4 Material Flow Analysis and Ecological Footprint of Waste in the South East

4.1 Current Waste Policy

Within the European Union (EU) and the European Free Trade Area the total amount of waste generated increased by approximately 10 per cent between 1995 and 2000. Most waste streams are expected to increase over the next decade with a 40 to 60 per cent increase in the generation of paper, cardboard, glass and plastic waste compared to 1990 levels[1]. The majority of waste produced in the EU is either incinerated or sent to landfill, both of which result in a number of environmental impacts including the emission of greenhouse gases (GHGs)[2]. The 1989 Community Strategy for Waste Management set out four priorities for dealing with waste: prevention (including re-use), recycling, energy recovery, and optimisation of final disposal and regulation of transport. The Waste Strategy is embodied in the Waste Framework Directive (75/442/EEC) and there are a number of supporting directives that address specific waste streams[3].

With regard to packaging waste, the EC Directive 94/904/EC on Packaging and Packaging Waste places an obligation on various parties in the 'packaging chain' and is the first example in Europe of 'producer responsibility'. One of the fundamental aims of the Directive was to 'harmonise national measures concerning the management of packaging and packaging waste' (EC, 1994, p12)[4]. The Directive established two targets: a recovery target for packaging waste of between 50 and 60 per cent and a recycling target of between 25 and 45 per cent. Both of these targets, as highlighted by Coggins (2001), are end-of-the-pipeline solutions to waste management.

In the United Kingdom, 106 million tonnes of household, commercial and industrial resources are treated as waste each year. In 2000, approximately 66 per cent of commercial and industrial waste and 83 per cent of municipal waste produced went to landfill where the energy embodied within the product is effectively lost[5]. Household waste in the UK is increasing by approximately 3 per cent each year. If this growth rate continues the number of new waste management facilities will have to almost double by 2020 to deal with the problem. This would increase pressures on the land available for development and result in a number of environmental impacts associated with the construction and operation of waste management facilities and the loss of resources from the system never to be used again. In 1995, the UK Government came close to establishing a target for overall waste reduction. However, no overall waste target was ever established and the focus was placed on recycling targets for household waste.

The UK Government's Waste Strategy 2000 sets out targets to reduce the amount of industrial and commercial waste sent to landfill to 85 per cent of 1998 levels by 2005. In meeting this target, the strategy focuses on recovering value and reducing environmental impacts. Currently, 9 per cent of UK household waste is recycled and a further 8 per cent has energy recovered from it.

The UK Government has set targets to increase the recycling of municipal waste. The targets require that at least:

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[1] EEA (1999) *Environment in the European Union at the Turn of the Centu*ry, European Environmental Agency, Copenhagen, Denmark.

[2] Petts, J. and Edjljee, G. (1994) *Environmental Impact Assessment for Waste Treatment and Disposal Facilities*, John Wiley, Chichester.

[3] Haq, G. and Artola, (1996) A. Waste policy and management in the European Union, *International Journal of Environmental Education and Information* **15**(1). pp 1-16.

[4] EC (2001) Environment 2010: Our Future, Our Choice: the Sixth EU Environment Action Programme 2001-10, European Commission, Brussels, Belgium.

[5] DETR (2000) *Delivering Emission Reductions*, Department of Transport, Environment and the Regions, HMSO, London, UK.

- 25 per cent of household waste is recycled or composted by 2005
- 30 per cent of household waste is recycled or composted by 2010
- 33 per cent of household waste is recycled or composted by 2015

To ensure that all local authorities contribute to achieving these targets, the Government has set statutory performance standards for local authority recycling in England. The standards form part of the existing Best Value framework which requires local authorities to set challenging targets to improve waste management services. Local authorities will therefore need to make significant progress on recycling and composting to meet these new statutory standards. However, recycling rates have been criticised for not being a valid indicator of progress towards sustainable waste management. Jackson (1996)[6] argues "the energy of collection, separation, treatment and redistribution can make the recycling loop the least efficient of the loops from a materials perspective".

4.1.1 The PIU Report

The latest UK Government Report on waste was published in December 2002 entitled "Waste Not, Want Not – A Strategy for Tackling the Waste Problem in England" produced by the Strategy Unit at the Cabinet Office. Important points emphasised in the report include the need to reduce the growth of waste and to recycle more. The fundamental shift in waste management relies on the "Waste Hierarchy" to establish the priorities for waste management. Major concerns are raised about the large amount of methane produced from landfill sites (about one quarter of UK methane emissions), the squandering of valuable resources and concern for individuals who need to live near landfill sites. Moreover, there is a particular fear in the South East that there is very little available space suitable for landfill sites. Finally, the Strategy Unit suggest that a change to a more sustainable approach to waste management could take between 10 and 15 years. This highlights a need for urgent action in the area of waste.

While the targets that this report suggests are not government policy at this stage, there are clear signs that they may be in the future. The key success measures set out in the strategy are:

- reducing the rate of household waste growth to 2 per cent per annum by the end of 2006;
- 50 per cent of households carrying out home composting by 2006;
- the roll out of kerbside recycling collections;
- a target of at least 35 per cent of household waste being composted or recycled by 2010 and at least 45 per cent by 2015;
- an absolute reduction in the amount of municipal waste going to landfill annually from 2007;
- 30 per cent of collection authorities to have tried incentive-based schemes to encourage sound management of household waste by 2005/6.

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[6] Jackson T. (1996) *Material Concerns: Pollution, Profit and Quality of Life*. Routledge, London.

These targets offer a useful framework for the development of waste scenarios for the South East. One of the interesting inclusions in the report is the introduction of “incentive-based schemes”. In reality this means Council Tax discounts for people who recycle or compost and giving the local authority freedom to introduce variable charging schemes, where the Council Tax element for waste would be removed and charges to households made according to the amount of un-recycled and unsorted waste they produce.

Finally, the Strategy report acknowledges the fact that a number of key stakeholders have a role to play in reducing the UK waste problem. Primarily, increases in waste generation are due to poor design and inefficient manufacturing processes. This requires a reduction of waste within the supply chain of a product. Central government needs to direct strategy and policy while local authorities need to implement these strategies by providing the necessary infrastructure to support recycling, composting and waste minimisation. The waste industry itself needs to provide an appropriate range of waste-handling facilities and identify opportunities for developing new technologies. The householder requires a greater awareness of the impact of waste by considering the packaging on various products, recycling and composting. Finally, NGOs need to educate the households in waste minimisation while at the same time developing partnerships with local authorities and businesses.

4.1.2 “No Time to Waste: Draft Regional Waste Management Strategy for the South”

The report immediately emphasises the importance of tackling the growing amount of waste within the South East as well as increasing rates of recycling and composting. The following guiding principles are proposed for the Strategy, which will:

1. Change our perception of waste to regard it as a resource and shift the emphasis of policy from disposal to processing.
2. Take a holistic and integrated approach to waste management which is wider than land use planning.
3. Prioritise reduction and minimisation.
4. Promote regional net self-sufficiency in terms of waste management capacity (which will include provision for a declining amount of waste imported from London).
5. Set out an integrated approach which does not exclude any waste management method.
6. Aim to meet statutory targets as a minimum and plan for provision of infrastructure to enable these to be exceeded.
7. Promote sub-regional net self-sufficiency in terms of waste management capacity, where this is pragmatic.
8. Improve the quality and availability of information, understanding and openness.

The Waste Management Statement presents a number of scenarios in order to compare the sustainability performance and the advantages and disadvantages of a mixture of management routes that would enable the diversion and recovery targets of the Waste Strategy 2000 and the Landfill Directive to be met. The “Waste Management Statement” is a technical report produced on behalf of SERTAB setting out data on waste arisings, current management, forecast arisings and management needs, scenarios of management and sustainability (BPEO) appraisal of scenarios. The draft Regional

Waste Management Strategy has drawn on this technical advice and information. It seems logical to consider what the material flow and ecological footprint of these scenarios would be as opposed to constructing numerous other scenarios. This has been done below.

4.2 Methodological Approach for Ecological Footprint

The ecological footprint of waste can be divided into six categories:

- The ecological footprint of waste to landfill
- The ecological footprint of recycled and composted waste
- The ecological footprint of organic waste to landfill
- The ecological footprint of waste transportation
- The ecological footprint of the energy requirements of landfill processing
- The ecological footprint of incineration

The methodology employed for the ecological footprint of waste in the study for all these categories has been given below.

4.2.1 The ecological footprint of waste to landfill

The ecological footprint of waste that goes to landfill considers the total energy required in producing the product that is being disposed of. The assumption is that the embodied energy of the product has not been utilised by it going to landfill, so has therefore been wasted. The Stockholm Environment Institute–York has developed an embodied energy database of over 600 products. This database has been used for this study. The embodied energy is then converted into the carbon dioxide emissions associated with the production of the product assuming the average UK energy mix.

The carbon dioxide emissions are converted into an ecological footprint by considering the amount of forest land that is required to absorb the carbon dioxide (assumption of 5.2 tonnes of carbon dioxide per hectare of forest land) and an equivalence factor for energy land of 1.35.

4.2.2 The ecological footprint of recycled and composted waste

The recycling footprint is the amount of energy required to recycle the product minus the energy required to produce it. The ecological footprint of composting is the energy required in composting the organic material. For organic material that goes to landfill the ecological footprint considers the un-recovered methane production at the landfill site. All calculations include the transportation requirements either to recycle or deliver to landfill (explained below).

The energy required to recycle is always lower than that used in producing the product from virgin materials. However, there is a large variation between products in the potential for energy savings from recycling. Aluminium cans produced from raw materials have an ecological footprint of 6.72 ha per tonne. The energy required to recycle aluminium cans is relatively small with an ecological footprint for recycled aluminium of only 0.40 ha per tonne. The ecological footprint for recycled aluminium cans is therefore 95 per cent less than that for aluminium cans made from virgin materials. For plastics the saving is not so favourable. PET from virgin material has an ecological footprint of 2.31 ha per tonne, while the recycled PET ecological footprint is 2.06 ha per tonne. Thus there is only an 11 per cent advantage of recycling over the use of raw materials.

The more material that is recycled the lower the ecological footprint will be. However, the issue of the throughput of materials is also taken into account. The higher the volume of material consumed by South East residents, the greater will be the resultant ecological footprint. The methodology employed is therefore responsive to different waste strategies. For example, the ecological footprint will decrease with the introduction of recycling and composting schemes, waste minimisation schemes, product substitution and incineration.

4.2.3 The ecological footprint of organic waste to landfill

Methane emissions are combined into the ecological footprint calculations for organic waste materials. Methane (CH_4) is the second most important Green House Gas (GHG) (after CO_2) and has a "Global Warming Potential" (GWP) many times that of CO_2. GWP is a measure of the relative global warming effect of a given substance compared to another (usually CO_2 as is the case in this study) integrated over a chosen period of time (the so-called 'time horizon'). The need to specify the time horizon arises from the fact that different GHGs have different lifetimes in the atmosphere: about 12 years for CH_4 and about 150 years for CO_2. The choice of time horizon used for determining the GWP of a gas depends on whether the user wants to emphasise short-term processes (e.g. the speed of climate change) rather than longer-term processes (e.g. sea level rise). The Intergovernmental Panel on Climate Change (IPCC) [7] present GWPs for 20, 100 and 500 year time horizons: the GWPs given for CH_4 being 62, 21 and 7 respectively (CO_2 = 1). The 100 year time horizon was chosen for the purpose of the Kyoto Protocol on Climate Change and it is the GWPs based on this time horizon that have also been assumed for the current study. In this report therefore, CH_4 is assumed to have a potency 21 times that of CO_2. This assumption is important because the ecological footprint of the CH_4 emissions from a landfill site would have been almost three times bigger (i.e. with a GWP of 62 rather than 23) if the shorter time horizon had been chosen.

Approximately 5–20 per cent of annual global anthropogenic CH_4 emissions are the by-product of the anaerobic decomposition of organic waste in landfill sites. Over the next 20 years, methane emissions from rotting organic matter in British landfill sites are likely to cause as much warming as half of all the country's transport emissions [8]. Waste disposal on land will result in CH_4 production if the waste contains organic matter. In particular, managed disposal (controlled placement of waste) tends to encourage the development and maintenance of the anaerobic conditions that lead to the formation of CH_4. Organic waste in landfills is broken down by bacterial action resulting in the formation of CH_4 and CO_2 (termed 'landfill gas'). The more degradable organic matter (DOM) there is in the waste, the more landfill gas is produced. Landfill gas consists of approximately 50 per cent CO_2 and 50 per cent CH_4 by volume. Landfill gas from these sites can be collected and utilised in energy-from-waste electricity generating plants (considered in the scenarios).

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[7] IPCC (2001), *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

[8] Quote from Euan Nesbet in the *New Scientist*, 16 February 2002, pp 6-7.

The CO_2 released from the decomposition of organic material from crops or forests, which are regrown on an annual basis, are not treated as net emissions for the purposes by the IPCC and therefore, are not included when calculating the landfill ecological footprint. The method used to calculate the annual CH_4 emissions from the waste disposal sites was based on the default methodology recommended in the IPCC Guidelines[9]. This is a mass balance approach that involves estimating the degradable organic carbon (DOC) content of the waste, i.e. the organic carbon that is accessible to biochemical decomposition. The IPCC guidelines give default DOC values for the major organic waste streams (see Table 4.2.1) and these were assumed for the present study.

Table 4.2.1 Default degradable organic carbon (DOC) values **for the major waste streams**

Waste stream	DOC (% by weight)
Paper and textiles	40
Garden and park waste, and other (non-food) organic putrescibles	17
Food waste	15
Wood and straw*	30

* excluding lignin C

The following equation was used to calculate the landfill CH_4 emissions per tonne for each category of organic waste:

CH_4 emission (tonnes/year) = MCF x DOC x DOC_F x F x 16/12 x (1- R) x (1-OX)

Where:

MCF = methane correction factor (1 for managed sites)

DOC = degradable organic carbon content of the organic waste (see Table 4.2.1 above)

DOC_F = fraction dissimulated DOC, i.e. the portion of DOC converted to landfill gas (IPCC default = 0.77)

F = fraction of CH_4 in landfill gas (IPCC default = 0.5)

R = fraction of methane recovered

OX = oxidation factor (UK default value = 0.1)

Ecological footprint conversion factors (as hectares per tonne organic waste) were then calculated for each of the organic waste streams as follows. The equivalent CO_2 emissions were converted into ‘energy land’ (assuming 5.2 hectares of newly planted forest in the UK can sequester one tonne of CO_2 per annum) and the energy land area then converted into the equivalent area of land of global average productivity (assuming an average UK forest productivity of 1.35 times the global average).

9 IPCC (1996) *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Intergovernmental Panel on Climate Change

Table 4.2.2 Ecological footprint conversion factors for landfilled organic waste methane emissions

Paper, card and textiles (1 tonne)	Degradable Organic Carbon (DOC)	Fraction of DOC dissimilated (DOC_F)	Fraction of CH_4 in landfill gas (F)	Fraction recovered CH_4 (R)	Oxidation factor (OX)	Methane emissions per tonne (t C /year)	Methane emissions per tonne (t CH_4/year)	GWP/tonne (t CO_2 equiv)	Energy Land (ha)	Equi-valence Factor	**Ecological footprint (ha/tonne)**
	0.40	0.77	0.50	0.70	0.10	0.0416	0.0554	1.16	0.224	1.78	**0.398**

Garden and park waste, (1 tonne)	Degradable Organic Carbon (DOC)	Fraction of DOC dissimilated (DOC_F)	Fraction of CH_4 in landfill gas (F)	Fraction recovered CH_4 (R)	Oxidation factor (OX)	Methane emissions per tonne (t C /year)	Methane emissions per tonne (t CH_4 /year)	GWP/tonne (t CO_2 equiv)	Energy Land (ha)	Equi-valence Factor	**Ecological footprint (ha/tonne)**
	0.17	0.77	0.50	0.70	0.10	0.0177	0.0236	0.49	0.095	1.78	**0.169**

Food waste (1 tonne)	Degradable Organic Carbon (DOC)	Fraction of DOC dissimilated (DOC_F)	Fraction of CH_4 in landfill gas (F)	Fraction recovered CH_4 (R)	Oxidation factor (OX)	Methane emissions per tonne (t C /year)	Methane emissions per tonne (t CH_4 /year)	GWP/tonne (t CO_2 equiv)	Energy Land (ha)	Equi-valence Factor	**Ecological footprint (ha/tonne)**
	0.15	0.77	0.50	0.70	0.10	0.0156	0.0208	0.44	0.084	1.78	**0.149**

Wood and straw (1 tonne)	Degradable Organic Carbon (DOC)	Fraction of DOC dissimilated (DOC_F)	Fraction of CH_4 in landfill gas (F)	Fraction recovered CH_4 (R)	Oxidation factor (OX)	Methane emissions per tonne (t C /year)	Methane emissions per tonne (t CH_4 /year)	GWP/tonne (t CO_2 equiv)	Energy Land (ha)	Equi-valence Factor	**Ecological footprint (ha/tonne)**
	0.30	0.77	0.50	0.70	0.10	0.0312	0.0416	0.87	0.17	1.78	**0.299**

4.2.4 The ecological footprint of waste transportation

For domestic waste collected from households (bins and kerbside collection) the average distance travelled by the waste collection lorries was considered. If a CO_2 emission factor for diesel of 808.6 g CO_2/km (given in UK emission factors database for rigid HGVs for the year 2000) is assumed, this equates to 58.22 kg CO_2/vehicle/day. As the average load per waste truck is 9.5 tonnes, the CO_2 emissions per tonne of collected waste were calculated thus:

$$58.22 \div 9.5 = 6.128 \text{ kg } CO_2 \text{ per tonne waste}$$

For domestic waste taken directly to landfill from civic amenity sites, a figure of 14 km/vehicle/day can be assumed which equates to 1.192 kg CO_2 per tonne waste.

The CO_2 emission factors (per tonne waste) were then converted into waste transport conversion factors (ha/t) assuming 5.2 tonnes of CO_2 can be sequestered by one hectare of forest and an equivalence factor for energy land of 1.35, e.g. for domestic refuse bins:

$$\text{Waste transport (bins) conversion factor} = 6.128 \times 1.35 \div 5.2 \div 1000 = 0.00210 \text{ ha/tonne waste}$$

Finally, the waste transport conversion factors were multiplied by the annual tonnage of waste landfilled to give the equivalent ecological footprint in hectares. The equivalent impact for the transportation of recycled and composted products is also calculated.

4.2.5 The ecological footprint of the energy requirements of landfill processing

After the waste arrives at the landfill site, it is spread and compacted by bulldozer/compactor. The fuel energy required to do this is approximately 80 MJ per tonne which equates to a GWP of 6.5 kg CO_2-equivalent per tonne waste.[10] The ecological footprint for landfill processing was then calculated after conversion of the CO_2 emissions into equivalent energy land (dividing by 5.2) and then into the equivalent land area of global average productivity (multiplying by 1.35).

4.3 Data Collection of Household Waste

The household data were predominately taken from the CIPFA Waste Collection and Disposal Statistics 2000-2001 Actuals report, so the data are for the financial year and not the calendar year 2000. This provides information at local authority level and includes far more detail than the DEFRA data. The composition studies used to estimate the breakdown into waste categories are as near to this year as possible, but range from 1999 to 2001. Waste categories are based on those used by the Welsh Assembly for their recent Household Waste Survey. DEFRA regional data are included for verification purposes. Household waste is defined as including waste from household collection rounds, including bulky waste collection, hazardous waste collection and separate garden waste collection, plus waste from services such as street sweeping, litter and Civic Amenity (CA) sites. Home composted waste is not included in the arisings figure since there is no reliable way to estimate this. Non-household municipal waste is regarded as being included in the Industrial and Commercial waste statistics, since this is calculated on a per-employee basis.

Household arisings are based on Waste Disposal Authority (WDA) and Unitary Authority (UA) reporting, since 13 out of 57 Waste Collection Authorities (WCAs) did not report. Non-reporting UAs were estimated based on households using the nearest available data with similar ACORN breakdown (Berkshire, Southampton), and in the case of Brighton & Hove aggregated up based on an Ecosys survey using ACORN[11] categories (ACORN data supplied is 2002 data). Composition is based on actual sorts in the county where possible. No detailed surveys were found for Oxfordshire and Surrey, so composition here is based on the average for the other counties. These were done in Windsor and Maidenhead (2001), Brighton & Hove (2001), Arun (2001), Milton Keynes (2000), , Medway (1999/2000) and Hants Project Integra (1999).

Civic Amenity (CA) site waste is also based on CIPFA WDA and UA reporting (this is not reported by WCAs), excluding rubble. CA waste for non-reporting authorities has been estimated based on averages from reporting CA sites (see below for details). This doesn't allow for the fact that a proportion of waste going to CA sites will be Industrial & Commercial waste – no reliable way has been found to estimate this. The total arrived at from the CIPFA data is significantly higher than the DEFRA verification figure for household waste going to CA sites. This appears to be explained by differences between CIPFA and DEFRA in recording WDA recycling, in particular centralised

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[10] Calculated by the EAP (Energy Analysis Program), Centre for Energy and Environmental Studies, University of Groningen, The Netherlands

[11] ACORN stands for "A Classification of Residential Neighbourhoods". This provides a socio-demographic classification of all UK neighbourhoods into 17 groups and 54 types.

composting, since the overall household waste total arrived at agrees closely with the DEFRA total. This supports the case for better co-ordination and integration between the DEFRA and CIPFA data collection exercises. Little CA waste composition work has been done in the region, so only an aggregate breakdown is included, based on the average national composition from WRAP's [12] recent Analysis of Household Waste Composition report by Julian Parfitt.

WCA recycling data are included separately since they are additional to the WDA/UA reporting. The CIPFA guidelines make it clear WCAs should only include recycling which does not go to WDAs, and vice versa. Non-reporting WCAs were estimated based on households. Composition breakdowns are based on data from reporting WCAs, applied to total recyclate.

Disposal data are based on WDA reporting, with WCA data added for recycling. Recycling includes central composting but no attempt is made to include home composting since this is very hard to estimate. WDA recycling composition is based on WDA and UA reporting. Non-reporting UAs are estimated based on households with a correction factor for those with no kerbside collection. Non-reporting WCAs are estimated based on averages for reporting WCAs. Strictly speaking, recycling data refer to waste collected for recycling, conforming to the definition of recycling in place at the time. There will have been some residuals that weren't recycled at the MRF (processing) stage (where applicable) and at reprocessors. Although difficult to estimate, typically this would be at least 5–10 per cent of material collected. The definition of recycled material now in use has changed to take account of this.

It was assumed that the composition of waste in landfill and waste for incineration was equal to the household collection composition percentages. This will probably mean an over-estimate of paper/card and glass, due to significant proportions of these being diverted for recycling, and an under-reporting of waste metal/WEEE due to much of this waste going directly to CA sites.

4.4 Results for the South East – Household Waste (Analysis and Ecological Footprint)

In 2000, the average person in the South East produced half a tonne of waste. The average household produced over 1.2 tonnes which amounts to 4.4 million tonnes for the South East as a whole. Eighty-one per cent of the waste was disposed of in landfill sites, 13 per cent was recycled, 6 per cent composted and the remainder was incinerated. This makes the South East the best performing region in the UK for recycling.

An analysis of packaging in the waste stream was also undertaken (see section 3.6). Twenty per cent of the waste stream was packaging, 14 per cent was newspapers and other paper waste and the organic waste represented 27 per cent of the total. The impact of each material was considered separately and can be seen in Table 4.4.1. Data for waste collected from households have been combined with data from civic amenity sites.

An embodied energy analysis and ecological footprint was undertaken using the methodology described above. The embodied energy analysis considers the ability of the waste management system to retain or utilise the embodied energy of the waste. This figure has been converted into CO_2

[12] Waste and Resources Action Programme (www.wrap.org.uk)

emissions for the purposes of this analysis. The results of the analysis for landfill can be seen in Table 4.4.1.

Table 4.4.1 Greenhouse gas emissions of products disposed of to landfill (tonnes)

Material	Waste Landfill (tonnes)	CO_2 emissions of products (tonnes)	CO_2 emissions of Processing (tonnes)	CO_2 emissions of Transport (tonnes)	CH_4 (as tonnes CO_2 equivalent)	Total GWP of Landfill (as tonnes CO_2 equivalent)
Paper and card	753,257	2,580,561	24,857	6,681	876,971	3,489,071
Plastic film	116,387	632,994	3,841	1,032		637,867
Dense plastic	163,164	1,126,059	5,384	1,447		1,132,890
Textile	94,586	756,521	3,121	839	66,072	826,554
Other combustibles	356,699	1,551,640	11,771	3,164		1,566,575
Other non-combustible	137,216	318,341	4,528	1,217		324,086
Glass	204,387	248,364	6,745	1,813		256,922
Putrescibles	1,216,629		40,149	10,792	531,168	582,108
Metals	198,275	1,116,287				1,116,287
Hazardous waste	5,371	32	177	48		257
Fine material + other	113,747		3,754	1,009		4,763
Totals	3,359,717	8,330,798	104,328	28,042	1,474,212	9,937,379

The total energy required to produce, process, transport and dispose of the waste to landfill emits over 10 million tonnes of CO_2 equivalent (1.25 tonnes per person). The most significant impact is the emissions from the embodied energy of the products that is then effectively lost through disposal by landfill (82 per cent). The impacts of waste transportation and the energy required to process the waste at the landfill site are minimal by comparison (0.3 and 1.1 per cent respectively). The emissions of methane have also been taken into account. It is assumed that 63 per cent of all methane emissions are recovered[13]. Three products in the waste stream are responsible for methane emissions: paper, textile and putrescible matter. The disposal of these materials by landfill leads to the production of methane, methane emissions representing a significant proportion (16 per cent) of the total impact of landfilling.

In terms of materials and products disposed of to landfill, paper has the most significant impact (43 per cent). Although plastic film and dense plastic only represent 11 per cent of the waste disposed of by landfill, they are responsible for 22 per cent of the total greenhouse gas emissions. This disproportionate impact is due to the high embodied energy of the plastic that is lost through landfill disposal. As previously discussed, 93 per cent of this plastic is packaging material. There is also a considerable amount of organic material in the waste, which has a significant impact in terms of methane emissions.

A similar analysis has been undertaken for recycled and composted materials although different transport figures have been assumed (Table 4.4.3). The methodology employed for recycling was given in section 4.2.2. For recycled products the distance travelled is assumed to be five times greater than waste to landfill. Therefore, the assumption is that recycled products travel an average of 360 km

[13] Personal correspondence with Brian Jones, Environment Agency

by road. In terms of CO_2 emissions this is also equivalent to travelling over 3,000 kms by ship[14]. Therefore, as a considerable percentage of recycled materials have travelled further, the approach does take into account the increasing levels of greenhouse gas emissions that this causes. With the extra transportation of recycled goods taken into account the GHG emissions are still relatively small. Table 4.4.2 shows the relative efficiency of recycling (including transportation, methane emissions, processing and production) for each product, expressed as a percentage difference from the impact of landfill.

Table 4.4.2 Efficiency of recycling

Material	Landfill CO_2/tonne	Recycling CO_2/tonne	Percentage Efficiency Gain/Loss
Paper and card	4.63	1.92	+ 59
Plastic film	5.81	4.74	+ 18
Glass	1.26	0.20	+ 84
Metals	5.63	3.71	+ 34

For all of the materials considered there is an advantage in recycling even taking into account the extra transport required for recycled materials. However, there is a significant variation in the energy savings of different materials. For example, there is only an 18 per cent saving for plastics whereas for glass the saving is 84 per cent.

The total emissions of CO_2 equivalent, for the domestic waste stream, is 10.7 million tonnes. On average, for every tonne of material disposed of to landfill 3 tonnes of CO_2 equivalent are produced. For recycling, the ratio is more favourable with 1.6 tonnes of CO_2 equivalent produced for every tonne of material. This ratio could change with a change in the composition of recycling materials. The reason for this being that there is a vast difference in the benefits of recycling different products. The benefits of composting are considerable as methane emissions are no longer produced and the energy required to compost is minimal. For incineration, there is a benefit in comparison to landfill in terms of embodied energy, however it is still not as beneficial as recycling.

Table 4.4.3 CO_2 Emissions of the domestic waste stream (tonnes)

Material	Waste Landfill (tonnes)	CO_2 emissions of recycling (tonnes)	CO_2 emissions of transport for recycling (tonnes)	Total GWP of recycling (tonnes CO_2 equivalent)
Paper and card	212,393	398,415	9,420	407,834
Plastic film	2,373	11,138	105	11,243
Textile	9,670		429	429
Glass	98,034	15,631	4,348	19,979
Metals	91,080	333,602	4,039	337,642
Fine material + other	121,547		5,391	5,391
Totals	535,098	758,786	23,732	782,518

[14] Taken from assumptions developed during the York Ecological Footprint project (www.yorkfootprint.org)

The results of the ecological footprint for waste are shown in Table 4.4.4 below.

Table 4.4.4 Ecological Footprint of the domestic waste stream

Material	Total Landfill (ha)	Total recycling (ha)	Total composting (ha)	Total Incineration (ha)	Total EF (ha)
Paper and card	2,192,488	105,510			2,297,998
Plastic film	165,021	2,909			167,930
Dense plastic	293,088				293,088
Textile	281,870	111			281,981
Other combustibles	728,786				728,786
Other non-combustible	83,844				83,844
Glass	66,468	5,169			71,636
Putrescibles	242,208		1,030		243,237
Metals	288,792	87,350			376,143
Hazardous waste	67				67
Fine material + other	1,232	1,395			2,627
Totals	4,343,862	202,443	1,030	188	4,547,523

The total ecological footprint of domestic waste in the South East is 4.5 million hectares. This figure is of little use by itself. However, it does become useful when used to generate scenarios and understand whether the impact of domestic waste in the South East is getting better or worse.

A scenario for South East domestic waste has been given below. The scenario has been selected by the Steering Group for the project and was identified as one of the most realistic options for the South East. Further applications of the approach have been identified in the section 4.6.

4.5 Waste Scenarios for Municipal Waste in the South East

In an attempt to ensure that a scenario for municipal waste is both realistic and applicable, advice was taken from the project Steering Group who are made up of “waste experts” from the region. The scenario explained below has been taken from the South East Regional Assembly waste plan and the ecological footprint has been calculated. **Please note:** This scenario refers to municipal waste rather than household waste, which includes some non-household waste collected by local authorities, for instance small amounts of Industrial and Commercial waste.

4.5.1 Growth rate for the scenarios

Within the South East Regional Waste Statement a number of scenarios have been generated that attempt to predict the future growth in domestic waste until 2025. Figure 4.1 highlights the potential growth rates in domestic waste.

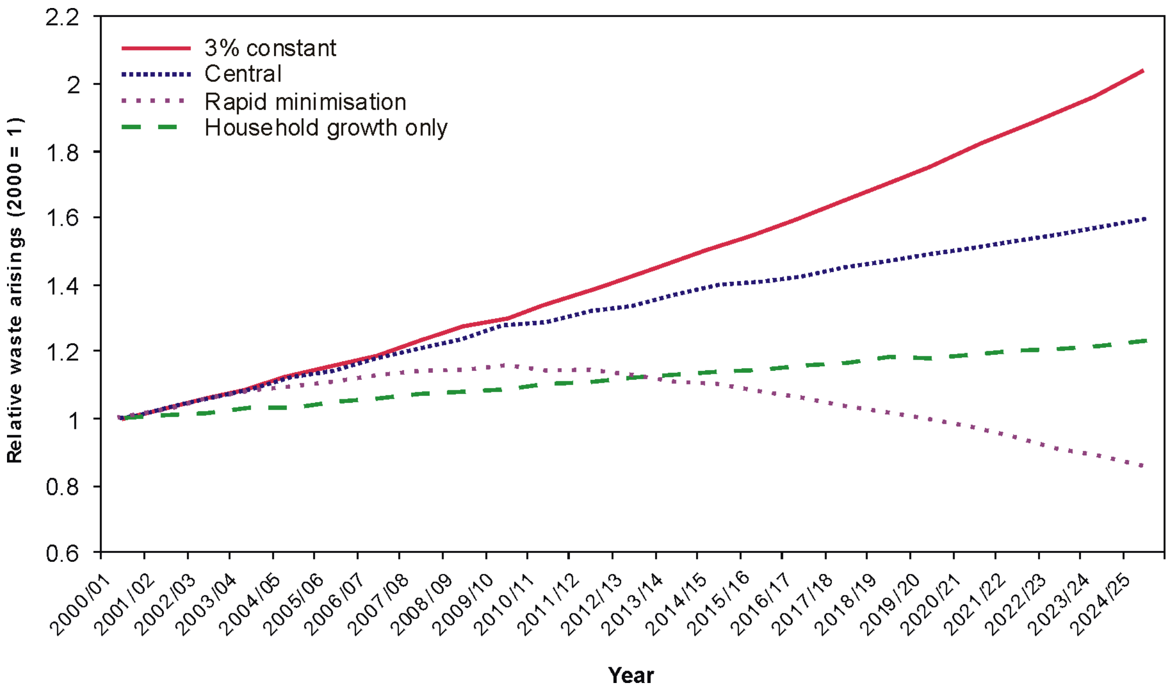


Figure 4.1 Potential growth rate of municipal waste in the South East
Source: South East Regional Waste Statement

For the past few years there has been a growth of approximately 3 per cent in domestic waste per year. The blue line indicates the situation if this growth rate was to continue. The "Rapid Minimisation" line indicates a revolutionary policy to reduce the tonnage of municipal waste by 14 per cent below the year 2000 baseline. The "Household Growth Only" line indicates the growth in waste due to an increase in household numbers in the South East. Finally, the "Central" line indicates the most realistic projection and was used in the Strategy and the Waste Statement. For this reason, this is the growth rate that has been applied to the scenario. The "Central" scenario does include assumptions that the growth rate in domestic waste will be decreasing based on the introduction of waste minimisation policies.

Within the "Central" scenario the fact that economic growth and increasing household numbers will continue to drive increases in waste has been taken into account. Also, there is an in-built assumption that the current growth rate will slow. Finally, it proposes a number of policies will be introduced that will minimise waste production in the first place.

Therefore, the "Central" scenario has been employed as the most realistic option. Therefore, based on the current waste composition of domestic waste the ecological footprint will rise from 0.56 ha./capita to 0.69 ha./per capita.

4.5.2 Recycling rates for the scenarios

The "preferred" scenario within the Regional Waste Management Strategy suggests achieving a 60 per cent recycling rate by 2025. At present, we would suggest that approximately 80 per cent of the material that can appear in the domestic waste stream could be recycled. Therefore, to recycle 60 per cent of waste would require a recycling rate of recyclable materials of 75 per cent. This is an ambitious target as the average participation in a kerbside collection scheme is approximately 65 per cent. However, as mentioned earlier there will be policies based on waste minimisation in an attempt to reduce the growth rate. These policies would concentrate on un-recyclable products (such as nappies) meaning that the percentage of recyclable products may increase. It is also assumed that other un-recyclable materials will be targeted, for example approximately 14 per cent of paper cannot be recycled. This un-recyclable paper is often covered in a glossy surface and enters the household as "junk mail". Therefore, the promotion of the "Mailing Preference Service" to discourage unsolicited mail shots could reduce un-recyclable paper appearing in the waste stream.

The "preferred" scenario gives details of the overall recycling target but not the recycling targets for individual materials. At present, paper is the most recycled product followed by glass, however there is a considerable variation between counties (see Table 4.5.1). For example, it would be useful to explore why Hampshire has achieved 51 per cent for glass while West Sussex has only achieved 22 per cent and why West Sussex has achieved a 15 per cent composting rate while Hampshire has only achieved 7 per cent.

Within the scenario for recycling and composting, it is assumed that there will be different growth rates in the recycling of different products. For example, the potential for growth within plastic recycling is greater than metals. The scenarios have been generated for five-year intervals up to 2025 (as in the waste strategy).

Table 4.5.1 Varying recycling rates of different materials by county

	Paper	Glass	Composting	Metal	Plastic
Kent & Medway	22%	24%	10%	25%	0%
East Sussex & Brighton & Hove	13%	22%	15%	39%	3%
West Sussex	38%	51%	7%	33%	0%
Hampshire & IoW	100%	11%	35%	23%	12%
Surrey	27%	34%	14%	29%	0%
Buckinghamshire & Milton Keynes	26%	32%	22%	33%	0%
Berkshire	23%	48%	10%	39%	0%
Oxfordshire	25%	38%	9%	32%	4%
South East	41%	29%	13%	26%	9%

4.5.3 Municipal waste scenario for 2005

This suggests that recycling rates have increased to 25 per cent and have met the Waste Strategy 2000 target for municipal waste recycling and composting. Further waste has also been diverted from landfill and is being incinerated with energy recovery (10 per cent). The remaining waste is still disposed of by landfill.

To form a realistic scenario different recycling rates have been applied to different materials as opposed to suggesting a blanket rate across all material types. The increases in the recycling of the various materials are based on suggestions taken from WRAP reports on the different recycling potentials of different materials. This more in-depth form of analysis also ensures that products that cannot be recycled are not assumed to be recycled. Table 4.5.2 represents the suggested increases in the recycling of the various materials and the information in tonnes of materials that would be recycled.

Table 4.5.2 Recycling rates of different materials – 2005 Scenario

Material	Current Recycling Rate (2000)	Recycling Rate 2005	Tonnes of material recycled
Paper	22%	38%	390,000
Glass	32%	46%	127,000
Plastic	1%	3%	15,000
Metals	31%	42%	250,000
Composting	14%	19%	240,000
Recycling Rate for SE	12%	25%	632,000

There is also an increase in material that will go to incineration with energy recovery. It is assumed that these materials are combustibles. Therefore, approximately 430,000 tonnes of domestic waste will be incinerated.

Table 4.5.3 Scenario 2005 – Ecological Footprint

	Landfill EF (ha)	Recycling + Composting EF (ha)	Incineration (ha)	Total EF (ha)
2000	4,343,862	203,473	188	4,547,523
2005 BAU	4,561,055	213,647	197	4,774,900
2005 “Preferred Option”	3,553,430	459,242	91,766	4,105,688

From the 2000 baseline the “preferred scenario” would reduce the ecological footprint by 441,545 hectares (0.05 ha/capita). This scenario is heavily based on the assumption that the growth rate in waste will be no greater than 1 per cent a year up to 2005. With a 3 per cent growth rate in waste the ecological footprint would not reduce by 2005 compared to the 2000 baseline. The increased levels of recycling, composting and energy recovery would only act to compensate for the growth in domestic waste.

4.5.4 Municipal waste scenario for 2010

By 2010 the “preferred option” suggests a recycling rate of 35 per cent will be achieved. This figure has been selected because it is recommended as a target for recycling and composting of municipal waste by the Cabinet Office Strategy Unit in their publication “Waste not, want not”. There is also a suggested increase in alternative waste disposal options such as incineration or mechanical biological treatment (22 per cent). The scenario for 2010 will assume that this is incineration with energy recovery. Therefore, the remaining 43 per cent will be disposed of by landfill.

The scenario assumes that domestic waste is continuing to grow at 1 per cent a year. Therefore, the tonnage of domestic waste has increased by 10 per cent since 2000. Table 4.5.4 indicates the suggested increases in the recycling rates of the various materials and information on the corresponding tonnes of materials that would be recycled.

Table 4.5.4 Recycling rates of different materials – 2010 Scenario

Material	Current recycling rate (2000)	Recycling rate 2010	Tonnes of material recycled
Paper	22%	51%	600,000
Glass	32%	59%	170,000
Plastic	1%	10%	29,000
Metals	31%	55%	350,000
Composting	14%	34%	450,000
Recycling rate for SE	12%	35%	1,599,000

Over 1.5 million tonnes of materials are recycled or composted, of which the majority is paper and organic material for composting. A considerable proportion of the waste is incinerated (over 1 million tonnes). This is made up of entirely combustible material. Therefore, it is suggested that 25 per cent of the material that is disposed of by incineration was also suitable for recycling.

Table 4.5.5 Scenario 2010 – Ecological Footprint

	Landfill EF (ha)	Recycling + Composting EF (ha)	Incineration (ha)	Total EF (ha)
2000	4,343,862	203,473	188	4,547,523
2010 BAU	4,778,248	223,820	207	5,002,275
2005 "Preferred Option"	3,553,430	459,242	91,766	4,105,688
2010 "Preferred Option"	2,132,794	680,966	230,446	3,044,205

By achieving the targets by 2010 the ecological footprint will have reduced from 0.56 ha/capita to 0.38 ha/capita. Again this reduction is heavily dependent on achieving a considerable reduction in growth of waste. If the growth rate were 3 per cent then the ecological footprint for 2010 would be 0.48 ha/capita. Therefore, the increase in the efficiency of waste (i.e. maintaining a greater amount of embodied energy within the economy) is responsible for a reduction of 0.08 ha/capita while the waste minimisation programme is responsible for a further 0.1 ha/capita reduction.

4.5.5 Municipal waste scenario for 2015

This suggests that by 2015 only 21 per cent of municipal waste will be disposed of by landfill. Forty-five per cent of all waste is recycled meaning that the remaining 34 per cent is incinerated. As there is a considerable proportion of combustibles being disposed of by incineration this limits the tonnage of paper and plastics that can be recycled. Paper recycling has only increased by 5 per cent. Table 4.5.6 indicates the suggested increases in the recycling of the various materials and the information on tonnes of materials that would be recycled.

Table 4.5.6 Recycling rates of different materials – 2015 scenario

Material	Current recycling rate (2000)	Recycling rate 2015	Tonnes of material recycled
Paper	22%	56%	640,000
Glass	32%	66%	199,500
Plastic	1%	12%	62,000
Metals	31%	66%	435,000
Composting	14%	60%	817,000
Recycling rate for SE	12%	45%	2,154,000

To achieve the target of 45 per cent there has had to be a major increase in composting from 37 per cent in 2010 to 60 per cent. Without this increase in composting it would be almost impossible to achieve this target. Glass and metals recycling continue to increase at a steady rate. If achieved, the new waste management system would cause a substantial reduction in the ecological footprint to 0.27 ha. /capita.

Table 4.5.7 Scenario 2015 – Ecological Footprint

	Landfill EF (ha)	Recycling + Composting EF (ha)	Incineration (ha)	Total EF (ha)
2000	4,343,862	203,473	188	4,547,523
2015 BAU	4,995,441	233,994	216	5,229,651
2005 "Preferred Option"	3,553,430	459,242	91,766	4,105,688
2010 "Preferred Option"	2,132,794	678,623	230,446	3,044,205
2015 "Preferred Option"	716,370	825,816	373,822	1,916,008

4.5.6 Municipal waste scenario for 2020

It is assumed that the recycling rate will have increased further by 2020. When applying the current waste composition, achieving a recycling rate of 55 per cent is extremely ambitious. Issues outside the control of the regional strategy will need to be addressed such as building recycling into the design process of products. There is the likelihood that a greater proportion of the waste stream will be "recyclable". However, for this scenario that proportion is a difficult variable to predict and therefore the current waste composition is still assumed. The recycling figure has been derived from a study undertaken for the South East Regional Assembly by Jones (2003)[15]. The figure of 55 per cent represents the practicable limits to recycling. Even less material is disposed of to landfill (17 per cent) while the remaining 28 per cent is disposed of by incineration. This is a reduction in incineration as well as landfill.

It must be noted that the Regional Assembly is exploring other disposal methods as well as incineration, such as mechanical biological treatment, anaerobic digestion and gasification. Therefore, these approaches could supersede a policy of incineration. For this scenario however, incineration has still been considered.

[15] Jones B. (2003) *Analysis of the Practicably Achievable Recycling and Composting Rates*, Unpublished advice to the South East England Regional Assembly 2003.

Table 4.5.8 Recycling rates of different materials – 2020 scenario

Material	Current recycling rate (2000)	Recycling rate 2020	Tonnes of material recycled
Paper	22%	75%	878,000
Glass	32%	75%	235,000
Plastic	1%	17%	90,500
Metals	31%	80%	550,000
Composting	14%	72%	1,020,000
Recycling rate for SE	12%	55%	2,750,000

From the domestic waste stream 2.7 million tonnes of waste will be recycled. A recycling rate of 72 per cent has been achieved for most materials. Table 4.5.9 demonstrates the change in the ecological footprint.

Table 4.5.9 Scenario 2020 – Ecological Footprint

	Landfill EF (ha)	Recycling + Composting EF (ha)	Incineration (ha)	Total EF (ha)
2000	4,343,862	203,473	188	4,547,523
2020 BAU	5,169,196	242,133	224	5,411,553
2005 “Preferred Option”	3,553,430	459,242	91,766	4,105,688
2010 “Preferred Option”	2,132,794	678,623	230,446	3,044,205
2015 “Preferred Option”	716,370	825,816	373,822	1,916,008
2020 “Preferred Option”	568,319	1,093,331	318,499	1,980,149

The ecological footprint has increased by 3 per cent since 2015. The reason for this is that there is a still an increase in waste and this increase outpaces the gains that are made through increased levels of recycling and composting. More than anything this highlights the importance of waste minimisation and targeting the reduction in the consumption of key products that maintain materials with a high environmental impact.

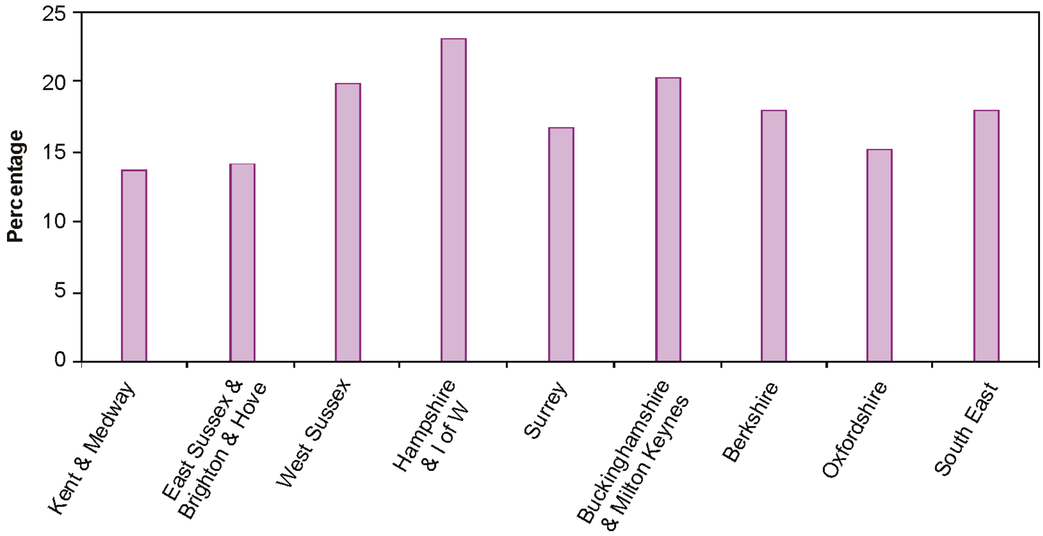
4.5.7 Scenario conclusions

The scenario has demonstrated that the preferred option for the South East Regional Assembly would bring about a substantial reduction in the ecological footprint. Without the reduction in the waste the benefits of increased recycling and composting would not be so visible. Overall, the scenario suggests that a 58 per cent reduction in the ecological footprint could be achieved by 2020.

4.6 A County Level Breakdown for the South East – Household Waste

A description of data collection methodology can be found in section 4.3 along with the household waste data for the region. The county level breakdown offers a more comprehensive insight into the use of the ecological footprint as a method to assess the sustainability of waste disposal systems. The analysis below investigates the raw data (such as tonnages and recycling rates) alongside the ecological footprint methodology. Figure 4.2 indicates the recycling rates for the South East sub-regions.

Figure 4.2 Recycling rate of the South East sub-regions



Three of the sub-regions have a significantly higher recycling rate than others (Hampshire and West Sussex and Bucks and Milton Keynes). There is a considerable difference between the recycling rates of the sub-regions, the lowest being Kent and East Sussex (14 per cent) and the highest Hampshire (23 per cent). Hampshire is the only sub-region that has nearly achieved the government target of a 25 per cent recycling by 2005. All the sub-regions of the South East have achieved a higher recycling rate than the UK average. In terms of the tonnage of waste produced per capita, Figure 4.3 indicates that sub-regions that have higher recycling rates also, an average, produce more rubbish.

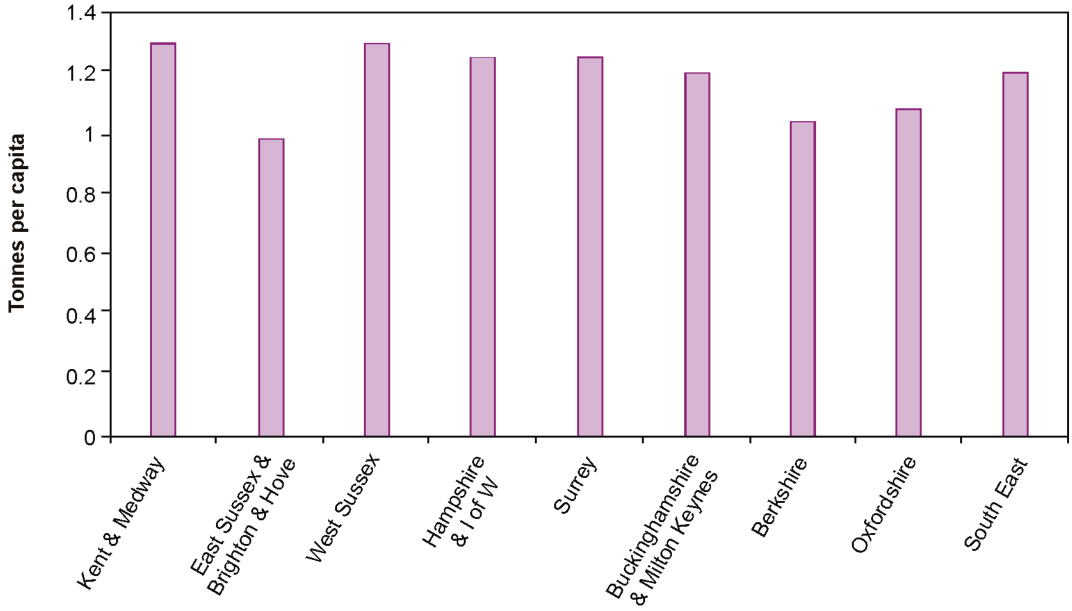


Figure 4.3 Tonnes per capita

East Sussex produces 25 per cent less waste (per household) than Kent. The ecological footprint analysis (Figure 4.4) combines both the efficiency of the waste management system with the tonnage produced for each of the sub-regions. The methodology for calculating the ecological footprint of waste combines both the impact of the various disposal methods and the volume of waste produced.

The sub-regions with the lowest ecological footprint per household are West Sussex and Hampshire (0.83 ha/household and 0.87 respectively) while East Sussex has the highest ecological footprint per household (see Figure 4.4). As well as a measure of the overall domestic waste system, the ecological footprint can be employed as an efficiency rating by considering the ecological footprint per tonne of waste. This will vary due to material composition and the efficiency of disposal.

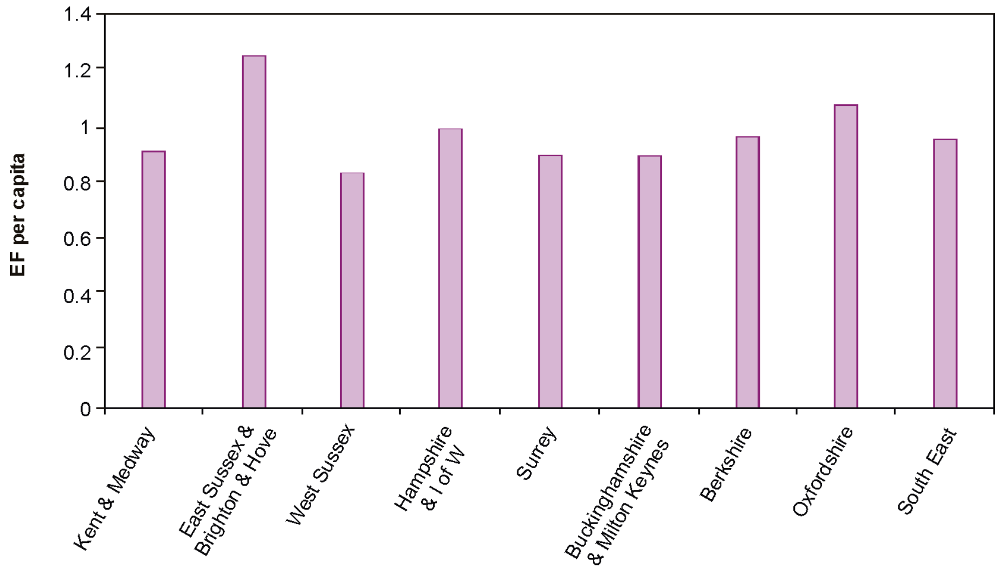


Figure 4.4 EF per capita (hectares)

The ecological footprint results for the sub-regions can also be expressed as a resource productivity measure. Figure 4.5 highlights the ecological footprint per tonne of waste for the different sub-regions.

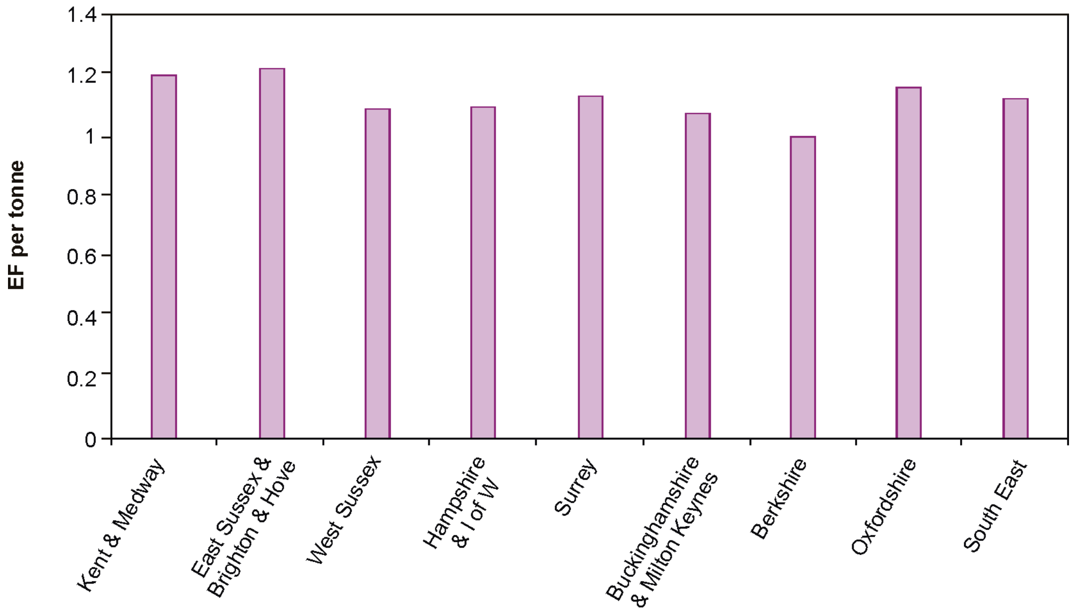


Figure 4.5 EF per tonne (hectares)

This analysis indicates the ability of the sub-region to maximise the efficiency within the waste stream. In essence, "EF per tonne" provides a valuable indicator of resource productivity. Berkshire is able to process their waste more efficiently than any of the other sub-regions. Potential reasons for this include lower embodied energy in the waste stream due to a different material composition or the different recycling composition.

4.7 Results for the South East – Commercial Waste

Aggregate waste arisings for 2000 are estimated based on averaging the three most recent reports from the South East on industrial and commercial waste arisings per employee by SIC sector groupings, multiplied by the number of employees in these groups from the NOMIS 2000 employment data. Construction and demolition waste is excluded since this is dealt with separately, and the reports by MEL Research[16] exclude this SIC category so it is excluded from average waste per employee estimates.

Environment Agency (EA) waste per employee figures were taken from data sent by Alan Bell. The other two data sets are from MEL Research reports on industrial and commercial waste arisings and

[16] MEL Research, 8 Holt Court, Aston Science Park, Birmingham

composition in Medway and Surrey. In both of these reports, 12 SIC divisions (including most significantly construction and demolition waste) were excluded due to their abnormal/distinctive waste. Estimates for groups of SIC codes were produced taking into account the non-normal distribution of waste (most companies produce little, a few produce a lot). Detailed methodology is contained in the reports.

The resulting estimate of regional I & C waste (7.15 million tonnes) is considerably lower than that in the last South East SWMA (Strategic Waste Management Assessment) based on the EA 98/99 survey (9 million tonnes). This is partly explained by the exclusion of inert/construction and demolition waste, but mainly by the methodology using waste per employee estimates from other studies. MEL has a very detailed justification for their methodology, which appears convincingly rigorous. In addition there are a number of recognised problems with the EA survey data, the main one being that only half the businesses surveyed provided waste data by weight – the rest were estimated using volume to waste conversion factors which are prone to inaccuracies, tending to over-estimate. Also, no pre-set list of waste categories was used, leaving companies to describe their waste. This was later allocated to categories. The differences in methodology, together with the lack of alternative data sources make it difficult to verify our results.

Waste composition proportions are based on EA figures for South East from the 98/99 survey, adjusted to take account of general industrial and commercial category composition breakdowns obtained from EA (construction and demolition waste is excluded).

Disposal proportions are based on EA 98/99 data from SWMA, applied to the industrial and commercial estimates arrived at for 2000. The broken down general categories are included based on the disposal proportions of general waste, rather than the disposal proportions of the materials themselves, since they are disposed of as general waste.

The commercial sector is responsible for producing 30 per cent more waste than the household sector. Of the 5.8 million tonnes produced in 2000, 80 per cent of this was by commercial services and the other 20 per cent by public administration. A considerable proportion of the waste was paper and cardboard (2.5 million tonnes). The majority of the waste was disposed of by landfill (56 per cent), 22 per cent was recycled and the remainder underwent special treatment before disposal or its disposal method was unknown.

The overall total for commercial waste is based on the average waste per employee from the three South East studies mentioned, for the commercial SIC codes (most of 50-93), multiplied by the number of employees in these codes in 2000 (from NOMIS stats).

The waste composition for commercial waste has not been investigated to the same level as the domestic waste stream. There is a lack of information on the composition of commercial waste meaning that very little is known about 25 per cent of this waste stream. An analysis of the other 75 per cent has been undertaken, meaning that the final results are an underestimate of the environmental impact of this waste stream.

Table 4.7.1 Commercial waste production in the South East (tonnes)

Material	Landfill	Re-use/land spreading[17]	Recycled	Treatment[18]	Other	Total
Paper and card	1,395,040		682,190		477,788	2,555,018
Food	512,815	36,299	67,963		155,235	772,312
Plastics and polymers	386,708		39,167		125,777	551,652
Wood	60,537		5,923		20,643	87,103
Glass	60,537		5,923		20,643	87,103
General industrial	504,035		50,404		164,892	719,331
Other general and biodegradable	92,207	119,732	183,038	27,525	36,241	458,742
Metal and scrap equipment	40,694	1,487	127,844	1,487	14,494	186,005
Contaminated general	170,582	5,627	79,368	7,108	33,169	295,854
Mineral wastes and residues	2,903		2,903			5,807
Chemical and other	19,139	4,460	22,113	38,372	8,826	92,910
Total	3,245,199	167,603	1,266,836	74,490	1,057,708	5,811,836

A significant part of commercial waste currently disposed of by landfill could be recycled or composted. Over 1.8 million tonnes of paper, 0.7 million tonnes of food and 0.5 million tonnes of plastic could be recycled but are currently not. In fact, paper represents an extremely large proportion of the waste stream in total (44 per cent) of which 27 per cent is currently recycled.

4.8 Results for the South East – Construction and Demolition (C & D) Waste

Construction and demolition (C & D) waste was derived from regional estimates of C & D waste for 1999 found in the SWMA report, based on the study done by Symonds in 2000. This was repeated in 2002, giving data for 2001. To arrive at estimates for 2000, the economic value of construction activity in the South East was used (from the DTI Construction Statistics Annual 2002). Starting with the 1999 value, inflation adjusted estimates were made for 2000 and 2001. Estimates for waste arisings for 2000 were then made based on this trend data.

[17] Includes use for engineering or restoration at licensed landfills. Will also include some use to restore former mineral workings/quarries, and some spreading at 'exempt sites' - e.g. for land reclamation or agricultural improvement (often sludge type wastes, e.g. by-products from paper/pulp processing or food processing).

[18] Includes solvent and oil reprocessing, and various physical, chemical or biological treatments. Possibly includes a small amount of burning e.g. of diseased wood.

The way the data are presented also indicates crude composition, without having a detailed material breakdown, and the broad method of disposal is also incorporated into the tables.

A separate estimate is given for quarry waste, since this is excluded from the Symonds surveys. This is taken from the Construction Industry Mass Balance report by Viridis (2002). A regional estimate is proxied from the national figure based on the proportion of employees in SIC code 14 ('Other mining and quarrying') in the South East (9.8 per cent). No composition breakdown is given, and there is also no disposal information. Most if not all of this waste will presumably remain on site.

Various wastes from the manufacture of construction materials and products are also listed separately. Regional estimates for these waste streams are taken from the SWMA (1998/99 data) and the composition breakdown percentages come from the Construction Mass Balance report. No disposal information is available.

Table 4.8.1 Construction and demolition waste in the South East (tonnes)

	Recycled aggregate and soil	Material used for landfill engineering or restoration	Material used at exempt sites/quarry voids	Material disposed of at landfill	Mining & quarrying	Production for construction	Total
Hard C&D/excavation [CDEW] waste	4,413,500	1,369,000	3,890,000	339,500			10,022,000
Excavation waste/mixed CDEW screened for use as soil.	703,000						703,000
Mixed CDEW		574,000	301,000				875,000
Mixed and/or contaminated hard C&D waste				836,500			826,500
Clean excavation waste							
Mixed CDEW and unspecified material				857,000	5,754,000		6,611,000
Wood products						25,080	25,080
Finishes, coatings, adhesives etc						9,405	9,405
Plastic products						4,180	4,180
Basic metals and fabricated metal products						17,765	17,765
Cabling, wiring and lighting						4,180	4,180
Glass-based products						18,810	18,810
Ceramic products						8,360	8,360
Bricks and other clay-based products						52,250	52,250
Cement, concrete, plaster etc						66,880	66,880
Stone and other non-metallic mineral products						2,090	2,090
Total	5,116,500	1,943,000	4,191,000	2,033,000	5,754,000	209,000	19,246,500

Over 19 million tonnes of construction and demolition waste was produced in the South East. A large percentage of the waste is crushed aggregate of which the majority is disposed of by landfill, albeit at specific landfill sites, some material is used for landfill engineering and some disposed of at a quarry. In essence, all these forms of disposal can be described as landfill. Most of the material being disposed of is described as "low-grade" material. However, a comparison of the inputs of construction material into the South East shows that the materials are predominately "high-grade" materials (i.e. high embodied energy). Therefore, it is possible to suggest that the materials classed as "mixed CDEW and unspecified material" are made up of more "high-grade" material. It is reasonable to assume that there is a high percentage of recyclable materials within this waste stream.

4.9 Results for the South East – Agricultural Waste

Waste arisings data are taken from the table in the appendix at the back of 'Towards Sustainable Agricultural Waste Management', giving a regional breakdown based on the methodology developed by Marcus Hodges Environment Ltd. This uses a combination of a mass balance approach and a 'bottom-up' farm practice approach. Unit waste estimates were then applied to the June 1998 Agricultural Census results (the most recent comprehensive data) to arrive at regional estimates. Data were not available for 2000 and, as no easy way was found to produce estimates for this period from the available data, 1998 data have been used instead.

There is some debate about what constitutes waste in an agricultural context. Definitions vary, e.g. between this country and the EU. Information is included about waste and by-products, although these are totalled separately. Agricultural waste is not normally controlled under waste management legislation, although this is under review at the moment. There is no information available about the management or disposal of agricultural waste and by-products. Much agricultural waste is disposed of on farms, often burned or buried.

Table 4.9.1 Agricultural waste production in the South East *(tonnes - corrected to tally with waste data figures)*

Packaging	
…plastic	2,401
…cardboard and paper	745
…metal, wood, glass and rubber	155
Non packaging plastics	5,414
Agrochemicals	14,961
Animal health products	5,016
Machinery waste	8,289
Construction and demolition waste	2,352
Organic by-products/wastes	5,941,550
Animal by-products	16,537
Total	5,997,420

4.10 Results for the South East – Industrial Waste

A description of the data collection methodology for industrial waste can be seen in section 4.7 (commercial waste). This is because the same methodological approach was adopted for both commercial and industrial waste.

Table 4.10.1 Industrial waste production in the South East (tonnes)

Material	Landfill	Re-use	Recycled	Treatment	Other	Total
Paper and card	122,773		101,841		10,349	234,963
Food	37,914	34,332	13,366		1,660	52,940
Plastics and polymers	52,706		2,832		2,254	92,124
Wood	17,160		828		828	18,816
Glass						
General industrial	105,181		5,895		4,508	115,584
Other general and biodegradable	49,166	96,375	72,403	11,986	14,676	148,231
Metal and scrap equipment	10,479	835	77,712	835	2,782	188,183
Contaminated general	55,335	2,551	34,143	3,336	3,041	96,690
Mineral wastes and residues	110,140		88,112		2,003	202,806
Chemical and other	42,578	9048	33,707	79,833	12,241	168,359
Total	603,432	143,141	430,839	95,990	54,342	1,327,744

By employing a SIC approach, consistency between the methodology for production (following chapter) and waste generation was ensured. The data have been presented in this section to demonstrate potential links between this project and the Environment Agency's REWARD project.

4.11 Results for the South East – Hazardous Waste

Waste production data are taken from the Hazardous Waste Interrogator 2000, on the EA website, listed by county by hazardous waste category. Composition amounts above one tonne are indicated. Most categories are based on industry type (SIC coding) rather than material type, making it difficult to accurately assess arisings by material. Due to this, and the fact that being based on transfers complicates disposal information, disposal information is not given. This waste is regarded as being included in data reported for the other waste streams (in particular I & C and C&D) and therefore it does not constitute additional arisings, so it is excluded from the overall waste total.

Table 4.11.1 Hazardous waste production in the South East (tonnes)

Main Category	Total South East
Mining and minerals	188
Agricultural and food production	3013
Wood and paper production	53
Leather and textile production	26
Petrol, gas and coal refining/treatment	2317
Inorganic chemical processes	4228
Organic chemical processes	58164
Paints, varnish, adhesive and inks	6924
Photographic industry	434
Thermal process waste (inorganic)	4878
Metal treatment and coating processes	440
Shaping/treatment of metals and plastics	2013
Oil and oil/water mixtures	129773
Solvents	4538
Packaging, cloths, filter materials	2089
Not otherwise specified	54376
C&D waste and asbestos	158959
Healthcare	2259
Waste/water treatment and water industry	27560
Municipal and similar commercial wastes	5284
Unclassified	876
Total	468,392

4.12 Priority Waste Streams

4.12.1 Tyres

The South East region's total tonnage is taken from the 'Tyre waste and resource management: A mass balance approach' report by Viridis. Figures are based on 1998 data which are the most recently available. Disposal routes are based on data in the same report, regional estimates arrived at using percentage of national arisings figure.

Table 4.12.1 Waste tyre production in the South East (tonnes)

Re-used as part worns	3741
Re-used by re-treading	10965
Recycling - engineering uses	3225
Recycling - shredding / crumbing	6192
Recovery - energy recovery	10875
Other	3635
Disposal – landfill	12546
Total	51179

Section 3.7.1 considers the inputs of cars in the South East. Approximately 20,500 tonnes of tyres from new cars were brought into the South East and 7,100 tonnes of tyres for replacement of the existing stock. Therefore, it can be assumed that 54 per cent of tyres (by weight) are from cars (see section 3.7 for explanation). Of the 51,179 tonnes of tyres produced, 47 per cent are recycled or re-used, 21 per cent are incinerated with energy recovery and the majority of the remainder (25 per cent) are disposed of by landfill.

4.12.2 End of life vehicles (ELVs)

When looking at the numbers of new cars entering the South East in the year 2000, it can be calculated that there was an input of approximately 415,000 tonnes of materials. This compares to an output of about 300,000 tonnes, which was calculated as follows. Using the SE SWMA data, the figure for materials for disposal from ELVs nationally is 1,884,000 tonnes. Using a conversion factor of 16% for the South East, based on vehicle registrations, this gives 301,440 tonnes. The disposal breakdown is based on the national proportions shown in the SWMA report applied to the South East region tonnage.

Compared to many products the car is generally a more "recyclable" product, in that the various materials can be separated for recycling purposes. This is demonstrated in table 4.12.2, where it can be seen that the majority of the car is recycled.

Table 4.12.2 Waste car production in the South East *(tonnes - table omits landfilled residues)*

Parts re-used - all types	30747
Recycled - ferrous metal	175137
Recycled - non-ferrous metal	8440
Recycled - fluids (Incl oil)	6933
Recycled – batteries	1507
Recycled – other	754
Landfilled residues	77922
Total	301440

4.12.3 WEEE (Electrical and Electronic Waste)

WEEE data was estimated from SE SWMA where 1998 data was presented. No detailed waste production or management figures are available – estimates are made using various sources, including sales information and population distribution. Main material components of WEEE are listed as Ferrous metal (47%); Plastics (22%); Glass (6%); Non-ferrous metals (4%). These figures correspond to the analysis of the inputs of electrical equipment (section 3.7.2) for the South East.

The recycling breakdown is based on national percentages from SWMA applied to regional figures – large appliances 77%; IT/office equipment 22%; Radio/TV/audio 1%. This waste is regarded as being included in household and I & C waste data, so is excluded from the overall waste total.

Table 4.12.3 WEEE production in the South East

		Tonnes
Composition of waste	Large household appliances	60200
	IT equipment	54600
	Radio, TV audio equipment	11200
	Small household appliances	4200
	Electronic and electrical tools	4200
	Gas discharge lamps	4200
	Other	1400
Disposal route		
Recycling	*Large household appliances*	*52820*
	IT/office equipment	*15090*
	Radio, TV, Audio	*680*
Landfill		*71410*

Table 4.12.4 provides a comparison between the inputs of electrical equipment and waste generation.

Table 4.12.4 Comparison of inputs and outputs of electrical equipment in the South East (tonnes)

Electrical Item	Input	Output	Percentage Recycled
Large household appliances	80,421	60,200	88
IT equipment	86,787	54,600	28
Radio, TV audio equipment	20,292	11,200	6
Small household appliances	5,887	4,200	Not available
Electronic and electrical tools	5,558	4,200	Not available

The input and output figures were calculated independently, employing different methodologies, however the results from both methods support each other. Table 4.12.4 suggests a steady increase in the stock of electrical equipment in the South East. For large household appliances this increase is approximately 25 per cent. More significant is the increase in IT equipment with a rate of nearly 40 per cent. A further concern is the poor recycling rate of IT equipment (28 per cent). With a vastly growing market the potential increase in IT equipment is set to rise substantially.

4.12.4 Fluorescent tubes

There is little data available for fluorescent tubes as they are not usually classified as special waste. Regional estimates for fluorescent tubes and sodium lamps are taken from SE SWMA, based on population based proportions of national usage figures. There is also an estimate for fluorescent tubes recycled. This waste is regarded as being included in household and I & C waste data, so it is already included in the overall waste total.

Table 4.12.5 Fluorescent tubes waste in the South East

	Tonnes
Fluorescent tubes	7344
Recycled	*184*
Landfilled	*7160*
Sodium lamps	918
Total	8262

4.13 Conclusions

The analysis undertaken of the different waste streams supports the theories behind the “Waste Hierarchy”. In every case it is beneficial not to produce the waste in the first place. This was demonstrated both in the scenario and the analysis of the counties. The 58 per cent reduction in the ecological footprint demonstrated in the scenarios would be a considerable achievement for the South East. This represents an average yearly reduction of 2.9 per cent. A high forecast for waste growth by 2020 (see Figure 4.1) suggests a 60 per cent increase in waste by 2020, while the scenario suggests that this can be limited to 19 per cent. Without limiting the growth in waste the ecological footprint of domestic waste in the South East would have decreased by 29 per cent, not 58 per cent. Therefore, it is possible to conclude that the waste minimisation component of the scenario was responsible for approximately half of the total reduction. Serious thought is required as to how the reduction in the growth of waste is going to be achieved. One of the suggestions listed in the PIU Report is to introduce a “Pay by Weight” scheme. This would involve the cost of waste disposal being shown separately from the Council bill and the weight of a household’s waste would determine the amount they would pay for waste disposal.

Within the county analysis the ecological footprint could be seen as an indicator that offers comparison of overall performance of the waste stream and as a measure of resource productivity. One of the interesting conclusions to draw from the analysis is that the sub-regions with the highest recycling rates did not necessarily have the lowest ecological footprint. The reasons for this being that the sub-regions in question produce a considerably larger volume of waste. Again, this underlines the importance of waste minimisation as the most effective method by which to reduce the impact of the waste stream.

The analysis highlights particular materials of concern that cannot be recycled or where the benefits of recycling are marginal. To achieve a waste stream that nearly consists of only recyclable materials would be a key indicator for 2020. This would make the recycling targets for 2020 easier to achieve.

As previously mentioned the South East is also considering a range of other waste disposal options such as mechanical biological treatment and gasification. Further work is required to understand the feasibility of such approaches and their potential impact.

Finally, once the waste system has achieved maximum efficiency (i.e. maximum recycling and composting rates), if the volume of waste continues to increase then the ecological footprint will increase, albeit at a lower rate than before. Therefore, in the short term more sustainable waste technologies can only act as a method to compensate for the growth in waste.

In conclusion, it makes little sense to view treatment technologies outside of the wider question of society's pattern of resource consumption, which today gives rise to a huge volume of waste through its continued growth.