials should therefore be separated – mixed collections can be uneconomic if further sorting is not undertaken as prices are significantly lower for mixed material bales.

The evidence

Recycling steel into re-melt reduces air pollution by 86%, water use by 40% and water pollution by over 75%. All grades of steel and non-ferrous metals can be easily recycled. Using recycled aluminium reduces energy consumed by 95%, whilst making steel from recycled sources saves 60%.

What this means for waste producers

Collect all metals for recycling - as a minimum separate metal components and equipment, metal off-cuts and swarf, drinks cans, food and product packaging into separate recycling containers. Even small amounts count – no metal should be disposed of in the residual waste bin.

Reconsider logistics - using durable metal secondary and tertiary packaging means longer reuse service life and lower lifetime impact.

Metal containing hazardous residues should be kept separate from other metal to avoid contamination.

Metal particles within wastewater or waste fluids can be recovered using filtration and separation technologies – consider options for treatment and recovery.

What this means for waste collections

Provision of separate collection of metal from households and businesses (e.g. as part of a mixed dry recyclables fraction).

Promotion of the different options for recycling metals such as recycling on-the-go, community recycling centres and metal bring-banks.

In addition to food and drink cans, ensure clear messages regarding the recyclability of other metal products (e.g. lids, aerosols, tins, food trays).

Collections should meet the quality specifications of the chosen recycling route. Metal does not need to be spotless before recycling but removing residues and liquid prior to recycling is preferable to avoid contaminating other recyclables, particularly where recyclable materials are collected together (co-mingled).

	What this means for processing and sorting waste Meeting the specifications for the chosen recycling route – tailor processes appropriately and ensure businesses are informed of what and how they should recycle. Provision of recycling services that facilitate recycling of metals, even where volumes are small - shared recyclables collection services for businesses can provide a cost-effective service across a high number of small volume waste producers. Metals should not enter the waste stream for energy recovery (i.e. separate pre-incineration) but if they do, recovery of the metal can be made from the ash.

Paper & Card

HIGH QUALITY

Prevent:
Better storage, using less, e-communications and marketing, procurement and technological solutions.

Reuse:
Reuse card-based packaging for storage and transit purposes, shredded paper can be a packing filler (replacing plastic film-based protective packaging) or used in animal bedding applications.

Closed loop recycling:
Recycling used paper and card as a paper mill feedstock for production of new pulp using recovered and recycled fibres.

ACCEPTABLE

Open loop recycling:
Turning into other fibre-based products (e.g. where PAS or paper mill specifications cannot be met).

High Efficiency Incineration:
Suitable for paper and card which cannot be recycled e.g. due to contamination or short/damaged fibres.

AVOID

Incineration:
Not suitable for separately collected paper and card capable of recycling - will be banned from 2014.

Landfill:
Not suitable for separately collected paper and card - will be banned from 2014.

Guiding principle

Preventing paper and card waste brings the greatest environmental benefits and can be done through simple changes such as using electronic communication solutions, opting out of paper-based mailings and working with packaging designers to decrease the use of paper and card in packaging. Where paper and card waste cannot be prevented or re-used, recycling through a closed loop to produce new paper products should be prioritised over other options.

Open loop recycling is only considered acceptable where the collected material does not meet the mill specifications or is contaminated.

The evidence

Scotland's households and businesses produced almost 1.5 million tonnes of paper and card waste in 2009. The evidence is clear that landfilling this material is significantly worse from an environmental perspective than all other alternatives. Preventing paper and card waste is most beneficial in reduced material, water consumption and carbon emissions terms. Recycling into closed loop, particularly higher quality fibres such as clean white paper, is more beneficial than open loop or incineration but the distinction between open loop and incineration is less clear.

Where energy recovery of lower quality or contaminated paper and card waste displaces fossil-fuel energy generation, this brings environmental benefits from a natural resource depletion and climate change perspective.

What this means for waste producers

Separate card and paper waste and keep it clean and dry. Where necessary, grade the waste paper material and separately store it.

Seek collection contracts for closed loop recycling over incineration with energy recovery.

Ensure you clearly establish the specifications required for closed loop recycling and take the necessary measures to ensure your paper and card waste consistently meets them.

What this means for waste collections

A graded and source segregated approach will yield better quality waste materials with a higher secondary market value. Ensure segregated and graded materials are not mixed with other wastes.

Provision of suitable storage solutions and clear recycling messages for paper and card waste increase participation, capture rates and quality.

On-the -go collections of paper and card waste (e.g. packaging) provide a source segregated feedstock suitable for fibre recycling.

What this means for processing and sorting waste

Meeting the specifications for the chosen recycling route and ensuring customers are informed of what and how they should recycle.

Materials that are deemed unsuitable for closed loop can still be

	recycled; secondary options should be prioritised according to the environmental benefits and availability of a suitable outlet.

Plastic Films

HIGH QUALITY

Prevention:
Minimisation of film use (e.g. shrink-wrap in secondary packaging) and using packaging systems that optimise recovery potential.

Reuse:
Carrier bags and some plastic film packaging can be re-used.

Recycling:
High value – recycling of plastic film into new packaging applications.

ACCEPTABLE

Recycling:
Recycling of plastic film into non-packaging products (e.g. for mixed polymers).

High efficiency incineration or conversion into liquid fuels:
Suitable for separately collected plastic film that can't be recycled e.g. due to contamination.

AVOID

Incineration:
Not suitable for separately collected plastic film capable of recycling - will be banned from 2014.

Landfill:
Not suitable for separately collected plastic film - will be banned from 2014.

Guiding principle

Prevention provides benefits due to avoidance of environmental impacts across the life cycle. Prevention in business is focussed on minimising the use of shrink wrap in secondary packaging applications (film comprises nearly 40% of commercial and industrial waste). There is no evidence of large-scale reuse of plastic film besides consumer reuse of plastic bags.

Businesses generating plastic waste are required to segregate materials and local authorities must make provision for separate plastic waste collection from households. This will facilitate recovery of plastic and plastic film waste. Sorting of plastic films at Plastic Recovery Facilities will increase recovery rates and reduces residual material requiring incineration or landfill.

The evidence

Recycling of plastic film demonstrates greater environmental benefits than thermal recovery methods (catalytic pyrolysis, blast furnaces, cement kilns, gasification, incineration with energy recovery). Mechanical recycling processes lead to the lowest cumulative energy demand and highest carbon dioxide savings, generate negligible hazardous emissions and generate low levels of inert residues compared to other recovery options.

Recycling and incineration have lower environmental impacts than landfill. An exception is for greenhouse gas emissions where landfilling performs better than incineration; however, landfilling plastic film removes the material from the resource economy and hence landfill has the lowest place in the hierarchy.

What this means for waste producers

Source segregation of plastic film waste and avoiding contamination of the waste stream to optimise recyclate quality.

Minimising the use of plastic film in secondary packaging (shrink -wrap around pallets etc.) and development of packaging systems that optimise reclamation of plastic film.

Participation in film collection services – particularly the construction and agriculture sectors.

What this means for waste collections

Separate plastic film waste collection services for business customers (particularly retail and wholesale to capture secondary packaging film) and construction and agriculture sectors to increase quality and minimise the need for downstream processing and sorting.

Waste collectors working with waste contractors and reprocessors to ensure high quality plastic film recyclate is being used for higher value applications thereby achieving the lowest environmental impact for plastic film waste management.

Encouraging householders to participate in supermarket plastic film bring services and separate waste collection rounds to optimise plastic film capture and minimise arisings.

Collecting plastic film separately (e.g. bagged within recyclables

	collections) rather than mixed with other recyclable materials to increase quality and minimise the need for and impacts on, sorting, cleaning and washing downstream. **What this means for processing and sorting waste** A focus on plastic film recyclate quality to enable recyclate substitution rates to be optimised by reprocessors. Diversion of low quality sorted plastic film waste not suitable for recycling for use as solid recovered fuel for incineration with energy recovery or conversion into liquid fuels.

Rigid Plastics

HIGH QUALITY

Prevention:
Behaviour change through changes to product design and manufacturing practice.

Reuse:
Reuse of rigid bulk plastic packaging (e.g. IBCs and drums).

Recycling:
Recycling of plastics into pellets and flakes for manufacture of new plastic products that can readily be recycled again.

ACCEPTABLE

Recycling:
Recycling of plastics into pellets and flakes for manufacture of lower grade plastic products which lose the ability to be recycled in the future (down-cycling).

High Efficiency Incineration:
Suitable for badly contaminated plastics that cannot be recycled.

AVOID

Incineration:
Not suitable for separately collected plastics capable of being recycled - will be banned from 2014.

Landfill:
Not suitable for separately collected plastics - will be banned from 2014.

Guiding principle

Preventing plastic waste provides benefits due to avoidance of environmental impacts across the life cycle. Prevention measures are focussed on product design and manufacturing practice. Reuse of plastic items is determined by product design and user behaviour (e.g. preparation of bulk plastic packaging such as drums and intermediate bulk containers for reuse). There is limited evidence of large-scale reuse of plastic products – recycling into new products dominates.

Key environmental benefits of recycling plastics are underpinned by substituting virgin plastic and avoiding associated impacts. Estimates are that a substitution rate of approximately 70% is needed below which other waste management technologies may become more favourable, such as solid recovered fuel for cement kilns. Optimising recyclate quality to help achieve high substitution rates is therefore important.

The evidence

Recycling of waste plastics demonstrates greater environmental benefits than incineration and landfill. This is the case across all main plastics types (polyvinylchloride, polypropylene, low and high density polyethylene and polyethyl terephthalate).

Recycling and incineration have lower environmental impacts than landfill. An exception is for greenhouse gas emissions where landfilling performs better than incineration; however, landfilling plastics removes plastics from the resource economy and hence has the lowest place in the hierarchy.

What this means for waste producers

Source segregation of plastic waste and avoiding contamination of the waste stream to optimise recyclate quality.

Product development that optimises reclamation of plastics or promotes plastics product reuse.

What this means for waste collections

Collecting plastics separately or as part of a mixed dry recyclables fraction to increase quality and minimise the need for downstream processing and sorting.

Waste collectors working with waste contractors and reprocessors to ensure high quality plastic recyclate is being used for closed loop applications thereby achieving the lowest environmental impact for plastic waste management.

Encouraging householders to participate in separate plastic waste collection rounds to optimise plastic waste capture and minimise arisings in residual waste streams.

What this means for processing and sorting waste

A focus on plastic recyclate quality to enable recyclate substitution rates to be optimised by reprocessors.

Diversion of low quality sorted plastic waste not suitable for recycling for use as solid recovered fuel or for incineration with energy recovery.

Textiles

HIGH QUALITY

Prevention: Eco-design, extended service life, design for repair and reuse.

Reuse: Reuse without the need for repair or alteration (e.g. on-line auction, donated to charities).

Fibre Recycling: Recycling textiles into yarn.

Recycling textiles into filling materials (e.g. insulation).

ACCEPTABLE

Recycling (low value): Converting textiles into usable products (e.g. wipers/rags).

Energy recovery: Recovery of energy with a high degree of efficiency – this may be an option for unusable or heavily contaminated textiles.

AVOID

Landfill: Not suitable for textiles which could be reused, recycled or otherwise recovered.

Guiding principle

Used clothing and textiles have a significant economic, environmental and social value. Sorting, re-selling and reusing textiles prevents them becoming waste; bringing the biggest environmental benefits by reducing the carbon, waste and water footprint of the fabrics. However, all textiles can be recycled with beneficial environmental impacts whatever the condition, even if they cannot be directly re-used. Landfill disposal is environmentally the worst option in all cases.

The evidence

More than 700,000 tonnes of textile waste arise annually in Scotland and across the UK more than 350,000 tonnes (£140 million) are sent to landfill. The manufacturing of textiles and textile products has significant environmental impacts - a typical pair of jeans uses 6,300 litres of water, emits 16 kg CO_2eq and uses 200 megajoules of energy (equivalent to the energy in 5.8 litres of petrol) across their lifetime.

Over 5% of the UK's carbon and water footprint comes from clothing consumption. The biggest environmental benefits are therefore associated with options that displace virgin fibre production (e.g. reuse, repair and re-manufacture), which contributes to 33% of the lifetime footprint impact, hence preference should be given to re-use options that prioritise avoidance of new textile production.

Extending the lifetime of the product, either through longer personal use, re-sale or reuse is environmentally the best option; 3 months extra life is equivalent to a saving of 5-10% in the item's carbon, waste and water footprint. Extending use by nine months would result in a 20% carbon, waste and water reduction as well as a 20% lifetime resource saving.

Designing using lower impact fabrics and incorporating recycled fabrics brings significant environmental benefit. Buying higher quality garments made to last longer provides better opportunities to reuse or re-sell products when finished with them.

Energy recovery from natural fibres (e.g. cotton) off-sets fossil fuel-based energy generation, but this is not true in the case of man-made (synthetic) fibres and therefore the benefit is reduced.

What this means for waste producers

Extending the lifetime of textiles – estimates suggest 50% of uniforms, clothes, rugs and textiles disposed of by business are re-usable without repair.

Working with organisations (e.g. charities) to reuse textiles before recycling them as lower grade rags, fillings or other products – 50% of clothes are currently re-used with ⅔ going overseas.

Separating textiles from other waste materials to avoid contamination and facilitate separate collection for reuse or recycling.

What this means for waste collections

Collecting textiles separately or as part of a mixed dry recyclables fraction to increase quality and minimise the need for downstream processing and

	sorting. There are textile recycling contractors that will collect and recycle textiles. As part of any service provision, the costs and benefits of using such services based on demand and capacity can be explored. Householders should be encouraged to recycle textiles by highlighting options for reuse and recycling services in collection or recycling information. **What this means for processing and sorting waste** Prioritising the sorting of textiles for reuse over fibre recycling - reuse in their primary function delivers the best environmental benefits. The impact of transporting textiles is lower than the combined benefits of either reuse or recycling hence lack of proximity of recyclers should not be an environmental barrier. Diversion of non-reusable or non-recyclable textiles for energy recovery rather than landfill.

Tyres

HIGH QUALITY

Reuse:
Reuse by retreading tyres.

Recycling:
Recovery of rubber for use in road surfaces, displacing the use asphalt.
Recovery of metals for recycling.
Using recycled tyre crumb in place of virgin rubber.

Energy Recovery:
Use of tyres in cement kilns as a substitute for conventional fossil fuels.

Treatment by pyrolysis to produce steel, carbon, oil and in some cases heat and power.

ACCEPTABLE

Recycling:
Sea defences or drainage fill, replacing materials such as gravel.

Guiding principle

High quality modern tyres have longer service lives and reduce vehicle fuel consumption. Choosing low-energy tyres as replacements can cut CO_2 emissions significantly over the tyres lifetime. There is a buoyant market for some re-treaded tyres (e.g. truck, trailer and agricultural vehicles) but all tyres have further beneficial potential in secondary products (recycling) or as a fuel (recovery). Landfilling of tyres is not permitted under Scottish legislation.

The evidence

Re-treading tyres results in a prolonged life for tyres and delays disposal. Consequently, the number of tyres manufactured and disposed of is reduced. Retreading offers high environmental benefits in terms of reduced greenhouse gas emissions, contribution to acidification, eutrophication and resource depletion by reducing the need for virgin materials.

Using recycled tyre crumb in place of virgin rubber or bitumen (e.g. in flooring and surfaces) has positive environmental benefits. Recycled tyre crumb when used in road surfaces, has a carbon footprint between three and seven times lower than virgin asphalt when assessed on a whole-life basis.

Environmentally, the best performing method of recovering the energy from waste tyres is by replacing the use of coal in cement kilns. This should be prioritised over other forms of energy recovery. Treating tyres using pyrolysis can also have environmental benefits by producing steel, carbon, oil and heat and power; however pyrolysis recovers less energy than cement kilns.

The use of tyres in applications such as sea defences and drainage fill by substituting natural resources has a lower environmental benefit than the above methods because such applications avoid the use of natural resources with low environmental impacts (e.g. gravel extraction).

What this means for waste producers

Segregating tyres from other waste materials to enable separate collection and onward recovery.

AVOID **Landfill disposal:** The disposal of tyres to landfill is prohibited.	Retreading tyres in preference to replacing with new tyres, forwarding for recycling or energy recovery. **What this means for waste collections** Collecting and segregating tyres suitable for retreading. Forwarding tyres not suitable for retreading for material recycling, crumb reclamation or energy recovery. **What this means for processing and sorting waste** Segregating tyres suitable for retreading. Prioritising the retreading of tyres over other management options where there is a market. For cement kiln operators, using tyres instead of conventional fuel (coal). Establishing what fuels the tyres will be replacing if energy recovery is selected and placing a preference on displacement of coal and fossil fuels (e.g. cement kilns).

Mixed Municipal Waste

HIGH QUALITY

Prevention: Segregation of recyclable and biodegradable materials at source.

Recycling: Reclamation of recyclable materials from mixed waste.

Incineration: Recovery of energy from the non-recyclable fraction with a high degree of efficiency.

ACCEPTABLE

No options in this category.

AVOID

Incineration: The incineration of the non-recyclable fraction of mixed municipal waste without the recovery of energy or with only low efficiency.

Landfill: Landfilling of biodegradable municipal waste will be banned from 2021.

Guiding principle

Mixed municipal waste is what is left after the required source segregation measures have taken place. The source segregation of recyclables must be prioritised in order to minimise the overall tonnage of mixed waste which requires treatment in Scotland. Recycling services whether for households or businesses are still developing and there remains a significant quantity of recyclable material left in the mixed waste stream. Once mixed in this way, many materials, such as paper, are rendered virtually unrecyclable. However it is possible to remove other materials such as metals, plastic bottles and cardboard and find recycling markets for them.

After this treatment, it may be possible to incinerate the remaining, non-recyclable waste. The Pollution Prevention and Control (Scotland) Regulations 2012 (as amended) require that the recovery of energy from waste is undertaken with a “high degree of efficiency”.

The evidence

Prevention of unsorted waste delivers environmental benefits as it avoids the impacts associated with having to treat/manage such waste. The focus of prevention should be on ensuring that as much waste as possible is sorted at source. Direct reuse and cleaning or repair activities are not feasible for mixed waste.

There are also emerging options for recycling common materials that arise in mixed municipal waste, such as nappies and other absorbent hygiene products. Whilst provision of a recycling service for these products is at an early stage, options for recycling are expected to grow. The environmental benefits can be significant - recycling nappies, for example, saves 600 kg CO2e/tonne recycled plus recovery of valuable fibres.

The Waste (Scotland) Regulations 2012 will ban Biodegradable Municipal Waste from landfill from January 2021. This will require alternatives to landfill to treat the waste, firstly to recover remaining recyclable materials and secondly to either recover energy and/or biostabilise waste prior to landfill.

What this means for waste producers

Segregating materials at source to ensure, as far as practicably possible, the prevention of mixed waste arisings.

Participation in source segregated waste collection services.

What this means for waste collections

Provision of waste collection systems for households and business that are founded on source segregation of recyclables to prevent mixed waste from arising.

Householders and businesses being encouraged to participate in segregated waste collection services to prevent mixed waste from arising.

What this means for processing and sorting waste

Provision of facilities for the processing of mixed waste to recover recyclable materials, produce a material suitable for incineration and/or a biostabilised fraction for landfilling.

Waste Electrical and Electronic Equipment

HIGH QUALITY

Prevention: Product design to facilitate increased lifetime expectancy, durability, upgrading and reconditioning. Development of new business models such as product leasing to facilitate product and material reclamation and reconditioning.

Preparation for reuse: Reconditioning of products for resale and reuse. Extraction of re-usable components.

Recycling: Recycling of materials (particularly, metals, plastics, glass and rare-earth metals).

ACCEPTABLE

Energy recovery: Suitable for residual WEEE following recovery of recyclable materials.

AVOID

Landfill disposal: Not suitable for WEEE which should be reused, recycled or otherwise recovered.

Guiding principle

Waste electrical and electronic equipment (WEEE) can contain hazardous components to which specific regulations and management requirements apply. Management of hazardous components are not covered by this guidance. The waste hierarchy should be applied to residual WEEE once hazardous components have been removed. WEEE Regulations apply to these wastes providing a regulatory framework for its management. Once hazardous materials have been removed, by far the largest mass of material in WEEE is metals followed by plastics, metal-plastic mixtures and glass from screens. Once separated, management of these materials should follow the relevant material hierarchy guidance.

The evidence

Preventing WEEE for some items such as mobile phones, drills, cameras, garden equipment, kitchen appliances and personal care products is the most preferable option, as the evidence shows that production impacts outweigh impacts of product use. Prolonging product lifetime and designing products for reconditioning or dismantling at the end of life presents opportunities to reduce production and linked impacts. For longer lasting, higher energy-consuming products such as white goods, designing to ensure ease of maintenance and component replacement to prolong lifetime should be integrated into products. In a similar way, reusing WEEE avoids impacts associated with production; there are established markets for the reconditioning and reuse of large appliances and IT equipment that achieve this. New business models incorporating leasing rather than purchasing of items also facilitate reuse and materials recovery.

Even when the environmental impacts of collection and reprocessing are considered, WEEE recycling is advantageous in terms of greenhouse gas emissions and resource depletion impacts compared to incineration and landfill. For speciality metals contained in WEEE, recycling is between two and ten times more energy efficient than production from virgin sources; there are also issues regarding ‘scarcity’ of certain high value materials that means recovery is important. Once all recyclable materials have been reclaimed, incineration with energy recovery is the preferred management route. Landfill is the least preferred management option.

What this means for waste producers

Using WEEE collection and drop of services.

For product manufacturers, designing products with increased lifetime expectancy, durability, the ability to be upgraded and reconditioned and provision of clear instructions on product reuse and recycling.

Development of new business models to enable collection of products at the end of life or leasing of products to enable take back and reconditioning for resale.

What this means for waste collections

Provision of civic amenity sites with separate WEEE collection facilities.

Forwarding collected WEEE for preparation for reuse / reconditioning in

	preference to materials recycling (e.g. for IT and white goods). Provision of WEEE bulky goods collection services for households and businesses to capture and divert WEEE for reuse or recycling. **What this means for processing and sorting waste** Ensuring separately collected WEEE is sent for preparation for reuse / reconditioning in preference to recycling. Development of specialist WEEE management services to capitalise on demand for 'scarce', high value specialty materials. Forwarding of residual WEEE materials (post recovery of recyclables) to incineration with energy recovery in preference to landfill.

Waste Wood

HIGH QUALITY

Prevention:
Behavioural change such as better material storage, accurate material ordering and good design.

Reuse:
Reuse of, for example, wood pallets and structural wood.

Recycling:
Recycling into other wood products.

ACCEPTABLE

Energy recovery:
Where high efficiency energy recovery is available.

AVOID

Landfill disposal:
Not suitable for wood waste which could be reused, recycled or otherwise recovered.

Guiding principle

Preventing wood waste results in the greatest benefits due to the avoidance of both upstream (forestry, processing and distribution) and downstream (waste management) impacts. Waste prevention can be achieved through changing business behaviours e.g. in construction by ensuring accurate ordering and good material storage that avoids contamination and soiling thereby reducing wood waste. Design of buildings can also reduce wood requirements (e.g. light-weighting). There are opportunities to reuse wood and wood products in a variety of applications such as pallets and construction which equally reduces life cycle impacts; this may be facilitated through wood reuse organisations that clean and grade wood.

The evidence

The environmental benefits of managing wood waste through recycling or energy recovery vary depending on the particular impact in question. Recycling (e.g. animal bedding, landscaping, secondary wood products) is preferable to energy recovery in terms of climate change impacts whereas energy recovery is preferable regarding resource depletion due to avoidance of fossil fuel use. For other air pollution impacts the relative performance of recycling and energy recovery is influenced by the management processes used.

The type of recycling possible is influenced by the type of wood (hard, soft), its form (dust, chip, block) and contamination levels (clean, painted, treated) hence effective grading is important to enable the optimum route. Non-recyclable wood should be incinerated with energy recovery rather than sent to landfill.

In landfill, wood breaks down releasing methane, a greenhouse gas; landfill should be avoided for wood. As a biodegradable material, wood will be banned from landfill in 2020.

What this means for waste producers

Prevention of wood waste through changing behaviours, particularly in the construction and construction products industry.

Reuse of wood and wood products.

Segregation of wood from other materials. Grading of wood waste into types, form and degree of contamination (for significant wood waste producers) to optimise recycling potential.

What this means for waste collections

Collecting wood separately from businesses to optimise wood grading and subsequent management.

Collection systems that incorporate separate wood waste collection and/or wood grading to enable classification of wood types, form and contamination level and hence optimise recycling opportunities. Mixed wood management may result in energy recovery as the only potential management route due to poor recyclate quality.

Provision of information to waste producers on grading and prevention of

	contamination of wood. **What this means for processing and sorting waste** Separate collection from significant wood waste generating customers combined with effective grading to optimise recycling opportunities. Wood recycling in preference to energy recovery however, where energy recovery efficiency is high (e.g. due to electricity and heat production), energy recovery can be preferable to recycling. Prevention of wood waste being landfilled.

Other materials

The guidance has focused on the most significant and common materials in the sorted waste and mixed waste streams. There are a wide variety of other materials in circulation, particularly within industry. **The guidance will be updated over time and further materials may be added** as the evidence base evolves and as more alternative management options emerge and are commercially viable. Examples of materials currently being considered include nappies and other hygiene products, and drill cuttings from the oil industry.

PART 3

Supporting guidance and information sources

How can my organisation prevent any of this waste? Avoiding waste saves money.

Many organisations underestimate the total cost of waste as they don't consider costs beyond that of waste. The 'hidden' costs of waste, such as waste raw materials, energy and labour, can be relatively easy to avoid with the right processes and a system in place to measure and monitor the causes of waste. Identifying the true amount and cost of waste will help to establish a base-line position, against which improvements and cost savings can be measured. Typically over 1% of turnover can be saved through reduced raw material use and waste disposal costs.

Zero Waste Scotland provides a range of online tools, training and publications to help organisations develop their own waste prevention plans and save money. Visit www.zerowastescotland.org.uk/category/what-we-offer/business-support to find out more.

Does your organisation design, manufacture or distribute goods?

Could you use less input material and/or less hazardous material in design and manufacture? Are you using the right amount of packaging for shipping? Could you design products to last longer or be repaired more easily?

Responsible design is a holistic way of thinking about design which takes into account the environmental impact of the product, packaging or service throughout its entire existence from raw material use, through to end of life treatment.

Over 90% of raw materials used in all stages of processing and manufacture, from natural resource, through components and beyond, are not present in the final product. By considering responsible design, an organisation can ensure that this level of loss is reduced and materials are more effectively recycled.

Once the product or service has been manufactured or developed it must then be taken to market, which leads to further environmental impacts through packaging and transportation. Considering appropriate packaging, such as whether the product can be adequately protected with less material or whether packaging could be made returnable or reusable, can reduce the associated impact.

The impact of product use can also be reduced by considering whether product life can be extended by making it easy to repair and service, or designed in such a way to allow upgrading or resale to a secondary market.

Does your organisation operate a sustainable procurement policy, or consider the life cycle of goods in your procurement process?

Sustainable procurement involves purchasing products and services that cause minimal adverse environmental impacts, ensuring the environment for the supply of raw materials remains secure for current and future generations and taking into consideration human health and resource scarcity concerns. It considers the life cycle of a product from extraction to disposal. Products are assessed on price, performance **and** impact on the environment.

It is also important to remember that most products cannot be evaluated on a single attribute – there is a range covering the entire life cycle of the product. For example, consider the purchase of a photocopier for a small office. The product could be refurbished, with low dust, low energy and solvent- free toner, designed for disassembly and with minimal packaging. However, if it cannot print on both sides of the paper, then it is does not provide you with the opportunity to reduce a key resource use.

There is a strong link between purchasing and waste management as what you buy has an effect, ultimately, on how much waste you produce. Before you buy any product ask yourself the following questions:

- Do I really need to buy it?
- Am I buying more than we need?
- How good is our stock control – is more being ordered than is actually required, resulting in materials being disposed of before they are used?
- Is it heavily over packaged?
- Can it be reused?

As well as collecting materials for recycling it is also important to close the recycling loop by purchasing materials with a recycled content (e.g. paper and stationery products, toilet paper and refuse sacks). The use of these materials will help to stimulate the market for recycled products and support the recycling process. Before you buy any product, ask yourself the following questions:

- Is it made from recycled materials?
- Is it made from easily recycled materials such as paper, glass or
- wood? Are its component materials easy to separate for recycling?
- Is its packaging easily recyclable? aim to purchase items in packaging that can be recycled easily and locally.

Organisations can use their procurement process to encourage suppliers to minimise waste generated from purchased goods and services, for example:

- Buy durable rather than disposable items e.g. reusable water glasses, cutlery
- etc; Buy materials such as cleaning fluids in bulk quantities to reduce packaging;
- Ask suppliers (including caterers) if regularly delivered goods can be provided in reusable/returnable packaging or if they can take back packaging for recycling;
- Rationalise deliveries to reduce transport emissions associated with your activities;
- Buy locally – supporting local businesses can reduce transport emissions and the associated environmental impact;
- Use suppliers that take back waste equipment at the end of its life (other than WEEE) e.g. furniture and carpets;
- Use suppliers that provide a maintenance service for equipment;
- Hire or lease equipment rather than purchasing new, or consider sourcing second-hand items;
- Consider whether equipment, furniture and textiles can be refurbished or repaired for further use, rather than purchasing new replacements;
- Sell/donate/swap unwanted items e.g. textiles, furniture, electronic and electrical equipment, stationary etc. for re-use. To find a re-use organisation in your area, try searching the Zero Waste Scotland Business Recycling and Reuse directory or the CRNS members directory (www.crns.org.uk);
- Use suppliers that provide environmental data on their products or services.

Useful links:

If you are involved in the construction sector tailored guidance is available at: http://www.zerowastescotland.org.uk/category/sector/construction

If you deal with paint, you can find ideas on how to reuse your surplus at: www.communityrepaint.org.uk/.

If you would like to see further guidance and examples for applying the waste hierarchy: http://www.wrap.org.uk/content/why-take-action-legalpolicy-case

Reuse directories & initiatives:

www.crns.org.uk/
http://www.fareshare.org.uk/

Online recycling directories & Resource market information:

www.crns.org.uk
www.ciwm.co.uk/
www.letsrecycle.com/
www.mrw.co.uk

Trade & Industry Bodies:

www.britglass.org.uk
www.textile-recycling.org.uk
www.bpf.co.uk
www.therecyclingassociation.com
www.paper.org.uk
www.adbiogas.co.uk
www.recyclemetals.org
www.organics-recycling.org.uk
www.r-e-a.net
www.ciwm.co.uk

Regulatory/Government Agencies & Advice:

http://sepa.org.uk
www.food.gov.uk
http://animalhealth.defra.gov.uk
www.netregs.org.uk

General Support & Information:

www.zerowastescotland.org.uk
www.wrap.org.uk

ANNEX 1

Overview of the environmental indicators

How was the Waste Hierarchy developed?

The position of individual Member States may vary with regard to the preferences given to particular management options when applying the waste hierarchy; for example due to variation in the technology and efficiency of electricity production (depending on the mix of fuels used and the efficiency of production); extent of landfill gas capture, and nature of the avoided materials.

This guidance sets out the Scottish Government's position with respect to an order of preference for waste management options, based on the requirement to apply the waste hierarchy. The position set out is based on the environmental impacts associated with specific options whilst taking into account the current technology and infrastructure, proposed developments in the waste, recycling and resource management sectors as well as a national ambition to be a European leader. The selection of particular options for preventing or managing wastes are based on current best evidence from across the United Kingdom taking into account specific national considerations.

With a few exceptions (e.g. aggregates), emissions from transport of recyclable materials (including collection from the kerbside) are a very small fraction of the total environmental impacts, and they are dwarfed by the benefits of recycling. Where possible, the review of evidence on relative impacts of different options within the waste hierarchy has been made based on life cycle analyses (as well as other studies) that take transport emissions into account in overall impact assessment.

The ranking of the various waste management options are based on current scientific research on how the options impact on the environment in terms of **climate change, air quality, water quality and resource depletion**.

Selected environmental indicators

In accordance with methodologies used by government to help in making decisions on waste management options, we have selected four environmental impact indicators against which to compare waste management options based on the evidence that is currently available to assess the options on.

Climate change

Climate change, or global warming, refers to the increase in the average temperature of the Earth's surface. This is caused by emissions of greenhouse gases including carbon dioxide, nitrous oxide and methane. Direct emissions from waste management contribute to all of these, and when emissions from the whole life of materials and products are included, the contribution of waste management, including prevention, becomes significant.

In Scotland, the Climate Change (Scotland) Act 2009 is the primary piece of legislation to drive reductions in greenhouse gas emissions and a transitioning to a low carbon economy. The Act sets in statue the target to reduce Scotland's emissions of greenhouse gases by 80% by 2050 as well as an interim target of 42% reductions by 2020. The Climate Change (Annual Targets) (Scotland) Order 2010 sets annual total greenhouse gas emission targets for the years 2010-2022 with the Climate Change (Annual Targets) (Scotland) Order 2011 setting targets for the years 2023-2027.

Air quality (incl. acidification, ozone creation, toxicity (human and aquatic))

Acidification, primarily as a result of emissions of nitrogen and sulphur oxides, has direct and indirect damaging effects, such as nutrients being washed out of soils, increased solubility of metals into soils, aquatic habitat degradation, vegetation health impacts and damage to stone buildings as well as many other effects. Modern pollution control measures and tighter regulation of industrial emissions has reduced these emissions substantially but waste management options that have the greatest impact on further reducing these emissions should be prioritised.

Photochemical Ozone Creation Potential (also known as summer smog) is implicated in impacts such as crop damage and increased incidence of asthma. Emissions of pollutants as a result of waste management, incineration and disposal can react with strong ultraviolet light creating temporary smog in areas of high population and industrial density.

The management of waste can contribute towards increased pollutant emissions that may have a direct or indirect negative human health effect. Emissions of nitrogen oxides and hydrocarbons can lead to summer smog and exposure to elevated concentrations of particulate matter (very fine atmospheric dust particles in the range 2.5 to 10 microns) can have a long-term negative impact on human respiratory health. Options that ensure emissions of these pollutants are as low as practical should be favoured according to the hierarchy.

Water quality (incl. eutrophication)

The quality of water and its ability to support a diverse range of life is based on the balance of constituent components within the water (*inter alia* dissolved oxygen, dissolved and particulate carbon, chemicals and nutrients) as well as the range of plants and animals it supports. The addition of toxic chemicals, organic pollutants and other contamination, produced as a result of management of waste materials, can cause disruption and damage to aquatic ecosystems such as estuaries, rivers, streams, ponds, lakes and reservoirs.

Eutrophication is when nutrient levels in freshwater bodies are elevated, often as a result of pollution or excessive applications of fertiliser to land or water, to a point where the delicate biological balance of aquatic habitats is disrupted. Fuelled by rising nutrient levels in the water, excessive growth (and death) of plants and algae can lead to decreased oxygen levels in water, creating conditions which cannot support diverse life. Certain areas of the Scottish countryside are particularly sensitive to such effects and careful monitoring and management of the nutrient balances may be required to reduce negative impacts on water quality and aquatic biodiversity.

Resource depletion

Resource depletion is the decreasing availability of natural resources including rare, precious and commodity products such as oil, metals, cereals and aggregates, some of which are renewable (e.g. wood) and some non-renewable (metals) . As populations and economies around the world grow, demand and competition for finite resources increases. Global demand, rising quality of life expectations and population increase will, at today's consumption rate, place

unacceptable strain on the planet's resources[3]. This will have a range of environmental, social and economic impacts.

Alternative options within the waste hierarchy have the ability to reduce our demand for resources and extend the life of the resources we currently use.

[3] Turner, R. K., Morse-Jones, S. and Fisher, B. (2007). *Perspectives on the 'Environmental Limits' Concept: A report to the Department for Environment, Food and Rural Affairs.* CSERGE, Norwich. Defra, London.

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