Waste Management Plan for England
Strategic Environmental Assessment: Environmental Report

Final Report for Defra

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Report for:

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Abbreviations

AD	Anaerobic Digestion
AONB	Areas of Outstanding Natural Beauty
AoSP	Areas of Special Protection
AQMA	Air Quality Management Area
ASSI	Area of Special Scientific Interest
B[a]P	Benzo[*a*]pyrene
C&D	Construction and Demolition (waste)
C&I	Commercial and Industrial (waste)
CAFÉ	Clean Air For Europe
CBD	Convention on Biological Diversity
CBD	Convention on Biological Diversity (Nagoya)
CCRA	Climate Change Risk Assessment
CHP	Combined Heat and Power
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
DCLG	Department for Communities and Local Government
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DPA	Data Protection Act
EC	European Commission
EEE	Electrical and Electronic Equipment
EIA	Environmental Impact Assessment
ELV	End of Life Vehicle
ER	Environmental Report
ETS	Emissions Trading Scheme
EU	European Union
FITS	Feed In Tariff Scheme
FOIA	Freedom of Information Act
GHG	Greenhouse Gas
GVA	Gross Value Added
HGV	Heavy Goods Vehicle

HIA	Health Impact Assessment
HSE	Health and Safety Executive
IACR	Integrated Approach to Crop Research
IED	Industrial Emissions Directive
IGCB	Inter-Departmental Group on Costs and Benefits
IPC	Infrastructure Planning Commission
IPCC	International Panel on Climate Change
IPPCD	Integrated Pollution Prevention and Control Directive
IVC	In-Vessel Composting
LCI	Life Cycle Inventory
LCPD	Large Combustion Plant Directive
LNR	Local Nature Reserves
LVIA	Landscape and Visual Impact Assessment
MBT	Mechanical Biological Treatment
MDF	Medium Density Fibreboard
MIT	Material Intensity
MSW	Municipal Solid Waste
NEEI	Non-Energy Extractive Industry
NH_3	Ammonia
NIA	Nature Improvement Areas
NNR	National Nature Reserves
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Projects
O_3	Ozone
ODPM	Office of Deputy Prime Minister
ONS	Office for National Statistics
OSPAR	Convention for the protection of the North East Atlantic
PAS	Publicly Available Standard
Plan	National Waste Management Plan
PM	Particulate matter
PO_4	Phosphates
PPS	Planning Policy Statement

PRN	Packaging Recovery Note
RDF	Refuse Derived Fuels
SAC	Special Areas of Conservation
SCI	Site of Community Importance
SCR	Selective Catalytic Reduction
SEA	Strategic Environmental Assessment
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Dioxide
SOC	Soil Organic Carbon
SO_x	Sulphur Oxides
SPA	Special Protection Area
SR	Scoping Report
SRF	Solid Recovered Fuels
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
TMR	Total Material Requirement
UWWTD	Urban Waste Water Treatment Directive
VOCs	Volatile Organic Compounds
WEEE	Waste Electrical and Electronic Equipment
WF	Water Footprint
WFD	Waste Framework Directive (2008/98/EC)
WID	Waste Incineration Directive
WRAP	Waste and Resources Action Programme
WRATE	Waste and Resources Assessment Tool for the Environment
WTS	Waste Transfer Stations
Zn	Zinc

Contents

1.0 Introduction

This Environmental Report (ER) sets out the likely significant effects on the Environment, at a strategic and non-site specific level, from the introduction of the Waste Management Plan for England (the Plan). In doing so, the document complies with the requirements of the Environmental Assessment of Plans and Programmes Regulations 2004[1] (the SEA Regulations) which transposes the requirements of EU Directive 2001/42/EC on the Assessment of the Effects of Certain Plans and Programmes on the Environment.

SEA is a process which seeks to look at whether a plan or programme is likely to have significant effects on the environment, and where these effects are negative, to try to identify ways by which these might be avoided or mitigated. The process is designed to work towards sustainable development, which is a concept enshrined in policy at a local, national and international level.

This Environmental Report relates to that part of the English Waste Management Plan which is the responsibility of Defra. Defra is not responsible for matters related to the siting of facilities, and decisions regarding the appropriateness of the use of land for waste management. This is the responsibility of CLG, and is currently set out in Planning Policy Statement 10 (PPS10) "Planning for Sustainable Waste Management". This is the Planning Policy Statement which relates to Waste Management, and which sets the framework for future waste management infrastructure at a planning, and therefore location specific, level. PPS10 is currently under review and also being subject to SEA.

Together, the Defra waste management plan and the CLG planning policies (currently set out in PPS10) implement, for England, the requirements of the revised Waste Framework Directive, and associated Directives, relating to the production of waste management plans.

An important consequence of this is that the part of the Waste Management Plan being developed by Defra does not consider any aspects of waste management that relate to waste planning and, therefore, has no influence on the location of specific facilities. It does provide the framework for policies which will influence the extent to which waste management infrastructure (of whatever type) might be required. Hence, the consideration of environmental impacts cannot take into account impacts on specific sites, but proceeds at a more strategic level, regarding what the mix of facilities might be at the national level, and what might be the 'high level' implications of changes in this mix for environmental quality.

2.0 The Waste Management Plan for England

The revised Waste Framework Directive (WFD) requires all Member States to have Directive-compliant waste management plans in place by 12 December 2010. The Waste Strategy 2007 is the current plan, but this needs updating and so Government have been updating the plan to both provide an overview of waste management in England and to fulfil the revised WFD Article 28 mandatory requirements, and other

[1] SI 1633/2004.

required content as set out in Schedule 1 to the Waste (England and Wales) Regulations 2011[2].

The mandatory requirements of Article 28 of the WFD specify that the Plan should contain the following information:

- An analysis of the current waste management situation in the geographical entity concerned, as well as the measures to be taken to improve environmentally sound preparing for re-use, recycling, recovery and disposal of waste and an evaluation of how the plan will support the implementation of the objectives and provisions of this.
- The type, quantity and source of waste generated within the territory, the waste likely to be shipped from or to the national territory, and an evaluation of the development of waste streams in the future;
- Existing waste collection schemes and major disposal and recovery installations, including any special arrangements for waste oils, hazardous waste or waste streams addressed by specific Community legislation;
- An assessment of the need for new collection schemes, the closure of existing waste installations, additional waste installation infrastructure in accordance with Article 16 (on the proximity principle), and, if necessary, the investments related thereto;
- Sufficient information on the location criteria for site identification and on the capacity of future disposal or major recovery installations, if necessary;
- General waste management policies, including planned waste management technologies and methods, or policies for waste posing specific management problems.

In addition Schedule 1 to the Waste (England and Wales) Regulations 2011 sets out other obligations for the Plan which have been transposed from the WFD. These other obligations include:

- In pursuance of the objectives and measures in Directive 94/62/EC of the European Parliament and of the Council on packaging and packaging waste(1), a chapter on the management of packaging and packaging waste, including measures taken pursuant to Articles 4 and 5 of the Directive.
- Measures to promote high quality recycling including the setting up of separate collections of waste where technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors.
- As appropriate, measures to encourage the separate collection of bio-waste with a view to the composting and digestion of bio-waste.
- As appropriate, measures to be taken to promote the re-use of products and preparing for re-use activities, in particular —

[2] SI 2011/988.

(a) measures to encourage the establishment and support of re-use and repair networks;

(b) the use of economic instruments;

(c) the use of procurement criteria; and

(d) the setting of quantitative objectives.

- Measures to be taken to ensure that:

  (a) by 2020, at least 50% by weight of waste from households is prepared for re-use or recycled; and

  (b) Measures to be taken to ensure that, by 2020, at least 70% by weight of Commercial & Demolition waste[3] is subjected to material recovery.

It is not the intention of the Plan to introduce any new policies or to change the landscape of how waste is managed in England. Its core aim is to comply with the requirements of the WFD, bringing current policies under the umbrella of a national plan. The Plan will therefore incorporate current waste policies into a single plan.

The Waste Review 2011 details the main policies which will fall under the WMPE umbrella. This will be supplemented by other information and policies contained within documents such as the Anaerobic Digestion Strategy 2011 and the UK Plan for Shipments of Wastes among others.

In addition, as mentioned in the introduction, PPS10 is currently being revised and when this is complete the new document will also form the part of the Plan which deals with the more Town and Country Planning/ locational requirements.

Whilst the new Plan is being developed, the Waste Strategy 2007, in conjunction with Planning Policy Statement 10 (PPS10), will continue to fulfil the role as the waste management plan for England until such a time as the new waste management plan is adopted.

As waste is a devolved matter, devolved administrations are responsible for producing a Plan for their areas, so the geographic scope of the proposed Plan discussed in this document is England only.

This Environmental Report is being consulted upon alongside the draft Plan and the reader is referred to the Plan in order to understand the full content of the plan.

3.0 Strategic Environmental Assessment (SEA)

The Environment Agency describes SEA as:

'A Strategic Environmental Assessment (SEA) is intended to increase the consideration of environmental issues during decision making related to strategic documents such as plans, programmes and strategies. The SEA identifies the

[3] This is C&D waste excluding hazardous waste and is naturally occurring and which falls within 170504 in Schedule 1 to the List of Wastes (England) Regulations 2005

significant environmental effects that are likely to result from the implementation of the plan or alternative approaches to the plan.'[4]

Government guidance on SEA[5] states that a SEA is a procedure comprising of:

- Preparation of a Scoping Report (SR) to establish the baseline for the subsequent Environmental Report (ER);
- Preparation of an ER setting out the likely significant effects of a draft plan or programme;
- Consultation on the draft plan/programme and the accompanying ER;
- Taking into account the ER and the results of consultation in decision making; and
- Providing information when the plan or programme is adopted and showing how the results of the environmental assessment have been taken into account.

This is preceded by a screening process which establishes whether the plan or programme requires an SEA.

Under the SEA Regulations there is a legal requirement to conduct an SEA for:

(a) a plan or programme which is prepared for waste management and sets the framework for future development consent of projects listed in Annex I or II to the EIA Directive (85/337/EEC as amended by 97/11/EC),

(b) a plan or programme which, in view of the likely effect on sites, has been determined to require an assessment pursuant to Article 6 or 7 of the Habitats Directive, or

(c) in other cases, a plan or programme which sets the framework for future development consent of projects and is likely to have significant environmental effects.

Annex I to the EIA Directive includes:

> *"Waste disposal installations for the incineration, chemical treatment as defined in Annex IIA to Directive 75/442/EEC (1) under heading D9, or landfill of hazardous waste (i.e. waste to which Directive 91/689/EEC (2) applies).*
>
> *Waste disposal installations for the incineration or chemical treatment as defined in Annex IIA to Directive 75/442/EEC under heading D9 of non-hazardous waste with a capacity exceeding 100 tonnes per day".*

And Annex II to the EIA Directive includes:

> *"Installations for the disposal of waste (projects not included in Annex I)"*

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[4] Environment Agency. Available at: http://www.environment-agency.gov.uk/research/policy/32901.aspx

[5] A Practical Guide to the Strategic Environmental Assessment Directive. ODPM (2006). Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/practicalguidesea.pdf

Therefore, where a plan or strategy relating to waste management sets a framework for the development of such waste disposal facilities (even if not specific in terms of location) an SEA will generally be required.

An overview of the SEA process is described in Figure 1.

The individual elements making up this Plan have each been subject to public consultation, or a call for evidence, and where relevant, an impact assessment has been carried out before the policy has been implemented. At the time of implementation the policies did not constitute a Waste Management Plan for England, as required by the revised WFD. Therefore they were not required to be subject to an SEA process. Given that the individual elements of the Plan do now constitute a document which falls within the requirements of the SEA directive, an SEA is being undertaken which will look at the Plan as a whole and the reasonable alternatives arising from it, and seeks to assess what the likely significant environmental impacts arising are.

The environmental issues assessed by this Environmental Report are in line with those suggested in the SEA Regulations. More detail is provided in Section 6.0, but in summary these are categorised as follows:

- Biodiversity (Including Flora and Fauna);
- Climatic Factors;
- Air;
- Population and Human Health;
- Soil;
- Material Assets;
- Water;
- Landscape;
- Cultural Heritage & the Historic Environment

Interactions between these environmental issues are also considered, along with defined timescales and effects of the potential impacts.

Figure 1: The SEA Process

STAGE A: SETTING THE CONTEXT & OBJECTIVES, ESTABLISHING THE BASELINE & DETERMINING THE SCOPE

- Identify Other Relevant Plans, Programmes and Environmental Objectives
- Collect Baseline Information
- Identify Environmental Problems
- Develop SEA Objectives
- Consult On The Scope Of The SEA

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STAGE B: DEVELOPING ALTERNATIVES & ASSESSING EFFECTS

- Develop Strategic Alternatives
- Predict The Effects Of The Plan (& Alternatives)
- Evaluate The Effects Of The Plan (& Alternatives)
- Mitigate Any Significant Adverse Impacts
- Propose Monitoring Plan

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STAGE C: PREPARE ENVIRONMENTAL REPORT

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STAGE D: CONSULTATION ON THE DRAFT PLAN & DRAFT ENVIRONMENTAL REPORT

- Consultation With Public And Statutory Consultees
- Assess Any Changes To The Strategy As A Result Of Consultation
- Inform Consultees How The Environmental Report And Consultees' Opinions Have Been Accounted For In Decision Making

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STAGE E: Monitoring Of The Significant Effects Of The Plan And Responding To Those Effects

Schedule 2 of the SEA Regulations require that the ER includes *"any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of a particular environmental importance, such as areas designated pursuant to Council Directive 79/409/EEC on the conservation of wild birds(***a***) and the Habitats Directive".* As the Plan is not site specific, Article 6 or

7 of the Habitats Directive are not directly applicable. Consideration is given to the possible (non-site specific) impacts on habitats, albeit through proxy measures in some cases, and these relate to habitats inside and outside England (for example, relating to extraction of raw materials).

4.0 Relevant Plans & Programmes

The legislative, regulatory and strategic environment within which the Plan must operate needs to be analysed. In doing so, any constraints the Plan may impose upon other plans and programmes, or vice versa, can be identified. A list of current legislation, plans, programmes and environmental protection initiatives is provided in Appendix A.1.0. This list represents those that are considered as having direct relevance to the Plan and to which the Plan should have regard. This is by no means an exhaustive list of plans and programmes relating to waste generally.

As a national Plan the focus of the list is on European, and national legislation. Where European Directives have been transposed into national law, then the focus of the Plan will be to the legislation through which the Directives are transposed into national law. However, given the fluid nature of policy and legislation, it is important to pay attention to the Directives as they are implemented and amended, and the status of their transposition in England.

Plans and Programmes at a more local level are not considered relevant to this SEA process, since these plans and programmes will need to have regard to the Plan rather than the other way around.

5.0 Baseline Information & Future Trends

To focus the appraisal and to ensure that the SEA picks up on the potential significant impacts of the Plan, the current environmental baseline has been set out, and an assessment made (where possible) as to how these elements are likely to evolve over the next few years.

Appendix A.2.0 sets out the relevant baseline information in accordance with the SEA criteria as laid out in Schedule 2(6) to the SEA Regulations. Where possible, the likely evolution of various environmental indicators, in the absence of the implementation of the Plan, has been highlighted.

6.0 Key Environmental Issues

In order to develop a set of relevant and appropriate objectives and indicators for this SEA, it is important to recognise the key environmental pressures and issues facing England. These have been derived from analysis of the baseline information, information provided in other relevant documents, and have also taken into account the views of Statutory Consultees to the SEA process (English Heritage, Natural England and the Environment Agency).

Table 1 identifies these key environmental issues facing England, and cover the key issues specified by the SEA Regulations. It is important to note that, while Table 1 compartmentalises the issues, there will be interactions between them. For example, the control of leachate from waste treatment processes can have a number of environmental effects, including, for example, on soil quality, water resources, and biodiversity.

Table 1: Key Environmental Issues

Key Issues	Relevance for Waste and the Plan	Information Source[6]
Biodiversity, Flora and Fauna General loss of biodiversity: reduction in habitats and species	Although this Plan is not locational specific, its effect can have an impact on global biodiversity through changes to the level of primary resources required to be extracted (and thus impact on habitat). Because impacts on biodiversity are highly site specific, the matter is only relevant to the extent that there is a threat to biodiversity from the Plan.	Natural England (Lost Life: England's Lost and Threatened Species 2010)
Population The rise in population (from 52m to 60m in England by 2030) increases pressure on resources and infrastructure	The Plan impacts how waste arising from a growing population will be managed. The Plan will need to be flexible enough to account for a growing population and the impact that this will have on waste arisings. A growing population also puts pressure on resources at a global scale. Waste management through waste prevention, preparation for re-use and recycling can help to reduce this pressure.	Office for National Statistics (various reports)
Human Health Air and water pollution from the operation of waste facilities and waste vehicles can affect human health by causing respiratory and other conditions	In line with Articles 1 and 4 of the WFD, the Plan must set the protection of human health as a guiding principle for waste management in England.	Office for National Statistics Family Resources Survey (Department of Work and Pensions)
Soil Soils in England continue to be degraded by human actions including intensive	Waste management activities can have effects on soil quality and the availability of land resource to be used for other activities, such as agriculture.	The Soil Strategy for England (Defra) Defra Evidence Paper (soil)

[6] See Baseline Information for specific references for these sources

Key Issues	Relevance for Waste and the Plan	Information Source[6]
agriculture, historic levels of industrial pollution and urban development, making them vulnerable to erosion (by wind and water), compaction and loss of organic matter. As the climate (including temperature and rainfall patterns) changes in the future, it is likely that soils have the potential to be further degraded, both as a result of the direct and indirect impacts of climate change, for example as land managers adapt their practices and the crops that they grow.	Equally, it may be a source of soil improvers and may improve soil organic matter status. The Plan should seek to address the negative impacts on soil from the development of new waste management infrastructure, but also identify opportunities for the use of the outputs from waste management to improve the quality of soil.	
Water Increasing pressure on resources due to climate change, a growing population and changes in water usage mean that water resources are becoming more scarce. Water quality is improving, but there are still areas where water quality is poor.	Many waste treatment technologies use water resources in order to work effectively. Control of effluent is important to avoid polluting water sources. Some management methods may reduce the need for water (for example, those that lead to the application of organic matter on land).	Water for Life (Defra 2011) Ofwat Sustainability web site. Report on Sustainable Sludge
Air Quality There are pockets of poor air quality in England with thirty five Air Quality Management Areas designated across the country.	Plan will impact on the amount of waste produced and treated and how it is treated. It could also have an indirect effect on the transport of waste. Waste storage, treatment and disposal can directly affect the level of air pollutants emitted to the atmosphere, and hence, they impact on human health. The Plan should seek to minimise these emissions.	Defra – Air Pollution in the UK (2010)

Key Issues	Relevance for Waste and the Plan	Information Source[6]
Climate Change Climate Change is likely to lead to changes in overall temperature and rainfall patterns which could lead to increased flooding, changes to growing seasons increased storms and droughts. Globally the potential impacts are likely to be both severe and complex and include land loss, famine, extreme weather, water shortage, and social upheaval.	The Plan will impact on how waste is managed including how much is prevented, prepared for re-use, recycled, otherwise recovered, or disposed of. Differing waste treatment methods lead to differing emissions of greenhouse gases (GHG). The Plan should seek to encourage those with a low carbon (and GHG) impact.	Waste Review 2011 DECC Impacts of Climate Change in the UK (website)
Waste Arisings The amount of waste produced in England (228mt as at 2008), remains a challenge in relation to how to collect, treat and dispose in the most effective manner.	The Plan will have a direct influence on the amount of waste generated, and the quantity that is prevented, prepared for reuse, recycled / composted, otherwise recovered, or left for disposal. The Plan should adhere to the waste hierarchy, moving waste up towards prevention as a priority.	Defra Waste Data Overview (June 2011) Waste Review 2011 Defra Economic Principles
Historic Environment England's historical sites require protection from damage and development. Many are under threat from decay.	The Plan will impact upon the type and number of waste treatment and disposal facilities to be developed, which in turn will impact upon emissions of pollutants to the atmosphere. These pollutants can have a negative impact upon historic sites through acidification (contributing to erosion of stonework, for example). Land take from facilities can also have a negative impact on the historic environment. The impacts on the historic environment will be both direct and indirect.	English Heritage
Energy	Waste prevention and	DECC publications

Key Issues	Relevance for Waste and the Plan	Information Source[6]
England is dependent on non-renewable energy sources.	management options will impact upon both energy usage and energy generation. The net energy balance of different treatment options needs to be considered.	(website) European Commission renewables target strategy

7.0 Proposed Sustainability Objectives and Targets

Having identified the baseline information, together with the key relevant environmental issues facing England, these are fed into the development of objectives against which the Plan will be assessed. Although the use of objectives in the assessment is not specifically required by the legislation, the method was chosen for this SEA process as it provides an approach which is relatively easy to understand, is robust and provides a good reference tool for future monitoring and assessment.

7.1 Identification of Relevant Objectives and Indicators

The information already presented has provided a strong steer as to the topic areas that the objectives should cover in order to address the key relevant issues. The development of the exact wording of the objectives has been shaped by the assessment of the key issues identified in the baseline research, expert judgement, including the views of the Environment Agency, Natural England and English Heritage and an analysis of relevant data and information sources. This helps to ensure that while the focus of the document is maintained, broader national objectives are also accounted for, and any inconsistencies can be identified and dealt with.

7.1.1 Coverage of SEA Issues

The SEA Regulations require that the environmental report must identify, describe and evaluate the likely significant effects on the environment of (a) implementing the plan or programme and (b) reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme. The report must include such information referred to in Schedule 2 to the Regulations as may reasonably be required (taking account of a number of factors, including the contents and level of detail in the Plan). As already stated, given that the Plan being consulted on here does not in itself deal with the exact location of sites and areas, where facilities may be developed (since this is dealt with at a local level through the local planning framework), some of the more common criteria used within an SEA process for other plans or programmes are set aside since they cannot be considered in any meaningful way.

For example, the impact of the Plan on flora and fauna will tend to depend upon its specific location, and so impacts can be discussed only at a general level when the policies set out in the plan do not determine the location of sites. Policies which lead to increased recycling rates can, however, have a significant impact on land disturbance at a global scale through reducing requirements for mining and harvesting activities for primary materials, and this therefore has implications for global biodiversity.

7.2 Proposed SEA Criteria

Figure 2 shows the proposed objectives, sub-objectives and guiding questions that will be used to assess the Plan. It also identifies the main topics covered as required under the SEA Regulations, thus providing a check to ensure that all required elements will be dealt with at an appropriate level.

Figure 2: Objectives and Assessment Criteria

Ref	Objectives	Sub-Objectives	Key Questions	Main SEA Topics Covered
1	**Protect natural material assets**		What is the likely effect of the plan on the total demand for materials (including energy carriers)?	Material Assets
2	**Reduce Air Emissions contributing to global problems**	To reduce emissions of greenhouse gases To reduce emissions of ozone depleting substances	What are the impacts on climate change and the ozone layer from the waste policies presented?	Climatic Factors Air
3	**Reduce Air Emissions of local relevance**	To reduce air pollution emissions including acidifying emissions	How does the plan affect emissions to air with a localised impact? What is the potential impact on health of these emissions? Will there be any impact on property (including historic buildings) arising from the emissions?	Air Human Health Population Cultural Heritage/ Historic Environment
4	**Protect & enhance biodiversity**	To minimise the negative impact on global resources, wildlife, flora and fauna	What is the effect on Total Material Requirement as a result of the policies presented? (Total Material Requirement can be used as a proxy for the impact on global wildlife flora and fauna).	Materials Balance Biodiversity Flora & Fauna

Ref	Objectives	Sub-Objectives	Key Questions	Main SEA Topics Covered
5	**Conserve water resources & water quality**	To minimise water use To reduce harmful emissions to water bodies	What is the likely impact of the plan on water use? What is the likely impact of the plan on water quality? What is the likely impact of the plan on protected water bodies?	Water
6	**Conserve and improve soil quality**	To minimise negative impacts on, or improve, soil quality To preserve the "best & most versatile" agricultural land	What is the likely impact on soil quality as a result of the Plan?	Soil
7	**Protect and enhance landscape & historic environment**		What is the likely impact on landscape and historic environment as a result of the Plan?	Landscape Cultural Heritage/ Historic Environment

8.0 Alternatives to be Assessed

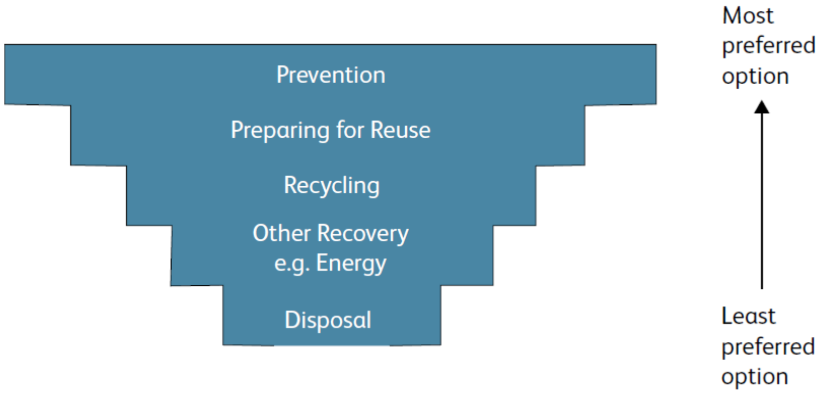
Article 5.1 of the SEA Directive states:

> *"..an environmental report shall be prepared in which the likely significant effects on the environment of implementing the plan or programme, and reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme, are identified, described and evaluated".*

The SEA Practical Guide[7] further advises that only realistic and relevant alternatives should be considered and they should be sufficiently distinct to enable a meaningful comparison of their different environmental effects.

The government's approach to managing waste is determined by the waste hierarchy (see **Error! Reference source not found.**), which sets out that waste prevention should be the main priority when it comes to managing waste, followed by (in order) preparation for re-use, recycling, other waste recovery activities, using waste disposal as a last resort.

Figure 3: Waste Hierarchy



Managing waste in this way is a requirement of the Waste Framework Directive although exceptions from the hierarchy can be made where specific circumstances change the most beneficial order of treatment. Article 4(2) of the Directive allows Member States to depart from the hierarchy for specific waste streams in order to deliver the best environmental outcome. As well as laying down the approach to be adopted in law (in the form of the Waste (England and Wales) Regulations 2011), Defra has produced guidance on applying the waste hierarchy to assist in understanding its application.[8]

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[7] ODPM (2005): A Practical Guide to the Strategic Environmental Assessment Directive. ODPM, Scottish Executive, Welsh Assembly Government and DoE. Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/practicalguidesea.pdf

[8] Defra (2011): Guidance on Applying the Waste Hierarchy. Available at: http://www.defra.gov.uk/publications/files/pb13530-waste-hierarchy-guidance.pdf

In 2011 the Government issued a Waste Review which sets out the direction for waste management in England. This document is generally guided by the waste hierarchy, and seeks to encourage waste prevention, followed by preparing for re-use, recycling, other types of recovery (including energy recovery), and last of all disposal (e.g. disposal).

The basis for the waste hierarchy is that as waste management moves up the hierarchy, environmental outcomes are improved, though as stated above, there may be exceptions to this. This needs to be balanced to ensure that one policy does not over-stimulate activity lower down the hierarchy to the detriment of those further up the hierarchy. For example, the Government has been very clear that it considers energy from waste treatment to be a valuable method of treating waste and creating energy, but it that it should never be incentivised to the point where waste is created, or not prevented, in order to provide feedstock for energy from waste plants.

Prevention, Reuse and Recycling

At all times, prevention of waste is preferable to subsequently having to manage waste that arises. The Government has stated in the Plan that waste prevention is a priority, and is producing a Waste Prevention Programme for England by 2013 with the objective of setting out detailed actions to enable better resource efficiency and waste prevention, and meet the obligations under the revised Waste Framework Directive.

Where prevention and reuse are no longer an available option, the next priority is to ensure the recycling of materials and working towards closing the resource loop.

Recovery

Where waste cannot be prevented, reused or recycled, and would otherwise be sent to landfill, policies acting in accordance with the hierarchy should seek to encourage the recovery of material from the remaining waste before any remaining material sent to landfill.

The Government has looked at the policy options available for encouraging waste up the hierarchy, and has considered the economic, environmental and social impacts of each. The policy instruments chosen by Government to move waste up the hierarchy have been explained in Waste Review. They range from the use of responsibility deals – encouraging voluntary changes in behaviour for the top end of the hierarchy (prevention, recycling); the use of regulation and enforcement (across the entire hierarchy) to provide a level playing field in which businesses can operate; and fiscal measures, such as the landfill tax, which will remain as the key driver to divert waste from landfill for local authorities and businesses (particularly with the demise of the Landfill Allowances Trading Scheme).

The approach to setting the alternatives in this SEA process focuses on the potential outcomes rather than proposals for specific implementation measures. This is for several reasons. Without understanding the detail of the implementation measures proposed, it is not straightforward to understand what the environmental effect of the measures would be. For example, the effect of a voluntary agreement concluded with a given industrial sector is not knowable without understanding the detail of the agreement which is ultimately concluded.

In addition, ‘waste management’ is effectively shaped by a range of incentives, regulations, targets and agreements. There is a very wide range of alternative measures which might be considered ‘reasonable’, not to mention ‘realistic and relevant’. An approach which was based around the elaboration of alternative implementation measures would therefore require the appraisal of a very wide range of alternatives, each of which would need – in order for it to be properly evaluated – an indication of the specifics of its design.

Finally, in principle, a wide range of possible policy alternatives could be considered capable of delivering similar, if not exactly the same, outcomes. For example, from the environmental perspective (as examined by the SEA) it does not greatly matter whether a given recycling target results from a tax, or a voluntary agreement, or a target, or any other policy instrument. As far as the environmental impacts are concerned, what drives the effects is the outcome[9].

Given that without well-specified and fully worked up alternatives, the magnitude of any effect cannot be defined with a high degree of confidence, the alternatives are based around changes in the level of performance relative to what is likely to result from the Plan.

The alternatives are elaborated at each tier of the waste management hierarchy and for each waste stream, these being (for the purpose of the analysis):

- Household waste;
- Commercial and industrial waste; and
- Construction and demolition waste.

This categorisation is deemed sufficient for the purposes of conducting a high-level report of this nature. It should, however, be acknowledged that these categories are not homogenous and that each contains different components which give rise to different impacts. The effects of managing the different components in different ways are considered against some of the environmental criteria where the data allows such disaggregation to be easily made.

The alternatives are not specified as specific targets, but as increases in, or a reduction in, the quantity of waste either:

1. Prevented;
2. Sent for preparation for re-use;
3. Recycled;
4. Sent for other forms of recovery;
5. Sent for disposal.

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[9] An Impact Assessment might take a very different view – the way in which the measure affects actors in the economy will be closely associated with the design of the specific instruments used to achieve a given outcome. The SEA, however, is concerned with the environmental effects.

The alternatives are considered independently of each other. They are considered in respect of the environmental outcomes which might be expected to result from them.

Although, as indicated above, the SEA does not consider the outcomes in terms of the effect of specific policies, it does list the types of measure which could give rise to the changes from the Baseline under consideration. In principle, therefore, this approach:

1. allows for an assessment of alternatives in terms of changes in performance;
2. allows for an appraisal of the alternatives in a straightforward sense (far more so than would be the case where the alternatives were specified in terms of policies); and
3. incorporates a list of possible policies which could be used to achieve the outcomes being examined, without explicitly stating which of these may be more or less preferable than another.

With regard to this final point, because the SEA does not take into consideration the full range of consequences of the possible alternatives i.e. does not include impacts at a social or economic level (as this will be covered in a separate Impact Assessment), it may be reasonable for Government *not* to pursue an alternative which the SEA indicates is environmentally superior (on grounds, for example, of costs being considered excessive relative to the benefits).

The alternatives being considered are shown in Table 2. These show a matrix of Alternatives for household, C&I and C&D waste. The first column shows the alternatives numerically; whilst the first row of columns 2-6 are given an alphabetic notation. As such, we can consider, within this matrix for example, Alternative 3C, which denotes higher recycling of C&I waste than in the Baseline. It should be expected, generally, that there will be some similarities in the assessment in a given level of the hierarchy, so that whilst the matrix appears to highlight a large number of Alternatives, in principle, there are five main areas for consideration (related to the tiers in the hierarchy).

It should be noted that the recent SEA of the Zero Waste Strategy in Scotland took an approach which was not dissimilar to this. However, instead of specifying 'marginal' changes (more or less managed) in the different tiers of the hierarchy, it adopted an approach based upon specific targets for the management of waste. Furthermore, it combined measures at different levels of the hierarchy. In essence, however, the implied approach to the assessment is similar.

Table 2: Proposed Alternatives for Consideration in SEA

Stream	Waste Prevention (A)	Preparation for Re-use (B)	Recycling (C)_	Other Recovery (D)	Disposal (E)
All Streams					
The Plan	Existing and planned policies	Existing and planned policies	Existing and planned policies	Existing and planned policies	Existing and planned policies
Household					
Alternative 1	Above Baseline levels (less waste)	Above Baseline (more sent for prep for reuse)	Above Baseline (more recycled)	Above Baseline (more recovered)	Above Baseline (more disposed)
Alternative 2	Below Baseline levels (more waste)	Below Baseline (less sent for prep for reuse)	Below Baseline (less recycled)	Below Baseline (less recovered)	Below Baseline (less disposed)
C & I					
Alternative 3	Above Baseline levels (less waste)	Above Baseline (more sent for prep for reuse)	Above Baseline (more recycled)	Above Baseline (more recovered)	Above Baseline (more disposed)
Alternative 4	Below Baseline levels (more waste)	Below Baseline (less sent for prep for reuse)	Below Baseline (less recycled)	Below Baseline (less recovered)	Below Baseline (less disposed)
C&D					
Alternative 5	Above Baseline levels (less waste)	Above Baseline (more sent for prep for reuse)	Above Baseline (more recycled)	Above Baseline (more recovered)	Above Baseline (more disposed)
Alternative 6	Below Baseline levels (more waste)	Below Baseline (less sent for prep for reuse)	Below Baseline (less recycled)	Below Baseline (less recovered)	Below Baseline (less disposed)

9.0 Methodology

9.1 Overall Approach to Appraisal

The methodology for the appraisal undertaken has been designed to fulfil two main aims: first, to ensure that the requirements of the SEA Directive are fulfilled, and second, to ensure that the appraisal is both robust and can work to inform the plan development process, including consideration of means to mitigate any significant negative impacts and identify appropriate post adoption monitoring measures.

In ensuring that the SEA regulations are adhered to, the key impacts of the Plan and reasonable alternatives will be outlined and the nature of these impacts discussed. The nature of the impact includes not only whether they are positive/ negative/ neutral or uncertain, but also whether they are:

- Secondary;
- Cumulative;
- Synergistic;
- Long/ medium or short term; and
- Temporary or permanent.

Definitions of cumulative effects and synergistic effects are provided in the Practical Guide to the SEA Directive:[10]

> *Cumulative effects arise, for instance, where several developments each have insignificant effects but together have a significant effect; or where several individual effects of the plan (e.g. noise, dust and visual) have a combined effect.*
>
> *Synergistic effects interact to produce a total effect greater than the sum of the individual effects. Synergistic effects often happen as habitats, resources or human communities get close to capacity. For instance a wildlife habitat can become progressively fragmented with limited effects on a particular species until the last fragmentation makes the areas too small to support the species at all.*
>
> *These terms are not mutually exclusive. Often the term cumulative effects is taken to include secondary and synergistic effects*

The definition of 'cumulative effects' make it less than clear whether one assesses this at the level of individual effects or at the level of the way in which effects combine. The examples given suggest that very few impacts will not be 'cumulative' as they are defined (since to be otherwise, there would need to be no additional effect from, for example, additional units of air pollution, or noise, or water pollution).

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[10] ODPM (2005): A Practical Guide to the Strategic Environmental Assessment Directive. ODPM, Scottish Executive, Welsh Assembly Government and DoE. Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/practicalguidesea.pdf

It is rather difficult, therefore, to imagine where impacts would not be ‘cumulative’ in the general sense implied here.

The definition of synergistic effects implies something different, where, for example, specific pollutants, whose effect when emitted in isolation is limited, are emitted in combination, and because of the combination, their impact is magnified (the effect could also happen in reverse).

We have chosen to consider these matters in summary terms at the plan level at the end of the appraisal.

Given that the plan is a) defined at a national level and b) is not location specific much of the assessment is naturally set at a high level and is largely qualitative in nature, although quantitative information has been included where relevant.

The results of the appraisal are presented across two sections. The first (Section 10.0) presents an analysis of how waste management impacts upon each of the SEA topics. This is effectively a literature review setting out the evidence base for the impacts of waste management as a whole, rather than the specific impacts of the plan and alternatives. It is hoped that this section will also be useful to those undertaking SEA / Sustainability Appraisal (SA) processes covering waste management issues at a more local level – e.g. through the development of local development frameworks which was highlighted as an important issue during preliminary consultation with English Heritage, the Environment Agency and Natural England.

The second part of the appraisal focusses on the Plan and the alternatives, with each alternative being assessed against each of the SEA objectives (see Figure 2) in turn.

For each objective, five matrices are presented, one for each level of the hierarchy as defined by the alternatives (see Table 2). The matrix will allow easy presentation of the ‘type’ of effect – i.e. whether and to what degree it is considered to be positive or negative, and the timescale over which the effect will occur, that is whether the effects will be directly seen in the short, medium or long term (further defined in

Figure 5), together with a brief description as to why this appraisal 'score' was given. An example blank matrix is shown in

Figure 4.

Figure 4: Appraisal Matrix

	Effect	Timescale	Reason for Score
Baseline			
A1 Household Waste: Above Baseline			
A2 Household Waste: Below Baseline			
A3 C&I Waste: Above Baseline			
A4 C&I Waste: Below Baseline			
A5 C&D Waste: Above Baseline			
A6 C&D Waste: Below Baseline			

The matrices for each objective will be accompanied by more detailed discussion where relevant as to the nature of the impacts, drawing on the general overview presented in the first section of the appraisal.

The assessment criteria to be presented in the matrices are shown in

Figure 5. The justification for the effect and timescale impacts are described for each objective considered in Section 11.0. It should, however, be recognised that the alternatives are set relative to the effects of the Plan. The implementation of the elements that make up the Plan (although not introduced by it) will have positive impacts going forward. The alternatives are set against this trajectory already implied – i.e. they are based on the improvements over and above (or below depending on the alternative in question) what is already happening. This is not intended to reflect any specific quantified limit for ‘above’ or ‘below’ the baseline, but merely to reflect the fact that if the Plan were to go further, then these are the impacts that might occur.

Figure 5: Key to Matrices

Effect	
Major Positive Impact	
Minor Positive Impact	
Negligible/ No Impact	
Minor Negative Impact	
Major Negative Impact	
Uncertain Impact	?
Timeframe	
Short (2013-2015)	S
Medium (2013-2020)	M
Long (To beyond 2020)	L

9.2 Limitations

There are a number of broad areas of uncertainty and limitations to this Environment Report which are important to highlight before the results of the appraisal are presented.

It is important to recognise the scale at which this part of the Plan is intended to operate and the limitations this brings in terms of collecting and analysis information. In accordance with the regulations and practice guidance on SEA, the collection of data and level of detail presented in the appraisal which follows has been restricted to the criteria directly relevant to the Plan, and by the spatial resolution that can be expected from this (part of) the Plan. Given that the Plan will not provide policies that will have a direct impact upon any one specific geographic area in England (e.g. through setting planning criteria), it is not relevant to try and provide detailed information at a more local scale. Therefore, the information required should only go so far as to provide a general picture of current issues and trends in England, and does not need to provide details of potential impacts at any one specific location. PPS10 is the national document which does set the framework for the location of waste management infrastructure. CLG are in the process of revising PPS10 and this will be consulted upon in due course.

It is also important to recognise that the Baseline is formulated as a 'trajectory' in terms of changing waste management performance over time. It is not static. It is based around what is already planned and intended through the Waste Review 2011, AD Strategy and others, so it is not a static snapshot. Therefore the Baseline – being a prediction of what might take place in future – is imperfectly defined. The actual outcome from the actions which are already being planned might be different from those we have estimated here.

Finally, this Environment Report focusses mainly on the Environmental Impacts arising from the Plan and its reasonable alternatives. The economic and social impacts are being covered by a separate Impact Assessment which will form part of the suite of documents which will accompany the consultation process on the Plan.

10.0 Appraisal Results: General Overview

This section sets out the evidence regarding the impact of waste management (as opposed to the Plan and the alternatives) in relation to each SEA topic as set out in the SEA Regulations. It provides the key reference base for the appraisal of the plan and specific alternatives as set out in Section 11.0. It may also have value as a reference tool to others carrying out similar appraisals, especially those at more local Government levels.

10.1 Biodiversity (Including Flora & Fauna)

The choices taken with regard to waste management can have both a direct and indirect impact on biodiversity. This in turn could impact on the degree to which some objectives of Government policy– e.g. those specified within Defra's Biodiversity Strategy - can be met. The nature and scale of these impacts are almost entirely dependent upon the specific location, and the number and scale, of different waste facilities. Given that the Waste Management Plan for England being consulted upon within this Environment Report does not have any bearing upon the location of individual facilities (this is dealt with at a national scale by PPS10), the focus here is on the possible impacts of waste management on biodiversity, discussed in a more generic way.

The direct impacts from waste management choices on biodiversity would be expected to arise from the scale and siting of specific facilities. Waste facilities clearly have a footprint, which varies depending on factors such as the type, configuration and scale of facility, and in specific circumstances, this could lead to habitat loss or fragmentation (further details on the footprint of various facilities is discussed in Section 10.8). However, this might be expected only in relatively extreme cases, and the planning system would be expected to act so as to prevent obvious fragmentation.

Emissions from facilities (in particular to air, water and soil) can also have a negative effect on local biodiversity and habitats. Where water and soil are concerned, the effect of emissions is likely to be highly location dependent. Where emissions to air are concerned, location will also have a role to play in determining the effects, though our knowledge of how location relates to impact is rather better than in the case of most emissions to water and land. In some planning inquiries, there have been concerns expressed regarding emissions. For example, in 2005, the Dorset Waste Planning Authority commissioned a study to examine the potential impact on sensitive environments of ammonia and nitrogen dioxide emissions from various waste management technologies. The facilities considered, including a number of open and in-vessel composting operations and mechanical-biological treatment plants, were all situated within or adjacent to heathland. The report noted a number of potential impacts on local vegetation, and that these could be mitigated by the use of biofilters or dilute acid scrubbers.[11]

There may be impacts on the marine environment associated with some specific facilities. On the negative side, emissions from facilities, or mismanagement of

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[11] See http://www.endsreport.com/index.cfm?go=13996

wastes, could potentially have a negative effect on marine water quality, for example, through excessive nutrient run-off from some wastes spread on land under recovery operations. Equally, the use of some waste management techniques might have a positive effect in binding the same nutrients that might lead to such run-off to humus, thereby reducing the problems of excessive nutrient loading.

In addition to the above, litter in the marine environment can cause harm to biodiversity. For example, according to KIMO, more than 1 million birds and 100,000 marine mammals die each year from becoming entangled in or ingesting marine litter.[12]

Plastics dominate marine litter and represent a significant threat to the marine environment due to their abundance, longevity in the marine environment and their ability to travel vast distances.[13] Despite representing only 10% of all waste produced, plastics account for between 50-80% of marine litter and this is not expected to decline for the foreseeable future (particularly as plastics do not degrade quickly).[14] As they are lightweight and long-lasting, and able to travel great distances, plastics are reported to present a long term threat to marine ecosystems, as they can:

- Directly harm wildlife:[15]
- Damage benthic environments;[16]
- Transport non-native and invasive species; [17] and
- Concentrate toxic chemicals from seawater.[18]

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[12] See http://www.kimointernational.org/MarineLitter.aspx

[13] KIMO (2010) Economic Impacts of Marine Litter, Kommunernes Internationale Miljøorganisation Local Authorities International Environmental Organisation, September 2010. Available at: http://www.kimointernational.org/Portals/0/Files/Marine%20Litter/Economic%20Impacts%20of%20Marine%20Litter%20Low%20Res.pdf

[14] Thompson, R.C., Swan, S.H., Moore, C.J. and vom Saal, F.S. (2009a) Our Plastic Age. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 1969-2166; Barnes, D.K.A., Galgani, F., Thompson, R.C. and Barlaz, M. (2009) Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 1985-1998; Thompson, R.C., Moore, C.J., vom Saal, F.S., and Swan, S.H. (2009b) Plastics, the environment and human health: current consensus and future trends. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 2153-2166.

[15] Sheavly, S.B. (2005) Marine Debris – an Overview of a Critical Issue for Our Oceans. Presentation at Sixth Meeting of the UN Open-ended Informal Consultative Process on Oceans and the Law of the Sea. Available at: http://www.un.org/Depts/los/index.htm

[16] Moore, C.J. (2008) Synthetic polymers in the marine environment: a rapidly increasing, long-term threat. Environmental Research 108: 131-139.

[17] Cheshire, A.C., Adler, E., Barbière, J., Cohen, Y., Evans, S., Jarayabhand, S., Jeft ic, L., Jung, R.T., Kinsey, S., Kusui, E.T., Lavine, I., Manyara, P., Oosterbaan, L., Pereira, M.A., Sheavly, S., Tkalin, A., Varadarajan, S., Wenneker, B. and Westphalen, G. (2009) UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. UNEP Regional Seas Reports and Studies, No. 186; IOC Technical Serious No. 83.

[18] Committee on the Effectiveness of International and National Measures to Prevent and Reduce Marine Debris and Its Impacts, National Research Council, Ocean Studies Board and Division on Earth

Of all plastics, it is, arguably, single use plastic bags that have the greatest impact. Data taken from the International Bottom Trawl Survey and the Clean Seas Environmental Monitoring Programme indicate that plastic bags make up 40% of all marine litter in the waters of the North East Atlantic. The French research institute IFREMER has also found that in the Bay of Biscay most of the waste items found on the seabed were plastic (92%) and of those 94% were plastic bags. [19] An increasing area of concern is the potential impact of microplastic particles, although the environmental significance of this form of pollution is not yet fully understood. [20] Therefore, policies which reduce waste and reduce the potential for marine litter (e.g. policies addressing the consumption of single-use bags) may have the potential to reduce impacts, through reducing litter which could end up in the marine environment.

In addition to the impacts of marine litter, other impacts of waste management that do not relate to the site specific location of facilities include the global impacts on biodiversity associated with material flows through England's economy. All things being equal, addressing the challenge of resource efficiency and reducing demand for primary materials through waste prevention activities (including reuse) and recycling should lead to an overall reduction in negative impacts on biodiversity.

Globally, a major cause of loss in biodiversity is habitat destruction, sometimes linked to exploitation of raw materials. Other things being equal, the lower is the demand for primary material, the lower will be the level of disturbance associated with primary resource extraction.

At a global scale we use the likely changes in Total Material Requirement (TMR) (see Section 10.6) resulting from different approaches to waste prevention and management as a proxy for the impacts on biodiversity. As shown in Table 18, the production of a tonne of secondary aluminium requires only 2.3% of the abiotic raw materials (i.e. minerals extraction) needed for the production of a tonne of primary aluminium. The raw material for primary aluminium production is bauxite, major deposits of which are found in a wide belt around the equator, with the largest reserves in Guinea, Australia, Brazil and Jamaica.[21] The great majority of the world's bauxite ores are extracted by open cut methods. Before mining can commence, it is usually necessary to remove topsoil and preserve it for rehabilitation post-closure.[22] This removal of habitat will clearly have an impact on local biodiversity, although the extent of the impact will vary on a case by case basis. A number of bauxite mines are in tropical rainforests, where biodiversity is high, so it can be expected that impacts

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and Life Sciences (2008) Tackling Marine Debris in the 21st Century. Washington D.C.: The National Academies Press.

[19] Seas at Risk (2011) Commission Consults on Binning Plastic Bags. Available at: http://www.seas-at-risk.org/news_n2.php?page=408

[20] T Thompson, R.C., Olsen, Y., Mitchell, R.P., Davis, A., Rowland, S.J., John, A.W.G., McGonigle, D. and Russell, A.E. (2004) Lost at Sea: Where is all the Plastic? Science 304: 838.

[21] International Aluminium Institute (2009) *Fourth Sustainable Bauxite Mining Report*, 1 January 2009

[22] OECD Environment Directorate (2010) *OECD Global Forum on Environment: Focusing on Sustainable Materials Management - Materials Case Study 2: Aluminium*, 1 January 2010

on biodiversity in such locations will be greater than in areas which exhibit lower background levels of biodiversity.

The production of a tonne of secondary copper likewise has a far reduced impact relative to primary production. As shown in Table 18, the production of a tonne of secondary copper requires less than 1% of the abiotic raw materials needed for the production of a tonne of primary copper.

While there may be specific concerns relating to the impacts on biodiversity associated with the extraction of specific ores (e.g. the production of arsenic as a by-product of copper), there are more general biodiversity impacts related to minerals extraction. Typically, the greatest risks to biodiversity are when mining ventures enter relatively remote and undisturbed areas.[23] The very act of building access roads for exploration purposes brings significant risks to biodiversity, as the raised expectations of potential large-scale benefits often trigger rapid in-migration. Large scale biodiversity loss occurs as colonisers must clear land for settlement and farming and take out economically valuable wild species to supplement their income or for food. Sometimes new people and activities in an area can also bring in alien pests and diseases that have detrimental effects. It is worth noting that much of this may all be at its most intense before mining starts, and before any major mining company is involved, and activities are frequently ungoverned and unregulated.[24]

10.1.1 Impacts on Biodiversity from the Non-Energy Extractive Industry

The Non-Energy Extractive Industry (NEEI) provides many of the basic raw materials for the UK's manufacturing and construction industries. The NEEI sector is often divided into three main sub-sectors, which are:

- Construction minerals: including aggregates in a range of particle sizes such as sand, gravel and various types of crushed rocks (e.g. chalk, limestone, sandstone, chalk, slate..), natural rock materials (such as marble and granite) plus a range of clays, gypsum and shale;
- Industrial minerals: loosely classified as physical minerals (e.g. bentonite, borates, calcium carbonates, diatomites, feldspar, kaolin, plastic clays, silica and talc) or chemical minerals (e.g. salt, potash and sulphur); and
- Metallic minerals: including a wide range of ores which, following processing, yield metals or metallic substances such as bauxite, chromium, copper, gold, lithium, manganese, nickel, selenium, silver, tin, tungsten etc…

The environmental impacts associated with raw material extraction will vary considerably from site to site, but may include:[25]

- Habitat loss and degeneration;
- Species disturbance and displacement;
- Land clearance;

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[23] International Institute for Environment and Development (2002) *Breaking New Ground: Mining, Minerals and Sustainable Development*, 1 May 2002

[24] ibid

[25] European Commission (2011) *Non-energy mineral extraction and Natura 2000: Guidance Document*, 2011

- Hydraulic disruptions (alteration of hydrology/hydrogeology conditions);
- Changes in water quality;
- Habitat changes that may promote invasive species colonisation;
- Noise and vibration;
- Movement-related disturbances;
- Dust; and
- Landslides and collapses

Such impacts can be avoided or reduced where waste prevention (including reuse) and recycling act to lower the demand for the extraction of primary materials.

10.1.2 Impacts on Biodiversity from Energy Requirements

As well as the extraction of non-energy materials, the use of primary materials in production processes often requires greater levels of energy input compared with the use of secondary materials (and this is one reason why the climate-related impacts from managing waste at higher tiers in the waste hierarchy tend to be lower than where waste is managed at tiers lower in the hierarchy – see Section 10.2 below). For example recycling one tonne of steel not only saves 1,100 kilogrammes of iron ore, and 55 kilogrammes of limestone, but where the energy source is coal, the use of 630 kilogrammes of coal can be avoided through recycling.[26] Extraction of energy carriers such as coal, oil and to a lesser extent gas, can have negative impacts on biodiversity in addition to those associated with the extraction of non-energy minerals, although the specific impacts will be dependent upon the location of the extraction activities.

10.1.3 Impacts on Biodiversity from Water Use

There is growing awareness of the fact that the consumption of materials not only implies the use of 'embodied energy' (see above), but also, embodied water (see Section 10.7. The knowledge base in this respect is evolving, but some studies suggest have started to identify the levels of (often imported) embodied water associated with domestic consumption of specific categories of goods (see Section 10.7.1). This understanding is likely to evolve rapidly in future years, as the European Commission is proposing to include water use as one of the 'dashboard indicators' (along with carbon and land) as part of the pathway to a Resource Efficient Europe. [27]

Evidently, growing consumption of water, especially in environments already under some stress in this regard, can be expected to impact upon biodiversity.

10.1.4 Summary

These considerations highlight the mix of local and global impacts which decisions made regarding the management of waste and resources can have for biodiversity. The actual nature of the impacts is likely to be location specific, not just in respect of where a waste management facility is sited, but which locations are affected,

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[26] See http://www.bir.org/industry/ferrous-metals/

[27] European Commission Directorate - General for Environment (2012) *Consultation Paper: Options for Resource Efficiency Indicators*

indirectly, by actions taken regarding the prevention of waste, and the management of whatever waste is generated.

10.2 Climatic Factors

This section quantifies the climate change impacts of waste management with reference to evidence from the literature. The section broadly follows the waste hierarchy, and begins with waste prevention (in Section 10.2.1) followed by preparing for reuse and recycling (Sections 10.2.2 and 10.2.3 respectively). Composting and Anaerobic Digestion are discussed in Section 10.2.4 – these technologies may operate at either the recycling or recovery levels of the hierarchy. Residual waste is discussed generally in Section 10.2.5, with sections on landfill, incineration and MBT following. The latter two treatment methods may operate at different levels of the hierarchy depending on the technology type and its performance.

Data is included on the climate change impacts per tonne of waste treated. This data is presented excluding the biogenic CO_2 emissions, in line with the approach typically taken when following the life-cycle methodology.[28]

10.2.1 Waste Prevention

Climate change impacts associated with waste prevention activities can be considered through the avoided greenhouse gas emissions associated with product manufacture. Avoided climate change impacts through waste prevention activities arise from:

- Avoided energy use in the manufacture of products that then become waste;
- Avoidance of direct emissions of greenhouse gases through avoided manufacturing and process (e.g. methane emissions during cattle farming);
- Avoided disposal impacts.

These impacts can be considered through data provided in life-cycle analysis databases such as ecoinvent, which allow for bottom up estimates of the potential GWP of specific products to be developed.[29] However the location of manufacturing activities will influence the climate change impacts due to the global variation in the carbon intensity of the supply of electricity and heat, making it necessary to obtain data on global trade patterns in order to obtain an accurate picture of the climate change impacts of specific product streams. Also some waste streams such as WEEE, textiles and food waste are made up of a range of products each having different manufacturing burdens such that a detailed analysis of the composition of each

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[28] A number of authors have suggested that these emissions should be included when undertaking such assessments. They have however been excluded in the current analysis, in order to present data that is line with that produced through other policy assessments. See : G. Finnveden, J. Johansson, P. Lind and A. Moberg (2000) Life Cycle Assessments of Energy from Solid Waste, FMS: Stockholm; Rabl A (2007) How to Account for CO_2 Emissions from Biomass in an LCA, International Journal of Life Cycle Assessment, 12, pp281; Searchinger D, Hamburg S, Melilo J, Chameides W, Havlik P, Kannen D, Likens G, Lubowski R, Obersteiner M, Oppenheimer M, Robertson G, Schlesinger W and Tilman D (2009) Fixing a Critical Climate Accounting Error, Science, 326, pp527-528

[29] See http://www.ecoinvent.ch

stream would be required in order to understand product related waste prevention impacts.

The foregoing discussion confirms the difficulty in obtaining reasonable estimates of the potential benefits from waste prevention activities. Analysis of the potential climate change benefits of food waste prevention in the UK has, however, been undertaken by WRAP, whilst analysis of the climate change impacts of European textiles production has been undertaken by several authors.[30] Data on potential climate change benefits of source reduction activities, such as would result from lightweighting (resulting from reductions in packaging), has been presented by the US EPA, and is also effectively included in the waste prevention impacts within the Scottish Carbon Metric.[31]

In considering the climate change benefits of some waste prevention activity there is also a need to consider the extent to which product manufacture has been avoided. In the case of the more durable items such as large household items, products are often sold to individuals on a low income who might not otherwise have purchased such products (they may, for example, have used a laundrette instead); the same issue may also arise where second hand clothing is purchased. This issue is considered in the recent work undertaken by WRAP with regard to the benefits of reuse, but is not taken into account in the figures presented in the Scottish Carbon Metric.

Table 3 presents typical values used to estimate the benefit associated with waste prevention, with values taken from the above literature sources. This confirms that per-tonne impacts are particularly significant for textiles and aluminium. The latter accounts for only a small percentage of waste arisings, whilst composition analysis suggests a significant proportion of textile arisings at the kerbside within residual waste is not suitable for resale or reuse (the proportion suitable for reuse is however much higher for textiles donated to charity shops).[32] Food waste, however, makes a relatively significant contribution to waste arisings, and analysis by WRAP indicates that a significant proportion is potentially avoidable.[33] As such, the climate change mitigation potential associated with a reduction in food waste arisings is relatively significant.

There is some evidence for a reduction in waste arisings where a source separated collection has been introduced; as such, an increase in the quantity of food waste

[30] WRAP (2011) New Estimates for Household Food and Drink Waste in the UK, November 2011; WRAP (2011) Benefits of Reuse – Case Study: Clothing

[31] Zero Waste Scotland (2011) The Scottish Carbon Metric: Final Report for Natural Scotland, March 2011; USEPA (2002) Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, May 2002

[32] MEL (2008) Desktop Textile Waste Study and Compositional Analysis; Report for Oakdene Hollins / Defra, December 2008

[33] WRAP (2011) New Estimates for Household Food and Drink Waste in the UK, November 2011

collected in this way may also be linked to increased waste prevention for this stream.[34]

Table 3: Climate Change Benefits – Waste Prevention

Material	Benefit per tonne of material, kg CO_2 equivalent
Paper	955
Card	1,038
Plastic film	2,590
Dense plastic	2,612 – 3,281
Textiles	22,310[1]
Wood	666 (MDF)
Glass	895
Ferrous	2,708
Non ferrous	9,844
Garden waste	No data
Food waste	3,800
WEEE	537 – 1,761

Notes: 1. The above figure is taken from the Scottish Carbon Metric which does not take into account the amount of avoided manufacture which will actually occur through the purchase of second hand textiles. Data from Wilcox suggests of charity shop donations, 90% is resalable (this proportion will be much lower for material collected from a kerbside collection). Data from Farrant suggests 70% of purchases from charity shops avoid the manufacture of new garments. This leads to an actual benefit of 14,055 kg CO_2 equivalent per tonne of textiles. The climate change benefits of *kerbside collected* textiles are, however, likely to be around half of this value

Sources: Data provided by textiles reprocessor JMP Wilcox, available from http://www.jmpwilcox.co.uk/products.html; Farrant L (2008) Environmental Benefits from Reusing Clothes, Masters Thesis, Technical University of Denmark

10.2.2 Preparing for Reuse

As with the waste prevention impacts, where manufacture has been avoided, data on the avoided greenhouse gas impacts from manufacture can be used as a reasonable proxy for estimating the benefits associated with the reuse of products, albeit that this may be difficult for product streams for aggregated product streams such as furniture and WEEE. However, as with waste prevention, it is difficult to determine the extent to which the manufacture of a new product has actually been avoided by the preparation for reuse and to which a purchase from new has been offset.

Recent work undertaken by WRAP considered the reuse of specific articles including some clothing items, domestic and office furniture and selected electrical goods.[35] It

[34] Evidence from waste collector May Gurney suggests a 20% reduction in food waste arisings following the introduction of the Sort-IT system in Somerset

is clear from their analysis that impacts vary considerably across different items within the same product group. This is partly determined by the extent to which the purchase of a second hand item is likely to negate the need for a new item to be purchased, although some variation in the impacts associated with the manufacturing process of different products within the same stream is also seen.

Table 4 presents values from the literature in respect of the climate change impacts associated with the reuse of products that would otherwise have become waste.

Table 4: Climate Change Benefits – Reuse of Products

Material	Benefit per tonne of material, kg CO_2 equivalent	Reasons for range
Clothing	4,100 – 22,310	Depends on mix of fabrics and extent to which reuse avoids manufacture. High end assumes all resold and all offset new purchase.
Electrical items	200 – 8,000	Low end – washing machines through reuse network; high end resale of TVs through second hand shop
Domestic furniture	380 - 1,500	Low end – dining tables through reuse network; high end - sale of soft furnishings through second hand shop
Office furniture	200 – 3,000	Low end – reuse of desks through reuse network; high end resale of chairs

Notes:

Benefits are dependent upon the type of product and the extent to which product reuse is assumed to avoid manufacture of a new product

Sources: WRAP (2011) Benefits of Reuse – Case Study: Clothing; WRAP (2011) Benefits of Reuse – Case Study: Electrical Items; WRAP (2011) Benefits of Reuse – Case Study: Domestic Furniture; WRAP (2011) Benefits of Reuse – Case Study: Office Furniture; Zero Waste Scotland (2011) The Scottish Carbon Metric: Final Report for Natural Scotland, March 2011

10.2.3 Recycling

The climate change benefits of recycling have been more widely studied than is the case for the waste prevention and reuse activities.[36] Nonetheless some challenges

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[35] WRAP (2011) Benefits of Reuse – Case Study: Clothing; WRAP (2011) Benefits of Reuse – Case Study: Electrical Items; WRAP (2011) Benefits of Reuse – Case Study: Domestic Furniture; WRAP (2011) Benefits of Reuse – Case Study: Office Furniture

[36] Relevant studies include: AEA Technology (2001) Waste Management Options and Climate Change: Final Report, European Commission: DG Environment, July 2001; USEPA (2002) Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, May 2002; WRAP (2006) Environmental Benefits of Recycling: An International Review of Life cycle Comparisons for Key Materials in the UK Recycling Sector, Final Report to WRAP, May 2006; Grant et al (2001) LCA

still remain in respect of obtaining representative data on the impacts. The difficulty arises in part because although re-processors may hold some data on the climate change burdens of their manufacturing process, they typically do not also have the relevant information on the comparable burdens associated with the manufacture of the same product from virgin materials.

As with the benefits associated with avoided manufacture more generally, impacts in respect of the electricity used will depend on the relative location of the primary and secondary manufacture. Thus some of the higher values associated with paper recycling come from studies where energy derived from coal is assumed to be avoided, whilst lower values are associated with avoidance of less carbon-intense fuel sources.

Table 5 presents data on the benefits of recycling taken from the previously cited literature. The table includes typical values, which have been developed taking into account the foregoing discussion on the variation between the different literature sources.

The table also confirms the very low climate change benefit associated the recycling of aggregate such as typically arises in the construction and demolition (C&D) waste stream.[37] It is important to note that opportunities for further reducing climate change impacts through the recycling of C&D waste may be fairly limited, as relatively inert materials (soils and aggregate) typically account for a significant proportion of waste arisings, and most metals in the stream are likely to be already extracted for recycling, although there may be some scope for additional recycling of waste wood and PVC (e.g. in the form of window profiles).[38]

of Paper and Packaging Waste Management Scenarios in Victoria, Report for EcoCycle Victoria; Paper Task Force (2002) Life cycle Environmental Comparison: Virgin Paper and Recycling Paper Based Systems, White Paper No. 3; European Aluminium Association (2008) Environmental Profile Report for the European Aluminium Industry: Life Cycle Inventory Data for Aluminium Production and Transformation Processes in Europe, April 2008; Zero Waste Scotland (2011) The Scottish Carbon Metric: Final Report for Natural Scotland, March 2011

[37] The same message is conveyed in the Environment Agency's carbon calculator for construction and demolition projects.

[38] Data from Wales suggests almost 90% of arisings are soils and aggregate, with wood and plastics accounting for 5%. See: Environment Agency (2008) Wales Construction and Demolition Waste Arising Survey 2005-06.

Table 5: Climate Change Benefits – Recycling

Material	Range of benefits per tonne of material, kg CO_2 equivalent	Reasons for range	Typical benefit per tonne of material, kg CO_2 equivalent
Paper	338 – 2,500	Higher values assume electricity use with coal is avoided, include avoided disposal, & high quality paper is collected. Lower value appropriate for lower quality paper collection excluding avoided disposal	338
Card	120 – 2,800	Higher values include avoided disposal	120
Plastic film	-850 – 2,600	High values relate to recovery of high quality uncontaminated film; low relates to open loop recycling process	450
Dense plastics	-1,820 – 2,300	Lower values generally assume a greater energy impact from washing, and a lower proportion of secondary material recovered. Very low value relates to open recycling loop process	1,200
Textiles	930 – 14,069	High values assume reuse through resale of clothing	930 (recycling)
Wood	10 – 1,200	High value assumes MDF recycling (rather than recycling of virgin timber)	600 (mixed)
Glass	30 – 440	Higher values generally relate avoided energy use from a more carbon intense energy mix. Low value relates to open recycling loop process	350 (closed loop)
Ferrous	430 – 1,790	Higher values relate avoided energy use from a more carbon intense energy mix and assume a greater recovery of secondary	1,340
Non ferrous	9,170 – 15,070		10,700
WEEE	1,266 – 1,482	Variable depending on product; very few data points available	1,374 (mixed)
Aggregate	21		21

Sources: AEA Technology (2001) Waste Management Options and Climate Change: Final Report, European Commission: DG Environment, July 2001; USEPA (2002) Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks, May 2002; WRAP (2006) Environmental Benefits of Recycling: An International Review of Life cycle Comparisons for Key Materials in the UK Recycling Sector, Final Report to WRAP, May 2006; Grant et al (2001) LCA of Paper and Packaging Waste Management Scenarios in Victoria, Report for EcoCycle Victoria; Paper Task Force (2002) Life cycle Environmental Comparison: Virgin Paper and Recycling Paper Based Systems, White Paper No. 3; European Aluminium Association (2008) Environmental

Profile Report for the European Aluminium Industry: Life Cycle Inventory Data for Aluminium Production and Transformation Processes in Europe, April 2008; Zero Waste Scotland (2011) The Scottish Carbon Metric: Final Report for Natural Scotland, March 2011; Enviros (2003) Glass Recycling – Life Cycle Carbon Dioxide Emissions, internal report for the British Glass Public Affairs Committee

10.2.4 Composting and Anaerobic Digestion

The climate change impacts associated with composting and anaerobic digestion processes arise both from the process itself and the benefits associated with the use of the products resulting from these processes, which include both energy and compost or digestate. Impacts of both composting and AD have been previously considered in detail by Eunomia, whilst other authors have also reviewed evidence from the peer reviewed literature on the greenhouse gas impacts of composting processes.[39]

The biogas produced from AD can be combusted in a gas engine or upgraded, whereby the carbon dioxide and other impurities within the gas are removed so that the gas can be used either as vehicle fuel, or injected into the gas grid. Several studies have confirmed that benefits are typically higher where the biogas is upgraded and the resulting bio-methane used as a replacement for diesel in heavy goods vehicles or in buses; the more significant benefit arising by virtue of the relatively high carbon content of diesel in comparison to natural gas (the marginal fuel source typically used in the UK for electricity generation).[40]

With regard to the waste hierarchy, composting is regarded as recycling when quality protocols are met, whilst anaerobic digestion is classified as “other recovery”. It should be noted, however, that Defra Guidance on Applying the Hierarchy has specified, as two of three departures from the hierarchy which have been justified by reference to life-cycle thinking (in line with Article 4 (2) of Directive 2008/98/EC), the following: [41]

1. Preference for recovery through anaerobic digestion of source segregated food waste over composting; and
2. Preference for recovery through anaerobic digestion of garden waste and mixtures over composting.

[39] Eunomia (2007) Managing Biowastes from Households in the UK: Applying Life-cycle Thinking in the Framework of Cost-benefit Analysis, Appendices to the Main Report, Report for WRAP, May 2007; Boldrin A, Anderson J, Moller J, Christensen T and Favoino E (2009) Composting and Compost Utilisation: Accounting of Greenhouse Gases and Global Warming, Waste Management and Research, 27, 800

[40] Carbon Trust / ORA (2011) Technology Update: Biogas from Anaerobic Digestion, CO2 Savings and Economics; Patterson, T., Esteves, S., Dinsdale, R., Guwy, A. (2011). Life Cycle Assessment of Biogas Infrastructure Options on a Regional Scale. Bioresource Technology, 102, 7313 – 7323

[41] Defra (2011) Guidance on Applying the Waste Hierarchy, June 2011. Available at: http://www.defra.gov.uk/publications/files/pb13530-waste-hierarchy-guidance.pdf

Table 6 presents the climate change impacts of source separated biowaste treatment methods, with values presented for AD as well as open air and in-vessel composting.

Table 6: Climate Change Impacts – Organic Waste Treatment

Material	Impact per tonne of material, kg CO_2 equivalent	Comments
Food waste - AD	-88 to -170	Worst performance: biogas is combusted on-site generating only electricity. Best: upgraded biogas replaces diesel in a HGV
Mixed food / garden waste to IVC	-30	Assumes 50% garden waste
Green waste to open air windrow	-37	Some offset of peat use which has greater environmental benefits

Key sources: Eunomia (2007) Managing Biowastes from Households in the UK: Applying Life-cycle Thinking in the Framework of Cost-benefit Analysis, Appendices to the Main Report, Report for WRAP, May 2007; Boldrin A, Anderson J, Moller J, Christensen T and Favoino E (2009) Composting and Compost Utilisation: Accounting of Greenhouse Gases and Global Warming, Waste Management and Research, 27, 800;

10.2.5 Recovery and Disposal of Residual Waste

The sections that follow present the climate change impacts of different waste streams treated through a variety of different treatment methods. For each treatment method, impacts vary considerably across the different materials; as such the composition of residual waste will be an important determinant of the impacts.

The following sections present impacts for one tonne of residual household waste alongside the material specific impacts. We have used a waste composition from a local authority with a recycling rate close to that which is anticipated in the baseline (50%).[42]

There is more uncertainty with regard to the composition of the non-household waste streams. The composition of commercial residual waste is anticipated to be similar to that of the household stream. Survey data suggests, however, that residual industrial waste may be very different from that from the commercial stream, although there is very little detailed characterisation and composition data available.[43] Survey data also confirms, however, that a significant proportion of industrial waste, such as

[42] The compositon is based on that from Somerset CC. In principle, we could have taken representative national data, but the residual waste would be related to current levels of recycling. To estimate the composition of residual waste at 50% recycling would have implied making estimates of the extent to which other materials would be captured to move from the current recycling rate to the 50% target. The collection scheme deployed in Somerset broadly is consistent with the waste hierarchy, including weekly food waste collections, weekly collection of dry recyclables, and a fortnightly charged garden waste collection, alongside fortnightly residual wasten collection (mainly using 180l bins). It goes without saying that locally, there will be varation in the composition of residual waste.

[43] Jacobs (2011) Commercial and Industrial Waste Survey, Final Report for Defra, May 2011

chemical waste, is treated through a variety of specialist recovery routes, and that there is very little disposal of this material.[44]

Survey data from Wales produced by the Environment Agency confirms that nearly 90% of construction and demolition waste is inert material, consisting of either soil or aggregate, and the situation is expected to be rather similar in England.[45] Biodegradable material accounts for around 5% of total arisings, with more than half of this being waste wood. Much of this is likely to be wood treated with preservatives, such that the material is much less likely to degrade in landfill than untreated wood, reducing the climate change impact of disposal to landfill. The climate change impacts of treating the residual waste stream produced by the C&D sector are therefore expected to be significantly lower in comparison to that of household residual waste, although it is acknowledged that there is relatively little recent composition data with regard to this stream.

Landfill is always considered a disposal activity. Incineration may also be similarly classified as a disposal activity where the energy generation performance is such that the facility does not meet the European Commission's R1 criterion which qualifies municipal waste incinerators as recovery facilities. The climate change impacts of landfill are considered next in Section 10.2.6 whilst those of incineration are discussed in Section 10.2.7. Section 0 discusses MBT systems, which operate at several levels of the waste hierarchy.

10.2.6 Landfill

Only waste of biogenic origin such as food waste and paper generates landfill gas - fossil-carbon containing materials such as plastics and synthetic textiles, and non-combustible materials do not degrade in landfill.

Table 7 presents climate change impacts for a range of materials along with data on typical impacts for residual waste. The impacts have been developed based on the model used by Defra and DECC to report GHG emissions under the Kyoto Protocol.[46] The results show that impacts associated with landfilling paper and card are highest, with those of garden and food waste about half these levels. These lower levels reflect a range of factors, in particular, the extent to which there is carbon in the waste stream which is readily degraded under landfill conditions. It might be expected that this would be higher for food than for paper and card, but a far greater proportion of food is moisture than is the case for paper and card.

The figure for residual waste reflects the relative mix of materials that do, and do not, degrade. As such, impacts are sensitive to the composition of residual waste.

Because landfills generate energy, the net impact is dependent on the assumptions made regarding the carbon intensity of the source of energy which is deemed to be 'displaced' by the new generation.

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[44] No information is available on the climate change performance of these recovery methods; as such they have not been considered further in the analysis

[45] Environment Agency (2008) Wales Construction and Demolition Waste Arising Survey 2005-06

[46] Eunomia and Oonk H (2011) Inventory Improvement Project – UK Landfill Methane Emissions Model: Final Report to Defra and DECC

Table 7: Climate Change Impacts – Landfill

Material	Impact per tonne of material, kg CO_2 equivalent
Paper and card	420
Textiles	175
Wood[1]	328
Garden waste	230
Food waste	220
Inert (non biodegradable)[2]	1
Residual [3]	170

Notes

1. The value for wood is based on impacts for virgin timber. Impacts are likely to be much lower for treated wood as the treatment is likely to prevent degradation.
2. Inert includes all plastic, metals, glass and other non combustible materials.
3. Values are presented for household residual waste; commercial residual is anticipated to be similar.
4. Impacts are presented assuming 75% of the landfill gas is captured, as this is the approach currently taken in the UK's methane generation model. It should be noted, however, that many authors consider this value to be rather high (see Eunomia and Oonk for further information).

Key source: Eunomia and Oonk H (2011) Inventory Improvement Project – UK Landfill Methane Emissions Model: Final Report to Defra and DECC

10.2.7 Incineration

In comparison to landfill, where emissions of carbon dioxide and methane occur over an extended period of time, incineration results in the instantaneous release of nearly all of the fossil and organic carbon contained in the combusted waste materials. In contrast to landfill, the vast majority of the carbon is emitted as carbon dioxide, whereas around half of the carbon degraded in landfills is converted to methane, a greenhouse gas which is 25 times more potent than carbon dioxide. There is less uncertainty in respect of the climate change impacts associated with incineration processes, as a number of key process elements such as energy generation are generally monitored by process operators.

Table 8 presents typical impacts for a range of waste materials, with values being separately presented for facilities with varying levels of performance in terms of the useful energy derived from the facility. The results have been generated using Eunomia's in-house treatment model, and have, in turn been informed by the literature cited above. Similar results could however be obtained using WRATE, as many of the key assumptions can be changed through use of the flexible incineration process contained within that tool.

In reality, with the exception of wood, materials are generally only incinerated as part of mixed residual waste. However, the results do confirm that when this mixed waste is incinerated, of all the materials in this waste, plastics generate the highest contribution to climate change impacts. For materials of biogenic origin, conventional practice is to assume that the emissions from combustion of these materials should be disregarded. Because energy is generated from combusting these materials, the net contribution to climate change emissions is negative (reflecting the emissions which are avoided from not having to generate energy from other sources). The figure for residual waste as a whole, therefore, reflects the relative mix of combustible materials of fossil origin, and the biodegradable materials (considered as 'carbon neutral' when combusted). As such, as with landfill, impacts are sensitive to the composition of residual waste. It also depends on the extent to which the energy content of the waste can be put to good use.

Table 8: Climate Change Impacts – Incineration (excluding CO_2 emissions of biogenic origin)

Material	Impact per tonne of material, kg CO_2 equivalent[1]		
	Performance with electricity generation only[1]	Performance with CHP	Performance with improved CHP
Paper and card	-220	-350	-400
Plastic film	1,375	1,200	940
Dense plastic	1,500	1,230	1,040
Textiles	280	185	110
Wood	-300	-420	-500
Ferrous	-755	-755	-755
Non ferrous	-2,692	-2,692	-2,692
Garden waste	-130	-200	-240
Food waste	-65	-100	-130
Other inert materials	6	-6	-14
Residual	235	135	63

Notes

1. Results generated using Eunomia's in-house treatment model but similar results would be obtained using WRATE. The marginal electricity generation source is assumed to be gas CCGT.
2. Assumes gross electricity generation of 21% with no heat utilisation. Ferrous metal recovery 70%; non ferrous metal recovery 30%; electricity use 80 kWh per tonne.
3. Gross electricity generation 19%, heat utilisation 16% of input energy (based on performance of Sheffield incinerator). Other assumptions as per typical incinerator.
4. Gross electricity generation 19%, heat utilisation 25% of input energy.

Key sources: Annual Reports of UK incineration facilities; DECC & HM Treasury (2011) Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, October 2011; Muchova L and Rem P (2008) Wet or Dry Separation: Management of Bottom Ash in Europe, Waste Management World Magazine, 9(3)

The results suggest that by the time a 50% recycling rate is achieved, climate change impacts of a typical UK incinerator may be greater than that of landfill where the latter is modelled with a gas capture of 75%, though the situation changes as the amount of useful energy generated by the facility increases. In these cases, the incinerator outperforms the landfill.

Because incinerators generate energy, the net impact is dependent on the assumptions made regarding the carbon intensity of the source of energy which is deemed to be 'displaced' by the new generation.[47]

10.2.8 Mechanical Biological Treatment

The term Mechanical Biological Treatment (MBT) covers a range of different technologies for treating residual waste. All, however, involve a mechanical and a biological treatment phase. The first involves the recovery of recyclables, typically metals and some dense plastic. The second may be either an aerobic or anaerobic process, the aim of which is either to:

- stabilise the waste using a controlled degradation process such that minimal landfill gas is produced when the stabilised product is landfilled;
- biologically dry the material so that a fuel with a lower moisture content is produced. The fuel may be sent to an incinerator or in some cases is used in a cement kiln where it avoids the use of coal;
- less commonly, the organic fraction may be removed and used as a feedstock for an anaerobic digestion process.

Treatment systems thus involve the recovery of recyclate, and also, often the recovery energy. Some material may be sent to landfill although this may be a very small proportion of the total input in some systems where there is output to an incinerator. Different aspects of MBT systems therefore function at the recycling, recovery and disposal levels of the waste hierarchy.

Where energy is generated from the Solid Recovered Fuel (SRF) sent to incineration, similar issues apply to that indicated in Section 10.2.7. Where the SRF from MBT systems is sent to a cement kiln avoiding the use of coal and petcoke, this results in greater climate change benefits, as coal and petcoke, the sources of fuel displaced, have a relatively high carbon content per unit of energy.

Table 9 presents typical climate change impacts for three example MBT systems. The table shows there is a significant variation in performance between the three types of system. The best performance is seen in the system where fuel is sent to a both a high performance incineration system and a cement kiln.

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[47] Data in Table 8 assume the displaced electricity generation source is gas CCGT. However, the calculation toolkit produced by DECC used to appraise policies for their climate change impacts indicates that the carbon intensity of the displaced generation source is anticipated to be reduced over time, decreasing the benefit accorded with electricity generation from incineration and thereby increasing its net climate change impacts. See the IAG section of DECC's website, available from http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

Table 9: Climate Change Impacts - MBT

Material	Impact per tonne of material, kg CO_2 equivalent		
	Biostabilisation (output to landfill)[1]	Biodrying with output to incinerator with electricity only	SRF to high incineration with CHP & cement kiln
Paper and card	95	-150	-280
Plastic film	2	1,350	475
Dense plastic	-290	1,200	220
Textiles	195	1,350	80
Wood		-270	-370
Ferrous	-790	-300	-930
Non ferrous	-4,090	-2,300	-5,000
Garden waste	125	40	16
Food waste	130	-6	10
Other inert materials	2	35	10
Residual – high recycling	18	285	3
Residual – low recycling	40	150	-33

Notes

1. Based on the process formerly operated by New Earth Solutions and Premier Waste
2. Based on the Eco-Deco process (similar to that operated by Shanks)
3. A dual fuel stream processes is currently operated by New Earth Solutions and is proposed by H W Martin and WRG

Key sources: Velis C, Longhurst P, Drew G, Smith R and Polland S (2009) Biodrying for Mechanical-biological treatment of wastes: a Review of process science and engineering, Bioresource Technology, 100, 2747-2761; University of Leeds (2010) New Technologies Demonstrator Programme – Research, Monitoring and Evaluation of the Premier Waste Tower Composting System in Thornley, County Durham, Report for Defra; Amlinger F, Peyr S, Cuhls C (2008) Greenhouse Gas Emissions from Composting and Mechanical Biological Treatment, Waste Management and Research, 26, 47

10.2.9 Adaptation to Climate Change

Recent research undertaken by AEA on behalf of Defra considered the climate resilience of the existing waste infrastructure.[48] The research concluded that extreme weather leading to floods was of particular concern, as the changing climate is expected to bring increases in extreme weather events, in respect of both the frequency with which such events occur as well as their severity.

The increased flood risk is likely to result in additional care being required in respect of the siting of new waste management facilities such that these risks can be minimised. This is, however, an issue that will need to be managed at a local level

[48] AEA (2012) Increasing the climate resilience of waste infrastructure, Final Report for Defra

through the land use planning system and cannot be addressed at a strategic level. The issue may become of increasing importance where a decentralised approach is taken in respect of developing facilities, such that more sites are required.

As will be indicated in Section 10.7, there is likely to be some scope for the mitigation of localised flooding impacts where compost is produced as this can result in improved water retention for the soil.

10.2.10 Summary

The picture in respect of climate change performance of waste management is fairly complex. In general there is scope for reducing the climate impacts of waste management through the movement of waste up the waste hierarchy by increasing activity in waste prevention, preparing for reuse, and recycling activities. This is particularly the case for materials such as food waste where quantities of material in the waste stream are greater.

10.3 Air

The impact of waste management activities on air quality can be appraised through various approaches. One method used comes from life cycle assessment and uses an indicator of Human Ecotoxicity. Such an assessment considers the emission to air, water and soil of a wide range of pollutants, many of which are typically not measured during the normal operation of a waste treatment plant. This type of assessment weights the emissions according to their toxicity impacts using data from epidemiological studies. Data is likely to be far less certain with regard to the impacts of many of the trace pollutants emitted to air, or in respect of the soil and water impacts. In addition, some such indicators focus more on toxicity than on other impacts related to air pollution (such as the effect on respiratory function) and so may fail to identify some key effects of pollutants which, though not toxic in the conventional sense, have consequences for human health.

An alternative approach is to use external cost data. In economics, an external cost, also known as an externality, arises when the social or economic activities of one group of persons has an impact on another group and when that impact is not fully accounted for or compensated for (in financial terms), by the first group. This type of appraisal considers the impacts on human health of air pollution, typically focusing on those pollutants for which epidemiological data is the most robust, namely NOx, SOx, particulates, VOCs and ammonia.[49] Impacts are calculated through a consideration of the costs associated with days lost to ill-health and costs resulting from hospital admissions, as well as those relating to deaths brought forward through exposure to pollution.[50]

One such set of external costs used in UK government appraisal is that developed through the UK's National Air Quality Strategy by the Inter-departmental Group on

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[49] The results of this type of assessment are roughly in line with those associated with appraisal using the acidification life cycle methodology, as this also considers pollution of NOx, SOx and ammonia.

[50] Further discussion on the health impacts associated with these pollutants is provided in Section 0.

Costs and Benefits (IGCB).[51] One limitation of this dataset is that it does not consider the impact of pollution originating in the UK on populations in other European Countries. However, guidance from HM Treasury and Defra developed to assist those undertaking appraisals of environmental impacts of policy options indicates that this dataset be used when undertaking such assessments.[52]

These costs are presented in Table 10, and are subsequently used throughout the remainder of this section to assess the impacts associated with air pollution from waste treatment facilities. Although largely focused on human health, the costs also consider the impacts on crops and materials including buildings. The methodology therefore also assesses to a certain extent the anticipated impact on cultural heritage associated with the air pollution impacts (see Section 10.9).

Table 10: External Costs of Air Pollution (£ per tonne of pollutant emitted)

	NOx	SOx	PM	NH_3
IGCB	£955	£1,633	£20,862	£1,972
Notes: All values presented in 2010 prices				

Source: IGCB

It is important to note that the costs presented in the Table represent a relatively conservative approach to assessing the damage associated with these air pollutants. External cost data developed by other studies elsewhere in Europe has largely attributed a much greater damage to the health impacts associated with these pollutants, in part because the other studies include a wider range of health impacts than is the case in the IGCB work.[53]

All waste treatment facilities result in some local pollution impacts, with both the size of the facility and the type of treatment technology having an influence on the local pollution impact. Local circumstances are also of importance when considering the air pollution impacts associated with a specific facility, and in determining where to site a new facility. As is indicated in Section A.2.8, a number of urban areas have already exceeded national air quality objectives for key pollutants including NO_2. Local circumstances may therefore dictate the type of facility that can be built in these areas (and this is likely to be considered in the context of applications for environmental permits).

10.3.1 Prevention and Preparing for Reuse

There is much less data on the local air pollution impacts of prevention and reuse activities than is the case with climate change impacts. In addition, the impact of

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[51] IGCB (Interdepartmental Group on Costs and Benefits); Various reports. Available at: http://www.defra.gov.uk/evidence/economics/igcb/publications.htm

[52] HM Treasury / Defra (2012) Accounting for Environmental Impacts: Supplementary Green Book Guidance

[53] Holland et al (2005) Marginal Damage Cost report - Damages per tonne emission of PM2.5, NH3, SO2, NOx and VOCs from each EU25 Member State (excluding Cyprus) and surrounding seas. Available at: http://www.cafe-cba.org/assets/marginal_damage_03-05.pdf

these activities is dependent on the location of the avoided primary manufacture - as such, waste prevention may not have a direct influence on air pollution in UK, but may bring about pollution reduction elsewhere in the world (reflecting the UK's dependency on imported products from elsewhere). In addition, there is no external cost data for many countries in the world. These factors make it difficult to quantify the air pollution impacts of such activities.

As is the case with the climate change impacts, one source of data in this respect is the life cycle databases such as ecoinvent.[54] However these databases typically consider the global impact of air pollutants associated with product manufacture and do not consider the relative locality of the primary and secondary manufacturing facilities. In addition, as was confirmed in respect of climate change impacts, although it is relatively straightforward to derive data on the impacts for a specific plastic polymer or for the extraction of raw metal, it is much more difficult to establish impacts for a specific product stream such as dense plastic waste.

Given that much of the climate change impact for the prevention and reuse activities relates to a reduction in energy consumption, such activities can also be expected to result in the avoidance of other air pollutants associated with the same energy generation activities. The same issues arise, however, in respect of the extent to which manufacture can be said to have been avoided through reuse activities as were discussed in Section 10.2 for the climate change impacts.

As indicated both above and in Section 10.2, much manufacturing activity is located outside of the UK, indicating that a significant proportion of the potential pollution reduction will not affect UK air quality. An exception to this is food waste, which was previously identified as having significant potential for to reduce climate change impacts through waste prevention. Recent work by WRAP has indicated that a significant proportion of the avoidable food waste relates to UK based manufacture, suggesting that waste prevention activities in respect of this type of waste would be expected to have a positive impact on UK air quality.[55]

10.3.2 Recycling

An examination of the local air pollution benefits associated with recycling activities requires consideration of the relative locations of both the primary and secondary manufacturing activities. As such, the development of greater reprocessing capacity within UK would be expected increase local air quality impacts, although the overall (global) impact would likely be a decrease in emissions to air. Thus although more data is available with regard to the air pollution impacts associated with recycling activities, there remains considerable uncertainty where some quantification of the local pollution impact is required.

The WRATE database includes data on the air pollution impacts of the main dry recyclate streams, much of which is derived from the aforementioned ecoinvent database. The 2006 review undertaken by WRAP of life cycle data in respect of the

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[54] See http://www.ecoinvent.ch

[55] WRAP / WWF (2011) The Water and Carbon Footprint of Household Food and Drink Waste in the UK, Final Report, March 2011

key recycling streams also presented some data on the air pollutants where this was provided by the studies included within the review, although it was noted that the majority of studies focused on the climate change impacts alone.[56] Data from WRATE is summarised in Table 11. The data confirm a relatively large pollution reduction potential associated in particular with the recycling of metals, whilst benefits associated with recycling aggregate are relatively minor. In both cases, benefits are assumed to be largely related to the energy requirements associated with the manufacturing / extraction process.

Table 11: Air Pollution Impacts Per tonne of Recyclate

	Units	Quantity of pollutant per tonne of recyclate					
		Paper	Dense plastic	Glass (closed loop)	Ferrous	Non ferrous	Aggregate
NH_3	g	-9.92	6.29	-159.00	-68.00	-145.00	-0.99
VOCs	g	-43.10	-3,540.00	-24.60	-248.00	-2,200.00	-26.60
$PM_{2.5}$	g	-99.90	-401.00	-190.00	-779.00	-4620.00	-0.75
SOx	g	-7.35	7.11	-30.70	-7.35	-7.35	-46.90
NOx	g	-918.00	-5,680.00	-296.00	-2,700.00	-18,000.00	0.00
Cd	mg	4.80	0.88	-6.58	-26.10	269.00	0.00
Cr	g	-0.10	0.07	-0.43	-0.17	-1.12	-0.01
Hg	mg	4.26	-196.00	-7.78	-88.30	1,180.00	-0.82
Ni	g	0.02	0.04	-0.08	-0.43	-3.53	-0.01
Pb	g	0.02	0.02	-0.15	-3.58	39.60	-0.01
Dioxin	ng	-0.0004	-0.0003	-0.0003	-0.0004	-0.0004	-0.0001
As	g	-0.02	0.01	-0.03	-0.02	0.67	0.00

Source: WRATE

10.3.3 Source Separated Biowaste Treatment

As indicated in respect of the climate change impacts, source separated biowaste treatment activities, such as composting and anaerobic digestion are classified as recycling activities where the compost and digestate produced within the process conform to the PAS100 and PAS110 standards respectively. Where this is not the case, both activities are deemed recovery activities.

The principal air quality impacts of composting activities stem from emissions of VOCs, ammonia and bioaerosols, and measurements of all three types of pollutant have been undertaken by various authors.[57] The air pollution impacts are reduced for

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[56] WRAP (2006) Environmental Benefits of Recycling: An International Review of Life cycle Comparisons for Key Materials in the UK Recycling Sector, Final Report to WRAP, May 2006

[57] Environment Agency (2000) Life Cycle Inventory Development for Waste Management Operations: Composting and Anaerobic Digestion, R&D Project Record P1/392/4; Amlinger F, Peyr S and Cuhls C (2008) Greenhouse Gas Emissions from Composting and Mechanical Biological Treatment, Waste Management and Research, 26, pp47-60; Nadal M, Inza I, Schuhmacher M, Figueras M and Domingo J (2009) Health Risks of the Occupational Exposure to Microbiological and Chemical Pollutants in a

enclosed composting facilities as abatement equipment such as biofilters and scrubbers can be employed. Of the three impacts, only the ammonia is attributed any weighting in an assessment of air pollution carried out using the IGCB methodology. It should be noted that the abatement technologies used have implications for GHG emissions since if not scrubbed before reaching a biofilter, ammonia can be converted into N_2O, a potent GHG.

Whilst the emission of bioaerosols from composting plant has attracted significant interest in the UK in recent years, the evidence suggests that these impacts are of primary concern to those working within the facility, and that they may be controlled to a significant extent through effective process management.[58] No external cost is available with which to assess these impacts.

Air quality impacts from AD largely are largely associated with the combustion of the biogas or bio-methane, although some pollutants such as hydrogen sulphide may be produced during the biogas generation process. Biogas combustion in a gas engine results in emissions of both NOx and SOx. NOx emissions from particularly the smaller plant may be relatively high, although data from larger plant suggests this impact can be relatively well controlled even without the use of abatement equipment.[59] The use of appropriate abatement equipment is also of importance in considering the air pollution impacts of AD facilities - SOx emissions can be reduced through the use of various measures to reduce the hydrogen sulphide prior to the gas being combusted in the gas engine.[60]

Where biogas is used to generate electricity, assessments of the pollution impacts undertaken using the life-cycle methodology usually quantify the benefit associated with this generation. These benefits will however typically occur in a different location to that of the AD facility.

There is some variation in the environmental impacts of AD processes depending on the use of the biogas. The use of the upgraded biogas in heavy goods vehicles also results in local air pollution impacts through a significant reduction in NOx emissions where the gas is used as a replacement for diesel in heavy goods vehicles (data from one study suggests that emissions of the pollutant can be halved in this way).[61] Upgraded biogas can also be injected into the gas grid, where it is assumed to replace natural gas; where this is the case, the combustion of the biogas results in the same pollution impacts as is the case with the natural gas.

Municipal Waste Organic Fraction Treatment Plant, International Journal of Hygiene and Environmental Health, 212, pp661-669

[58] D. Hogg (2002) *Waste Treatments Mk II: Health Effects*, Report for the Strategy Unit; European Agency for Safety and Health at Work (2007) European Risk Observation Report: Expert Forecast on Emerging Biological Risks related to Occupational Safety and Health, Belgium

[59] EML Air PTY (2008) *Test Report Prepared for Eastern Creek Operations, report for Global Renewables Ltd,* April 2008; Aschmann V, Kissel R and Gronauer A (2008) Efficiency and Environmental Compatibility of Biogas Fired Cogeneration Plants in Practical Service, 17th Annual Convention of Fachverband Biogas e.V, 15th-17th January 2008, Nuremberg

[60] European Commission (2006) Integrated Pollution Prevention and Control: Reference Document on Best Available Techniques for the Waste Treatment Industries, August 2006

[61] Bio-NETT (2008) Bio-methane in Lille: A Case Study

Table 12 presents the external costs of air pollution for source separated biowaste treatment methods, with results for AD presented both including and excluding the non-local avoided electricity generation impacts. For AD, benefits are greatest where upgraded biogas is used locally as a fuel for heavy goods vehicles. Air pollution impacts are greatest where green waste is treated at an open air windrow, as a result of the ammonia emissions.

Table 12: External Costs of Air Pollution – Source Separated Biowaste Treatment

Material		External costs, £ per tonne of waste treated
Food waste – AD[1]	Biogas combusted in a gas engine generating only electricity. Results include avoided electricity generation impacts	£0.08
	Biogas combusted in a gas engine generating only electricity. Results exclude avoided electricity generation impacts	£0.58
	Upgraded biogas injected into the gas grid (including avoided gas use)	£0.00
	Upgraded biogas used locally as a fuel for HGVs (including avoided diesel use)	-£0.51
Mixed food / garden waste to IVC		£0.14
Green waste to open air windrow		£0.64

Sources: EML Air PTY (2008) Test Report Prepared for Eastern Creek Operations, report for Global Renewables Ltd, April 2008; Aschmann V, Kissel R and Gronauer A (2008) Efficiency and Environmental Compatibility of Biogas Fired Cogeneration Plants in Practical Service, 17th Annual Convention of Fachverband Biogas e.V, 15th-17th January 2008, Nuremberg; European Commission (2006) Integrated Pollution Prevention and Control: Reference Document on Best Available Techniques for the Waste Treatment Industries, August 2006

10.3.4 Landfill

Where assessment of these impacts is undertaken using the IGCB methodology the principal air pollution impact resulting from the landfilling of waste is associated with the emission of ammonia. Most of the work undertaken with regard to understanding this impact stems from research undertaken by Munday in the 1990s.[62] This links the emission of ammonia to the biogenic nitrogen content of the waste stream.

Table 13 presents data on the external costs of landfilling residual waste. Data is presented for different rates of gas capture, and also identifies the non-local benefits from avoided electricity generation. Impacts are less sensitive to the proportion of gas

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[62] P. K. Munday (1990) *U.K. Emissions of Air Pollutants, 1970-1988,* Report LR 764, Stevenage, Warren Spring Laboratory. 1990; Sonoma Technology (2003) Recommended Improvements CMU Ammonia Emission Inventory Model for Use by LADCO, Revised Final Report, March 26, 2003.

captured over the lifetime of the landfill, as much of the impact is associated with the release of ammonia – the majority of which is released during the first year of waste deposition (when no permanent cover is in place even where a high lifetime capture rate is assumed).

Table 13: External Costs of Air Pollution – Landfill

	External costs £ per tonne of waste disposed
Including avoided electricity generation impacts	£1.33
Excluding avoided electricity generation impacts	£1.35
Notes Impacts per tonne of household residual waste. External costs calculated using IGCB dataset (see Table 10).	

Sources: Komex (2002) Investigation of the Composition and Emissions of Trace Components in Landfill Gas, R&D Technical Report P1-438/TR for the Environment Agency, Bristol; White P R, Franke M and Hindle P (1995) Integrated Solid Waste Management: A Lifecycle Inventory, Blackie Academic & Professional, Chapman and Hall; Enviros, University of Birmingham, RPA Ltd., Open University and Thurgood M (2004) Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes, Final Report to Defra, March 2004; P. K. Munday (1990) U.K. Emissions of Air Pollutants, 1970-1988, Report LR 764, Stevenage, Warren Spring Laboratory. 1990; Sonoma Technology (2003) Recommended Improvements CMU Ammonia Emission Inventory Model for Use by LADCO, Revised Final Report, March 26, 2003

The above table presents the data for waste which has a composition typical of household residual waste. The limited data available on commercial waste suggests that the residual stream has a similar composition to the household. There is however very little data on the composition of industrial wastes, although survey data indicates that the streams with the greatest pollution potential are typically sent for specialist treatment rather than being disposed of to landfill.

As indicated in respect of the climate change impacts, a significant proportion of C&D waste arisings consists of inert material such as soils or aggregates. The air pollution impacts of landfilling non-biodegradable waste are relatively minor; as such, the external costs associated with the air pollution from landfilling this material are expected to be reduced in comparison to those presented in the table above. The C&D stream is expected to contain a larger proportion of hazardous material than is the case with the household stream.

10.3.5 Incineration

The Waste Incineration Directive (WID) specifies limits for the key pollutants emitted from waste incineration facilities, and effectively requires that certain pollutants are continuously measured.[63] In addition, the health effects of the main pollutants emitted by incineration facilities are generally better understood than is the case for those emitted at the landfill. As such there is more certainty with regard to the air

[63] European Commission (2000) Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the Incineration of Waste

quality impacts of incineration facilities than is the case with waste disposed of to landfill.[64]

Because of the levels of abatement of the main air pollutants which incineration plants are required to achieve, the potential damages per tonne of waste incinerated are quite small. Of those potential impacts on human health which remain, the emissions of NOx appear to account for the most significant part where the assessment of impacts is based on the external cost of the emissions. Incinerators in the UK tend to use the Selective Non Catalytic Reduction (SNCR) abatement equipment which enables facilities to comply with – but to not significantly exceed - the requirements of the WID in respect of NOx.[65]

Table 14 presents the external costs of air pollution from incineration facilities calculated using the IGCB assessment methodology. The data does not include benefits associated with the recovery of recyclate from the bottom ash, as the associated benefits do not necessarily accrue locally, and more difficult to assess as a result. For this reason, the figures may slightly overstate the impacts, but the extent of this overstatement may be rather small.

The Table shows the figures before and after taking into account any benefits linked to pollution which is avoided by virtue of energy being generated by the facility. Typically, these offset around half the impact of the process emissions from the facility itself.

[64] All permitted waste incinerators report emissions to the regulator's publi register. This data is available from the Defra EPTR website and the Environment Agency. Some UK facilities publish their emissions data themselves. See, for example http://www.selchp.com which presents emissions data for the SELCHP incinerator in London operated by Veolia.

[65] Information Centre for Environmental Licensing (2002) Dutch Notes on BAT for the Incineration of Waste, Report for the Ministry of Housing, Spatial Planning and the Environment, The Netherlands, February 2000

Table 14: External Costs of Air Pollution – Incineration

	External costs of air pollution impacts - £ per tonne of waste incinerated		
	Performance with electricity generation only[1]	Performance with CHP[2]	Performance with improved CHP[3]
Including avoided electricity generation impacts[4]	£0.72	£0.72	£0.68
Excluding avoided electricity generation impacts[4]	£1.44	£1.37	£1.33

Notes

1. Typical performance in respect of energy generation. Assumes gross electricity generation of 21% with no heat utilisation. Ferrous metal recovery 70%; non ferrous metal recovery 30%; electricity use 80 kWh per tonne.
2. Best performance with respect to energy generation. Gross electricity generation 19%, heat utilisation 16% of input energy (based on performance of Sheffield incinerator). Other assumptions as per typical incinerator.
3. Gross electricity generation 19%, heat utilisation 25% of input energy.
4. Emissions data provided for SELCHP.
5. Impacts calculated for household residual waste composition, and assume gas CCGT as the avoided source of electricity generation. External cost data is presented in Table 10.

Sources: Information Centre for Environmental Licensing (2002) Dutch Notes on BAT for the Incineration of Waste, Report for the Ministry of Housing, Spatial Planning and the Environment, The Netherlands, February 2000; SELCHP data from http://www.selchp.com; European Commission (2000) Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the Incineration of Waste

The data suggests that the external costs associated with incinerated waste at typical UK facilities are less than those indicated for landfilled waste where the avoided electricity benefits are included. The data further indicates that there is very little benefit in respect of air quality impacts associated with CHP plant over facilities generating electricity only, as the benefit associated with heat generation is relatively small in comparison to that of electricity generation. As such impacts are likely to be similar for incinerators irrespective of the extent to which they generate useful energy (though as shown above, the effect on climate change is significant).

10.3.6 MBT

There is much less data on the MBT than incineration processes. Some information is presented in the Reference Document for the waste treatment industries whilst

WRATE also contains some information in its background databases.[66] A further study considered the emission of a range of substances including VOCs and heavy metals linked to the composition of waste treated at biostabilisation plant. [67]

As with incineration, the type of abatement equipment installed has an important influence on the impacts. The use of biofilters and scrubbers can reduce emissions from the biological treatment step as was discussed with reference to enclosed composting facilities.

Where the MBT process results in the production of a fuel subsequently sent to an incinerator, this is also likely to result in additional emissions resulting from the fuel combustion process, as was previously described in Section 10.3.5. In some cases, the SRF is sent overseas, resulting in a non-local impact. Where the SRF is combusted in a cement kiln, pollution impacts are typically similar to that seen where coal or petcoke is combusted, i.e., generally there is no net increase in NOx or SOx pollution (although some sources suggest there may be a minor reduction in these pollution impacts).[68]

Table 15 presents the external costs of air pollution from MBT facilities. Results do not attribute any benefit from the recovery of recyclate, as these are considered to be non-local impacts.

Table 15: External Costs of Air Pollution - MBT

Material	External costs of air pollution impacts - £ per tonne of waste treated		
	Biostabilisation (output to landfill)	Biodrying with output to incinerator generating electricity only	SRF to incineration with CHP & cement kiln
Including avoided electricity generation impacts	£0.70	£0.52	-£0.05
Excluding avoided electricity generation impacts	£0.70	£1.17	£0.45

[66] European Commission (2006) Integrated Pollution Prevention and Control: Reference Document on Best Available Techniques for the Waste Treatment Industries, August 2006

[67] Stefanie Hellweg, Gabor Doka, Goran Finnvenden and Konrad Hungerbuhler (2003) Ecology: Which Technologies Perform Best?, in Christian Ludwig, Stefanie Hellweg and Samuel Stucki (eds) (2003) Municipal Solid Waste Management: Strategies and Technologies for Sustainable Solutions, London: Springer.

[68] Lagan Cement Limited (2008) Lagan Cement News: Lagan Cement to Further Reduce Fossil Fuel use, CO_2 emissions

10.3.7 Summary

All waste treatment facilities result in some local pollution impacts, with both the size of the facility and the type of treatment technology having an influence on the local pollution impact. Local circumstances are also of importance when considering the air pollution impacts associated with a specific facility, and in determining where to site a new facility.

Consideration of the local air pollution benefits associated with activities further up the hierarchy requires consideration of the relative locations of both the primary and secondary manufacturing activities. As such, the development of greater reprocessing capacity within UK would be expected increase local air quality impacts, although the overall (global) impact would likely be a decrease in emissions to air.

10.4 Population and Human Health

10.4.1 Reviews of Health Studies

An extensive review into the health impacts of waste management facilities was undertaken on behalf of Defra in 2004.[69] This presented data on a wide range of treatment facilities including composting and MBT plant as well as landfill and incineration sites. The impact of a wide range of pollutants was studied, and the study suggested that health impacts were not a cause for significant concern. The study also concluded that those emissions responsible for most of the impacts that were identified were NOx, SOx and particulates.

The analysis of the health impacts concluded that impacts from incineration plant were greater than those of the other facilities including landfill, but that even in this case the impacts were relatively minor. Results were presented in terms of deaths brought forward, estimated at 0.003 per year for a typical 250,000 tonne per annum incinerator, and the number of respiratory hospital admissions, estimated at 0.250 per annum for a similarly sized facility.

A subsequent study by the Health Protection Agency focussed solely on the health impacts of incineration facilities.[70] This study concluded that the potential damage to human health from such facilities was likely to be "very small, if detectable". However the study only considered direct emissions to air of particulates, dioxin and carcinogens – the analysis did not appear to consider the impact on human health of NOx emissions which the previous Defra study had suggested were likely to contribute most to the limited impacts it identified.

The message which both studies convey is that the health impacts associated with waste facilities are small, though the studies differ in the extent to which they give attention to the different pollutants of relevance.

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[69] Enviros / University of Birmingham / Open University / M Thurgood (2004) Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes

[70] Health Protection Agency (2010) The Impact on Health of Emissions to Air from Municipal Waste Incinerators: Advice from the Health Protection Agency, February 2010

10.4.2 Study External Cost Analysis

It is difficult to compare the impacts calculated through use of the data on external costs with those presented in the report for Defra, as the latter did not express the outputs using the damage cost methodology, choosing instead to focus on the number of deaths brought forward.

The impacts of waste treatment facilities on human health are closely linked to the air pollution impacts outlined in Section 10.3, which are based mainly on these impacts. Assessments of treatment facilities presented within that Section provide an indication of the impacts of such facilities on human health, as the environmental impact is calculated through an analysis of the external costs of that pollution.

The external cost assessments indicate the two pollutants contributing most to the impacts identified are NOx and ammonia. Whilst NOx is associated with combustion-based technologies such as incineration and the generation of energy from biogas, ammonia is emitted from landfill sites and composting facilities.

In addition to the external cost data available for the major air pollutants, other authors have developed similar costs for some of the trace air pollutants, and this is shown in Table 16.[71] The data confirms that emissions of dioxin are attributed a very high external cost per unit of emission. However dioxin is only emitted from waste treatment facilities in very small quantities, and as such, impacts under normal plant operation are typically negligible, despite the high damage cost attributable to it.

Table 16: External Estimates for Trace Pollutants

Pollutant	External cost, £ per tonne of pollutant[1]
Arsenic	£340,000
Cadmium	£29,000
Chromium	£38,000
Lead	£920,000
Mercury	£870,000
Nickel	£3,800
Benzene	£75[2]
Dioxins	£26,000,000,000

Notes
1. Prices converted to £ for the year 2009.
2. Excludes ozone effects.

The calculation of the impact of trace pollutants in respect of waste management activities is subject to greater uncertainty than is the case with the major pollutants, since impacts will be influenced by the composition of waste being treated.

[71] Wagner, A., Palmer, T., Holland, M. and Spadaro, J. (2009) Technical Paper on Externalities

10.4.3 Emission of Bioaerosols from Composting Plant

The emission of bioaerosols from composting plant has attracted significant interest in the UK in recent years, as was indicated in Section 10.3.3. To most individuals, exposure to bioaerosols does not appear to cause significant problems. However, as with some more conventional pollutants, certain individuals, for example asthmatics and the immuno-compromised, may suffer adverse health effects after exposure to bioaerosols.

Risk assessments undertaken in respect of these emissions typically conclude that distances of 200-300 metres from the composting plant are sufficient for bioaerosol concentrations to return to background concentrations; as such, nearby dwellers are unlikely to be at great risk.[72] Although workers at composting plant are exposed to a certain load of dust particles, implanting an effective health risk management programme is expected to significantly reduce the health risks associated with bioaerosols.[73]

At present no external cost data is available for emissions of bioaerosols; as such it has not been possible to include this impact within the appraisal of health impacts.

10.4.4 Impacts of Waste Prevention, Preparing for Reuse and Recycling

The foregoing discussion on the local air pollution impacts associated with waste recycling, waste prevention and reuse has confirmed that impacts for the latter two activities are dependent on the location of the avoided primary manufacture, whilst the location of the reprocessing plant is also important where recycling activities are concerned. Analysis of the data associated with pollution resulting from recycling activities confirms a substantial decrease in overall the air pollution impacts is expected where material is recycled. It is difficult, however, to calculate external cost estimates for these activities in part because no external cost data exists for the majority of countries outside Europe.

A further issue of some interest is the illegal transportation of WEEE overseas for recycling. Information published by the UK's Health and Safety Executive confirms that electronic waste may contain a range of hazardous materials including arsenic, cadmium and lead – all of which may be released into the atmosphere where product dismantling takes place in an uncontrolled manner.[74]

External cost data previously presented in Table 16 confirms that the emission to air of these substances is associated with a very high external cost per tonne of pollutant emitted, although it is acknowledged that such elements are only found in small amounts in WEEE products. There is, however, very little information in the literature

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[72] Nadal M, Inza I, Schuhmacher M, Figueras M and Domingo J (2009) Health Risks of the Occupational Exposure to Microbiological and Chemical Pollutants in a Municipal Waste Organic Fraction Treatment Plant, International Journal of Hygiene and Environmental Health, 212, pp661-669; Swan J, Kelsey A, Crook B and Gilbert E (2003) Occupational and Environmental Exposure to Bioaerosols from Composts and Potential Health Effects, A Critical Review of Published Data, Health and Safety Executive, UK

[73] European Agency for Safety and Health at Work (2007) European Risk Observation Report: Expert Forecast on Emerging Biological Risks related to Occupational Safety and Health, Belgium

[74] http://www.hse.gov.uk/waste/waste-electrical.htm

on the health impacts of WEEE recycling even where this takes place under controlled conditions (where emissions are more likely to be monitored).

10.4.5 Summary

Table 17 presents typical values for the annual external costs of waste treatment facilities treating both source separated organic waste and residual waste. Impacts for the former are calculated assuming a 35,000 tonne per annum facility, whilst those for the latter assume the treatment of 250,000 tonnes of waste – reflecting the typical size of each type of plant. The calculations exclude the impacts associated with electricity generation, as these are deemed to be non-local impacts. The Table confirms that there are no treatment options with zero implications for human health. Waste management is about making choices as to how waste should be treated, and whilst some studies have indicated the small magnitude of the health impacts from waste facilities, none is without any impact.

Table 17: Local Human Health Impacts of Selected Waste Treatment Facilities

Facility type		**External cost of pollution, £/tonne of waste processed[1]**
Anaerobic Digestion of food waste	Generation of electricity only (biogas combustion)	£0.58
Open air windrow composting	Green waste only	£0.64
In vessel composting	Mixed food / green waste	£0.14
Incineration	Typical UK performance	£1.44
Landfill	75% gas capture	£1.35
MBT Biostabilisation	Stabilised output to landfill	£0.70
MBT Biodrying	RDF sent to UK incinerator	£1.17
MBT incin / cement kiln	SRF to high performance incinerator	£0.45
Notes 1. All totals exclude the avoided electricity generation impacts		

To place these figures into context, Annex A.2.4 includes an estimate of the costs for health damages form air pollution in the UK across the board. England generates an amount of waste of the order one to two hundred million tonnes (depending upon the range of wastes one considers). The damages from air pollution, as indicated in the above Table, and before accounting for avoided impacts from electricity generation, are of the order £0.14-£-1.35. If one assumes a rough average of £1 per tonne of waste treated, the grossed up damages would give a total of the order £100-200 million per annum. This compares with the £19 billion figure in Annex 2.4. Clearly, the underlying methodologies through which the two figures are derived are rather different, but they suggest that waste management is responsible for around 1% of the total health damages from air pollution in England / UK.

10.5 Soil

Soils play a vital role in regulating climate, water supplies and biodiversity, and therefore in providing the ecosystem services that are essential to human well-being.[75]

Interactions between waste management and soils can be both direct & indirect. Direct impacts include potential adverse impacts on soil quality associated with the management of waste facilities, e.g. leachate from landfill or composting facilities. The landtake resulting from the construction of a facility (see Section 10.8 for more information) could also impact negatively on soils, by reducing soil biodiversity, and contributing to other impacts such as reducing potential for soil water storage, thus increasing run-off. Equally, emissions to air, such as ammonia from some facilities may impact negatively on soil quality in sensitive areas (although limits on such emissions will be set by Environmental Permits).

Direct, site-specific impacts of a positive nature include the benefits associated with the application of compost, derived from organic wastes, to agricultural land or gardens and parks. These benefits may include an improved soil structure and increased soil organic carbon content, as well as increased soil biodiversity. There is also evidence that soils treated with compost have greater resistance to disease, and may help reduce requirements for use of pesticides.

Indirect impacts on soils, often associated with overseas supply chains, include the avoided soil impacts related to primary production of cash crops such as cotton from undertaking reuse of textiles. This can have a potentially significant impact in reducing land degradation in countries such as Pakistan. The same applies to food. While England's soil strategy[76] may assist in improving domestic soil management, much of the food consumed is imported. Through reducing the demand for food production, preventing food waste in England can also have a beneficial impact on soils overseas, where soil management practices may be less stringent.

10.5.1.1 Threats to Soil Quality

In the past 25 years, one-quarter of the global land area has suffered a decline in productivity and in the ability to provide ecosystem services because of soil carbon losses.[77]

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[75] UNEP (2012) UNEP Yearbook 2012, Chapter 2: The Benefits of Soil Carbon. Available at: http://www.unep.org/yearbook/2012/pdfs/UYB_2012_CH_2.pdf

[76] Department for Environment Food and Rural Affairs (2009) *Safeguarding our Soils: A Strategy for England*, 2009

[77] Bai, Z. G. and Dent, D. L. (2012) Recent land degredation and improvement in China, *Ambio*, Vol.38, 150-156.

Soil erosion associated with conventional agricultural practices can occur at rates up to 100 times greater than the rate at which natural soil formation takes place.[78] This is significant, as it means that in many cases, changes that occur in respect of soil degradation are to all intents and purposes irreversible.

Current changes in soil organic carbon (SOC) are mostly attributable to worldwide land use intensification and the conversion of new land for food and fibre production. Modern industrialised crop production relies on monocultures of cash crops, which generally create a negative carbon budget.[79]

10.5.1.2 Benefits to Soils from Textiles Reuse and Recycling

Reuse of textiles reduces the requirement for primary production. Where this leads to a reduction in demand for cotton, it is clear that there will be an associated reduction in negative impacts on soil. The example is given here of some of the damaging impacts of cotton production in Pakistan.

Pakistan's crop production, including export crops such as rice and cotton, is mainly located in the provinces of Punjab and Sindh. Limited rainfall in Punjab and Sindh makes water-intensive crops such as rice and cotton highly dependent upon irrigation. Over 90% of Pakistan's agriculture is now irrigation based, and 88% of Pakistan's irrigation occurs in Punjab and Sindh.[80]

Land degradation is widespread in several regions of Pakistan and appears to be increasingly the reason for poor performance in the agricultural sector. Agricultural activities have decreased the land vegetation cover, increasing wind and water erosion. Cotton production in Pakistan is found to increase salinization and waterlogging of soils, and other land contamination problems associated with intensive irrigated agriculture.[81]

Cotton requires twice the amount of water per acre as wheat or maize, and also involves higher rates of agro-chemical application.[82] While drip-irrigation technologies could reduce soil salinity and improve efficiency in water use in Pakistan, the cultivation of cotton would remain more damaging to soil than other crops such as wheat or maize.

Switching to alternative forms of textiles, such as hemp and flax, may assist in reducing the impacts on soils.[83] However, to the extent that policies relating to waste

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[78] Montgomery, D. R. (2007) Soil Erosion and Agricultural Stability, *Proceedings of the National Academy of Sciences*, Vol.104, 13268-13272.

[79] UNEP (2012) UNEP Yearbook 2012, Chapter 2: The Benefits of Soil Carbon. Available at: http://www.unep.org/yearbook/2012/pdfs/UYB_2012_CH_2.pdf

[80] Unisféra International Centre (2005) *From Boom to Dust? Agricultural Trade Liberalization, Poverty and Desertification in Rural Drylands: The Role of UNCCD*, Report for Canadian International Development Agency, April 2005. Available at: http://www.wto.org/english/forums_e/ngo_e/posp46_unisfera_e.pdf

[81] ibid

[82] ibid

[83] Piotrowski, S. and Carus, M. (2011) *Ecological benefits of hemp and flax cultivation and products*, Report for Nova Institut fur Okologie und Innovation, 2011

prevention and management can exert an influence on soil quality, promoting reuse of textiles would seem to be the most appropriate response.

10.5.1.3 Benefits to Soils from Food Waste Prevention

Processes like desertification, erosion, the decline in organic matter in soil, soil contamination (e.g. by heavy metals), soil compaction and salinity, can reduce the ecological state, and hence, productive capacity of soil. Such degradation can result from inappropriate farming practices such as unbalanced fertilisation, the excessive use of groundwater for irrigation, improper use of pesticides, use of heavy machinery, or overgrazing. Other causes of soil degradation include the abandonment of certain farming practices. For example greater specialisation towards arable farming has frequently meant an end of traditional crop rotation systems and fertilising with green legumes (working these plants into the soil) - practices that helped restore the organic matter content of soil.[84]

While amending the approaches taken to farming can seek to tackle these problems, a straightforward reduction in demand for food should, all things being equal, lead to a reduction in the demands placed on agricultural soils. Accordingly, damaging impacts associated with food production should be reduced.

10.5.1.4 Physical and Biological Improvements to Soil from Compost Application

Soil physical properties affect crops both directly and indirectly. The structure, porosity, aeration and moisture holding capacity are part of the root environment and so have direct effects on crop growth and nutrient release from the soil reserves. Better structure can lead to improved aeration, drainage and ability to provide water and nutrients to plants.

Trials at IACR Rothamstead have shown an improved efficiency of mineral fertilisers where soil organic matter is high and this has certainly also been seen in other trials.[85] There are many techniques for quantifying changes in soil physical characteristics (e.g. cohesion, sheer strength, water retention etc.) which may be brought about by organic matter changes but their interpretation is notoriously difficult. Sometimes trials have investigated other related soil features, as water retention and moisture intervals at different sucking forces; such features are primarily linked to the absorbing capacity of organic matter and to the porosity and its distribution between micro- and macroporosity.

While there may be debate about the actual nature of the soil improvements and the mechanisms whereby soil properties are affected, there is no doubt that high organic matter levels are generally associated with ease of soil management, better crop establishment and plant growth. Compost is a ‘living’ material and can only increase the density and diversity of the soil and microbiological populations which seem to be associated with increased productivity of the soil.

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[84] European Commission (2012) Agriculture and soil protection webpage. Available at: http://ec.europa.eu/agriculture/envir/soil/index_en.htm

[85] D. S. Jenkins (1991) The Rothamstead Long-term Experiments: Are They Still of Use? *Agronomy Journal* 83.

It is clear that in practice one of the most important reasons why farmers are, and will, in future, be using compost is to improve soil structure, and it is therefore important this effect is studied in greater depth. The effect needs to be quantitatively measured in order to make recommendation on how to make the best use of compost for this purpose.

It is also worth mentioning that codes of practice for organic farming stress the need to compost the organic matter in order to both stabilise it (thus avoiding any undesired side-effect related to oxygen uptake and release of phytotoxic compounds during mineralisation) and to activate its biological diversity.

10.5.1.5 Reduced Requirements for Soil Liming from Compost Application

One of the effects of compost on soil is to act as a buffer against changing pH of the soil. One typical remedy for falling pH is to apply lime to the soil. Lime is occasionally acquired as a by-product of industrial processes but more typically it is a product of mining. The effect of compost, therefore, may be to avoid the extraction of lime and to reduce farmers' expenditures on lime.

Applications of green waste compost in trials at the Henry Doubleday Research Association (at rates to supply 250, 500 and 750 kg N/ha) were found to raise pH from 6.5 to between 6.8 and 7.4, with the highest pH resulting from the highest rate of compost application (supplying 750 kg N/ha). This precluded the use of lime to maintain pH in this trial.[86]

Pot trials assessing performances of compost versus traditional peat-based growing media, have shown that compost has a much higher buffer capacity e.g. versus alkaline waters that tend very often to raise pH, causing a reduction in growth, flowering, and so on.[87] This effect is linked to the higher cation exchange capacity (per unit volume) of compost as opposed to peat, whilst the cation exchange capacity per unit weight tends to be quite similar.

10.5.1.6 Reduced Susceptibility to Soil Erosion from Compost Application

The condition of the soil surface determines whether rainfall infiltrates the soil or simply runs off. Soil therefore regulates, and partitions water. When water runs off land, it tends to carry soil particles. This results in costs to farms in terms of lost productivity, and off-farm impacts such as damage to commercial and recreational fishing, increased pressure on water treatment facilities, increased flood damages and requirement for repairs from redredging damaged waterways.

Compost improves soil quality and increases the capacity to hold moisture which, all things being equal, should help to reduce the amount of run-off and hence erosion. However, the degree to which compost reduces any risks, and associated costs, of

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[86] L. Jackson, personal communication, based on series of reports, *Researching the Use of Compost in Agriculture 1997-2001*, HDRA Consultants

[87] E. Favoino and M. Centemero (1995), Impiego di compost nella vivaistica: esperienze applicative svolte nel corso del 1994; in attachment to *Notiziario della Scuola Agraria del Parco di Monza*, May 1995

flooding would be difficult to discern in anything other than a location-specific context (and the costs would have this character also).

It is increasingly recognised that off-farm costs of soil erosion are probably greater than on farm ones. The off-farm costs associated with soil erosion in the US due to waterways alone were estimated at $2-$17 billion.[88] In the UK, a 1996 study estimated soil erosion impacts at between £23.8 - £50.9 million (1991 prices) with off-farm losses responsible for as much as 80% of this figure.[89] Defra's Soil Strategy for England put the cost of soil degradation at about £206-£315 million per year, but recognised that this was probably an underestimate.[90]

A more recent study updated this estimate, noting that, for England and Wales, soil degradation costs that can be quantified in money terms range between £0.9bn and £1.4bn per year, with a central estimate of £1.2bn.[91] About 45% of total quantified annual soil degradation costs are associated with loss of organic content of soils, 39% with compaction and 13% with erosion.

In future, severe storms may generate the bulk of soil erosion losses, and this may be a possible 'positive feedback' associated with global warming. Air-borne soil particles may also have impacts on human health, and their presence could be reduced through greater use of organic matter to bind soil into stable aggregates. Management factors play a role in reducing erosion, but so also does the soil texture and organic matter content.

It is difficult (for obvious reasons) to estimate the incremental reduction in soil erosion associated with applications of compost. However, given the costs associated with soil erosion, the potential benefits associated with reduced soil erosion through application of compost may be significant.

10.5.1.7 Bioremediation of Soil Using Compost

Compost and the composting process can be used successfully in the bioremediation of contaminated soils. In-situ remediation is commonly used whereby compost is deployed essentially as an inoculant to the contaminated soil, providing the microorganisms which break down the contaminants. This form of bioremediation is not suitable for all contaminants, but it has been proven to be successful in treating

[88] National Research Council (1989) Problems in US Agriculture, in *Alternative Agriculture*, Washington DC: National Academy Press; M. Ribaudo (1989) Water Quality Benefits from the Conservation Reserve Programme, *Agricultural Economic Report No.606*, Washington DC: USDA Economic Research Service; D. Pimentel, C. Harvey, P. Resosudarmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, L. Fitton, R. Saffouri and R. Blair (1995) Environmental and Economic Costs of Soil Erosion and Conservation Benefits, *Science* 267 (5201): pp.1117-1123

[89] R. Evans (1996) *Soil Erosion and its Impact in England and Wales*, London: Friends of the EarthTrust

[90] Department for Environment Food and Rural Affairs (2009) *Safeguarding our Soils: A Strategy for England*, 2009

[91] Cranfield University (2011) *Cost of Soil Degradation in England & Wales*, Report for Department for Environment Food and Rural Affairs, 30 June 2011

soils that have been contaminated with, for example: hydrocarbons, aromatic compounds, and aliphatic compounds.[92]

10.5.1.8 Micronutrients and Compost Application

Compost can provide a broad spectrum of nutrients; both macronutrients and micronutrients such as S, Mg, Ca, Fe and Zn. Conventional fertilisers provide merely the basic macronutrients (such as N, P and K), neglecting the minor elements beneficial to plant growth. There may also be links here to the presence of micronutrients in dietary uptake. These are important in the functioning of the endocrine system in humans.

10.5.1.9 Displacement of Peat Use by Compost

The primary losses to the environment through peat extraction are:

- Loss of biodiversity;
- Loss of landscape and recreational value;
- Loss of palaeoecological and archaeological value; and
- Increased carbon emissions and loss of carbon reservoirs

Many rare and protected species thrive in Europe's peatlands and bogs. The bog moss *Sphagnum imbricatum* is entirely restricted to bogs and is the principal peat forming species in oceanic peatlands. It is becoming increasingly rare as more sites are being developed. There is also the loss of rare and unique plants which have potential medicinal properties.

In Europe areas of peatlands and bogs have a cultural importance as some of the last true remaining wilderness areas. They attract visitors for this reason. Travel-cost and contingent valuation studies capture consumer surplus associated with, and preferences for, respectively, the continued existence of these landscapes. One study translates values for the Somerset Levels into a value of £7,245 per hectare.[93] Another study estimated a preservation value of £68.4 million, or £4.1 million per annum using a 6% discount rate.[94]

Compost derived from organic waste can displace the use of peat-based composts in a range of applications.

[92] Arcadis and Eunomia Research & Consulting (2009) *Assessment of the Options to Improve the Management of Bio-waste in the European Union*, Report for European Commission DG Environment, November 2009

[93] K. Willis, G. Garrod and C. Saunders (1993) *Valuation of the South Downs and Somerset Levels and Moors Environmentally Sensitive Landscapes by the General Public*, Report to MAFF, Newcastle-upon-Tyne: Centre for Rural Economy. This is the interpretation of the original study from Alan Ingham (1996) *The Use of Economic Instruments to Protect Raised Lowland Peatbogs*, Report to Royal Society for Protection of Birds, Department of Economics, University of Southampton

[94] N. Hanley and S. Craig (1991) The Economic Value of Wilderness Areas, in F. Dietz, F. Van der Ploeg and J. van Straaten (1991) *Environmental Policy and the Economy*, Amsterdam: North Holland

10.5.1.10 Waste to Land Contamination

The application of waste products to land, such as farmyard manure, sewage sludge and organic materials from industrial processes can have many agricultural and environmental benefits if they are well managed and the appropriate amounts of organic waste applied. However, if they are not well managed they may have adverse effects such as:[95]

- an accumulation of toxic components of waste in the soil, e.g. trace metals;
- a risk of (soil) biodiversity decline;
- unhealthy plant growth caused by unbalanced nutrient supply;
- the potential for water eutrophication through nutrient transfer from soil; and
- the potential for increased production of greenhouse gases to the atmosphere.

10.5.1.11 Leachate from Landfills

Leaching occurs when soluble components are dissolved (leached) out of a solid material by percolating water. Leaching may also carry insoluble liquids (such as oils) and small particles in the form of suspended solids.[96] Landfill leachate is a potentially polluting liquid, which unless managed and/or treated, and eventually returned to the environment in a carefully controlled manner, may cause harmful effects on the soils that surround a landfill site.

The quality of leachate is determined primarily by the composition and solubility of the waste constituents. This is particularly the case in landfills that contain non-hazardous local authority collected waste. Landfills may produce leachate that has elevated concentrations of contaminants, such as ammoniacal nitrogen, heavy metals and organic compounds. Even inert waste landfills can, if not managed correctly, generate uncontrolled run-off, which could contain high loads of suspended solids that could affect soil quality. While there is a regulatory framework in place to address such matters, the risk remains.

10.5.1.12 Recovery of Soil from Construction, Demolition and Excavation Waste

In 2005, over 4 million tonnes of soil were recovered from construction, demolition and excavation waste.[97] Some of this screened soil is sold as an alternative to natural topsoil for use in landscaping developments.

However, it is often a mixture of topsoil, subsoil, clay and numerous fragments of building waste materials – brick, concrete, mortar, ash, clinker and, to a lesser extent, glass, metal, wood and plastic. In terms of its physical and chemical properties, the

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[95] SEPA (2012) Threats to Soil Quality webpage. Available at: http://www.sepa.org.uk/land/soil/threats_to_soil_quality.aspx

[96] Environment Agency (undated) Guidance on monitoring of Landfill Leachate, Groundwater and Surface Water. Available at: http://www.environment-agency.gov.uk/static/documents/Business/report_1_533191.pdf

[97] Department for Environment Food and Rural Affairs (2009) *Soil Strategy for England: Supporting Evidence Paper*, 24 September 2009

material may often be extremely alkaline, saline, infertile, and contain elevated levels of chemical contaminants (heavy metals and hydrocarbons) and 'sharps', e.g. shards of glass or ceramics.

While the use of such material as topsoil avoids the need to use natural topsoil, the contamination could lead to a negative impact on surrounding soil.

10.5.2 Summary

Moves towards the top of the waste hierarchy would appear to lead to beneficial effects on soils. Key among these is the positive indirect (and often overseas) impacts arising from food waste prevention, and textile reuse. Recycling of organic waste and the subsequent application of compost to land would also appear to lead to a number of environmental benefits. At the bottom end of the hierarchy, continuing disposal in landfill poses a number of threats to soil quality.

10.6 Material Assets

In this section we introduce the concept of Total Material Requirement (TMR), which is an economy-wide measure of material flows, reflecting all of the physical materials[98] that are mobilized each year to support an economy.[99] . The 'Material Intensity Factors'[100] of a number of different materials are then shown, in order to demonstrate how savings in material flows can arise from waste prevention (including reuse) and recycling, thus reducing TMR. The application of such an approach is likely to become more widespread in future years, as the European Commission develops indicators on resource efficiency.[101]

10.6.1 Total Material Requirement

The extraction of virgin materials requires the movement and mobilisation of matter that is incidental to the recovery of the economically valuable product – i.e. when mining for a material e.g. iron, other materials are necessarily extracted in order to reach and extract the desired material. Often these incidental flows of matter – hidden material flows - can be of tremendous environmental significance. They can disturb natural habitats, destroy both flora and fauna, mobilise heavy metals into the water system and in the case of mining activities release greenhouse gases. Such impacts are frequently excluded from conventional environmental assessment work because they are difficult to quantify and do not always vary linearly with the amount of material extracted.

Hidden material flows are significant to the appraisal of waste management options because a reduction in material use, or the substitution of recycled material for virgin material, causes a reduction in the amount of virgin material extracted for every

[98] Including 'hidden' non-economic materials such as mineral overburden, processing waste and soil erosion

[99] See http://www.un.org/esa/sustdev/sdissues/consumption/cpp1224m9.htm

[100] This is a micro-level indicator, which indicates the impact per unit of material used.

[101] European Commission Directorate - General for Environment (2012) *Consultation Paper: Options for Resource Efficiency Indicators*

tonne of product that is used. As a result, waste prevention and recycling, will generally reduce not only the consumption of the primary material, but also an amount of hidden material flows otherwise caused by primary material consumption. In this assessment, this is used as an indicator of land disturbance and as a proxy for impacts upon biodiversity.

The types of perturbations that make up 'hidden material flows' include disruption to the land surface from the excavation during mining or forestry, soil erosion due to the reduction in vegetation cover, and lifting of soil / stone during the extraction of ores. Using the terminology used by the Wuppertal Institute[102] these impacts can be broken down into the following categories:

Ancillary material flow. This is the matter bound to the material of economic value that is extracted alongside the material and removed from the environment. It is released from the material during processing of the material. Examples of ancillary material include the components of a metal ore is that are discarded after the pure element has been refined, or the bark and brash from trees felled for timber.

Excavated material flow. This is the matter that is physically displaced from the extraction process but not transported away from the site of extraction. For instance, in an open cast mine, topsoil and earth are lifted from the excavation site to reveal the ore-bearing seam. Excavated material flows also include soil erosion arising from the loosening of soil structure caused by digging and clearance of vegetation.

Hidden material flow. This is the sum of ancillary and excavated material flows and represents the non-economic flows of material arising from the extraction of valuable products.

Direct material inputs. These are the desired and economically important materials recovered from the extraction, forestry, fisheries and agricultural activities (the last two not being relevant to this study).

Total material requirement. This is the sum of the hidden and direct material inputs and therefore comprises the total quality of material that is mobilised by an economy.

By convention total material requirement analysis measures all material flows in terms of their total mass. Note that the term direct material is taken to mean the material that is actually traded within the economy prior to its processing into a finished good. In the case of paper this would be the timber that is sold to the pulp mills. The finished good is the paper itself.

The latest edition of the UK's Environmental Accounts indicates that TMR for the UK decreased by 5.4 per cent, from 1,707 million tonnes in 2009, to 1,615 million tonnes in 2010, the lowest level since records began in 1970. Indirect flows account for the largest proportion of TMR, accounting for 56.1 per cent in 2010. This was largely driven by a fall in imports of fossil fuels by 121 million tonnes, partly offset by

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[102] Adriaanse, Albert, Stefan Bringezu, Allen Hammond, Yuichi Moriguchi, Eric Rodenburg, Donald Rogich, and Helmut Schütz (1997). Resource Flows. The Material Basis of Industrial Economies. Washington: World Resource Institute.

an increase in imports of both minerals and biomass by 6 million tonnes and 15 million tonnes respectively.[103]

10.6.2 Material Intensity Factors

Material Intensity (MIT) Factors are measured in units of kg/kg used (i.e. the total material input for each kg of product). The MIT of a number of different products is presented in Table 18 listed according to the five input categories of the material input per unit of service (MIPS) concept, namely:

- Abiotic raw material, e.g.;
    - mineral raw materials (used extraction of raw materials such as ores, sand, gravel, slate, granite);
    - fossil energy carriers (amongst others coal, petroleum oil, petroleum gas;
    - unused extraction (overburden, gangue etc.),
    - soil excavation (e.g. excavation of earth or sediment);
- Biotic raw material, e.g.;
    - Plant biomass from cultivation;
    - Biomass from uncultivated areas (plants, animals etc.);
- Water (used for processing and cooling);
- Air used for combustion, chemical and physical transformation; and
- Earth movement in agriculture and silviculture (forestry), both
    - Mechanical earth movement; and
    - Erosion.

Table 18 shows that the production of materials from the primary raw materials typically leads to much higher MIT factors than where manufacture is from the corresponding secondary materials. The left hand column indicates whether materials are primary or secondary, whilst the other columns indicate the materials used in the production of each.

[103] Office for National Statistics (2012) *UK Environmental Accounts 2012*, 27 June 2012. Available at: http://www.ons.gov.uk/ons/rel/environmental/uk-environmental-accounts/2012/stb-ukea-2012.html

Table 18: Material Intensity Factors (kg/kg used)

Material	Abiotic Raw Material	Biotic Raw Material	Water	Air	Earth Movement in Agriculture and Silviculture
Primary Aluminium	37.00		1,047.70	10.87	
Secondary Aluminium	0.85		30.74	0.95	
Primary Copper	348.47		367.16	1.60	
Secondary Copper	2.38		85.51	1.32	
Steel (rebar, wire rod, engineering steel, blast furnace route*)	8.14		63.67	0.44	
Steel (rebar, wire rod, engineering steel, electric arc furnace route**)	1.47		58.76	0.52	
Primary Container Glass	3.04		17.06	0.72	
Secondary Container Glass (53% cullet) (i.e. 53% recycled material)	1.72		13.36	0.58	
Secondary Container Glass (88% cullet) (i.e. 88% recycled material)	0.87		10.93	0.48	
Cotton	8.60	2.90	6,814.00	2.74	5.01
Polyester	8.10		278.00	3.73	
Note: * Blast furnace production is typically used in the primary production of steel ** Electric arc production typically makes use of recycled content					

Source: Wuppertal Institute (2011) Material intensity of materials, fuels, transport services, food. Available at http://www.wupperinst.org/uploads/tx_wibeitrag/MIT_2011.pdf

10.6.3 Summary

Material flows can be of tremendous environmental significance. They can disturb natural habitats, destroy both flora and fauna, mobilise heavy metals into the water system and in the case of mining activities release greenhouse gases.

As can be seen in Table 18, recycled materials (the secondary materials in the table) tend to have lower material intensity factors than primary materials. While the relative material intensity may not always accurately reflect the environmental impacts (due to different approaches to extraction, for example), all things being equal, one would expect a reduced environmental impact to follow from a lower material intensity.

Waste prevention measures, including reuse should lead to even greater material savings than for recycling, as impacts associated with secondary manufacture will be avoided.

While preparation for reuse by definition may involve further checking or repair of items, this is unlikely to detract significantly from the benefits associated with direct reuse, as much of the work involved will be labour intensive rather than materials intensive.

10.7 Water

Interactions between waste management and impacts on water resource and quality can broadly be classified into direct & indirect impacts. Direct impacts are often site-specific, and can include the abstraction of water for incineration, composting and anaerobic digestion, and potential adverse impacts on water quality associated with poor management of leachate from landfill and other (e.g. composting) facilities. Direct, positive impacts include the benefits associated with the application of compost, derived from food and garden waste, to agricultural land which can improve water retention through improved soil structure, leading to a reduced requirement for irrigation. The use of compost as mulch will also act to reduce water losses and therefore irrigation requirements. There may also be a reduction in flood risk if improved soil quality translates into increased porosity of soil, and a reduction in the potential for leaching of nitrates (which if derived from compost are also less readily available, being bound to organic matter, than if from conventional fertilisers).

Indirect impacts on water, often associated with overseas supply chains, relate to the avoided requirements to use water in primary production of materials as a result of undertaking waste prevention, reuse and recycling. A key example provided below is textiles, where reuse can have a potentially significant impact in reducing requirements for water use, often in countries, such as Pakistan and India that are defined as 'water stressed'.[104]

Food waste prevention likewise presents significant opportunities for reducing impacts on water, with much of the potential benefit occurring overseas. Recycling of other materials such as steel and paper also lead to reduced requirements for water (compared with primary manufacture, and reduced impacts on water quality).

10.7.1 Water Savings from Textiles Reuse and Recycling

There appears to be considerable potential, through reuse, preparation for reuse, and indeed recycling (to a lesser extent) of textiles and clothing, to reduce the impact on

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[104] URS Infrastructure & Environment UK Limited (2012) *Review of Data on Embodied Water in Clothing: Summary Report*, Report for WRAP, 16 July 2012

water. A recent study for WRAP estimates the total water footprint of clothing used in the UK in one year to be 6,300 Mm^3 (million cubic metres) of water, based on annual clothing use of 2.49 million tonnes (comprising 1.14 million tonnes of new clothing, and 1.35 million tonnes of existing clothing).[105]

On a per tonne basis, the water footprint is 2,534 m^3 for every tonne of clothing used in one year.[106] This comprises 2,202 m^3/tonne at the raw materials stage, 318 m^3/tonne at the processing and manufacturing stage, 0.01m^3/tonne for transport and distribution and 15 m^3/tonne from the consumer in-use stage. This same study assumed that there is minimal water use associated with the disposal of waste clothing, although the report presents no evidence to back up this assertion. Accordingly, the direct impact of waste management on the water footprint was scoped out of the study. The total water footprint (not accounting for direct waste management impacts) associated with clothing in the UK, is shown in

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For the UK, and hence for England, the vast majority of the impacts related to clothing occur overseas, with 87% of the water footprint related to UK clothing consumption being accounted for by production (cultivation/rearing) and extraction of raw materials. Of this, the cultivation of cotton accounts for 45%, silk 23% and viscose 11% (based on the fibre split for the UK).[107]

Accordingly, while there may be a relatively small impact associated with disposal, the potential for avoiding impacts relating to raw materials and manufacture, especially through prevention and reuse, is considerable. There are, however, indications that the low cost of some clothing is transforming these items into a disposable commodity.

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[105] URS Infrastructure & Environment UK Limited (2012) *Review of Data on Embodied Water in Clothing: Summary Report*, Report for WRAP, 16 July 2012

[106] This includes the water used by the consumer in washing items of clothing over a year.

[107] URS Infrastructure & Environment UK Limited (2012) *Review of Data on Embodied Water in Clothing: Summary Report*, Report for WRAP, 16 July 2012

Table 19: Total Water Footprint for UK Clothing

Fibre Type	%	UK Clothing Use (tonnes)	Water Footprint (WF)/m³				Total (Mm³)	Individual WF per Fibre Type (m³/tonne)	Share of Total WF (m³/tonne)
			Raw Materials	Processing and Manufacture	Transport	UK Consumer			
Cotton	43%	1,070,010	2,806,908,540	493,964,256	5,135	15,611,697	3,316	3,099	1,333
Wool	9%	223,956	444,834,463	52,975,738	3,161	3,267,565	501	2,237	201
Silk	1%	24,884	1,423,123,949	23,580,664	509	363,063	1,447	58,153	582
Flax/Linen	2%	49,768	94,351,009	7,788,438	224	726,125	103	2,067	41
Viscose	9%	223,956	709,611,213	144,552,699	1,069	3,267,565	857	3,829	345
Polyester	16%	398,143	39,637	25,267,560	1,766	5,809,004	31	78	13
Acrylic	9%	223,956	22,296	25,357,289	994	3,267,565	29	128	12
Polyamide	8%	199,072	19,819	12,633,780	883	2,904,502	16	78	6
Polyurethane / Polypropylene	3%	74,652	7,432	4,737,668	331	1,089,188	6	78	2
Total		**2,488,396**	**5,478,918,358**	**790,858,091**	**14,073**	**36,306,273**	**6,306**	**2,534**	**2,534**

Source: URS Infrastructure & Environment UK Limited (2012) Review of Data on Embodied Water in Clothing: Summary Report, Report for WRAP, 16 July 2012

10.7.2 Water Savings from Food Waste Prevention

The water footprint of avoidable food waste is 6,200 million m^3 per year, representing nearly 6% of the UK's total annual water footprint of 102,000 million m^3.[108] In per capita terms this is 243 litres per person per day, approximately one and a half times the daily average household water use in the UK. A large part (71%) of the avoidable food waste in the UK is from imported products, and much of the impact occurs in countries experiencing considerable 'water stress', such as Egypt, Israel, Spain, Pakistan, India and Thailand .[109] As the water footprint of food waste, as reported[110], relates entirely to the upstream impacts (i.e. is not affected by alternative waste treatment/disposal routes), it would appear that food waste prevention offers considerable scope for reducing impacts.

10.7.3 Water Savings from Recycling

The British Metal Recycling Association states that recycling of steel leads to a 40% reduction in water use, and a 76% reduction in water pollution.[111]

The Bureau of International Recycling states that recycling one tonne of paper avoids the use of 26 m^3 of water, and reduces water pollution by 35%.[112]

The recycling of one tonne of aluminium is reported by an industry organisation to save 15,000 litres of cooling water and 860 litres of processing water relative to primary production.[113] It is important to note that the report focuses exclusively on the savings associated with processing, but recycling also avoids the extraction of bauxite, which typically occurs through strip mining, which can have negative effects on water quality.

10.7.4 Impacts on Water from the Application of Compost in Agriculture

Studies have indicated that the application of composted products can enhance water use efficiency by improving infiltration and storage in the root zone and reducing deep drainage, run-off, and evaporation, and water use by weeds. The beneficial effects of compost application arise from improvements in soil physical and chemical properties.[114]

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[108] Chapagain, A. and James, K. (2012) *The Water and Carbon Footprint of Household Food and Drink Waste in the UK*, Report for WRAP, 1 March 2012

[109] Chapagain, A. and James, K. (2012) *The Water and Carbon Footprint of Household Food and Drink Waste in the UK*, Report for WRAP, 1 March 2012

[110] Chapagain, A. and James, K. (2012) *The Water and Carbon Footprint of Household Food and Drink Waste in the UK*, Report for WRAP, 1 March 2012

[111] http://www.recyclemetals.org/about_metal_recycling

[112] http://www.bir.org/industry/paper/

[113] European Aluminium Association and the Organisation of European Aluminium Refiners and Remelters (2005) *Aluminium Recycling: The Road to High Quality products*, 2005. Available at: http://www.oea-alurecycling.org/de/verband/oea_eaa_aluminium_recycling.pdf

[114] A. Shiralipour, D. B. McConnel and W. H. Smith (1992) Physical and Chemical Properties of Soils as Affected by Municipal Solid Waste Compost Application, Biomass and Bioenergy 3(3-4): 261-266; S.A.R. Movahedi Naeini and H. F. Cook (2000) Influence of Municipal Compost on Temperature, Water,

As organic matter decays to humus, the humus molecules bind mineral components of the soil (such as particles of sand, silt, and clay) and organic matter into water stable aggregates and improve soil porosity and soil structure. Due to the aggregate stability and improvements in soil structure, the application of composted soil conditioner reduces surface sealing, improves infiltration and the water holding capacity thus reducing runoff generation.

These aggregates are also effective in holding moisture for use by plants. In addition, humus molecules can absorb and hold large quantities of water. Therefore, the addition of composted soil conditioner may provide greater drought resistance and more efficient water use, reducing the requirement for irrigation water. Increased porosity and decreased soil compaction may also result in increased root penetration, resulting in deeper and more elaborate root systems to explore a larger soil mass for moisture and nutrients. Increased root exploration and water holding capacity can also reduce deep drainage below the root zone, resulting in reduced nitrate leaching. Low nitrate leaching can reduce eutrophication of water resources.

Use of composted mulch in cropping lands can also significantly increase the water use efficiency by lowering the evaporation losses from soil surface. Mulching reduces radiation and wind speed at the surface and hence reduces the water evaporation from soil surface. Researchers have reported that surface application of mulch has resulted in reduction of between 30–70% of irrigation water required by crops due to the reduction of water evaporation from soil surface.[115] Buckerfield and Webster showed that, in South Australia, the surface application of organic mulches to vineyard soils resulted in a 34% increase in soil moisture content and an increase in grape yield.[116] Whilst some of these figures are derived from more arid zones, they are likely to be of increasing relevance in the UK, especially if changes in rainfall patterns lead to increased prevalence of drought in some parts of the UK. This reduced evaporation offers obvious benefits for irrigated agriculture.

To the extent that compost application increases water holding capacity, it results in a reduction in leaching and irrigation water requirements. As a consequence, water extractions from natural waterways may be reduced leading to increased water flows and improved water quality in natural river systems, potentially reducing negative impacts on biodiversity from reduced flow rates in riparian environments. Moreover, reduced leaching may result in reductions in eutrophication and induced salinity, and

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Nutrient Status and the Yield of Maize in a Temperate Soil. Soil Use and Management 16:215-221; L. M Bresson, C. Koch, Y. Le Bissonnais, E. Barriuso and V. Lecomte (2001) Soil Surface Structure Stabilization by Municipal Waste Compost Application. Soil Sci. Soc. Am. J. 65:1804-1811; J. Albaladejo, V. Castillo and E. Diaz (2000) Soil Loss and Runoff on Semiarid Land as Amended with Urban Solid Refuse, Land Degradation & Development 11: 363-373; M. Agassi, A. Hadas, Y. Benyamini, G. J. Levy, L. Kautsky, L. Avrahamov and H. Zhevelev (1998) Mulching Effect of Composted MSW on Water Percolation and Compost Degradation Rate. Comp. Sci. Util. 6(3): 34-41

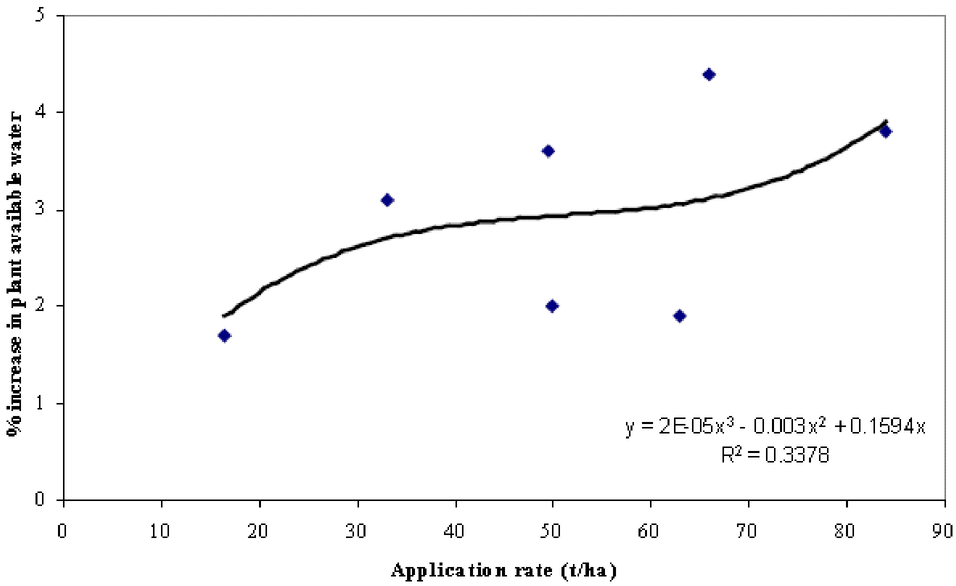
[115] A. M. Abu-Awwad (1998) Effect of Mulch and Irrigation Water Amounts on Soil Evaporation and Transportation. J. Agron. Crop Sci. 181: 55-59; A. M. Abu-Awwad (1999) Irrigation Water Management for Efficient Use in Mulched Onion. J. Agron. Crop Sci. 183: 1-7

[116] J. C. Buckerfield and K. A. Webster (1995) Earthworms, mulching, soil moisture and grape yields: earthworm response to soil management practices in vineyards, Barossa Valley, South Australia. Australian and New Zealand Wine Industry J. 11:47-53

possibly also to reduced silting.[117] In addition, increased water holding capacity of soil can reduce stresses due to soil moisture deficits, leading to higher crop yields.

On the basis of a literature review, one study has sought to plot relationships between compost applications as soil improvers (Figure 6) and mulches (Figure 7) on soil moisture content in the 0-15 cm layer.[118] This was used to estimate the quantity of water saved through the application of compost. If the same relationships are assumed then it could be assumed that an application rate of 20 tonnes per hectare fresh matter would deliver a 2% increase in plant available water.

Figure 6: Effect of Compost Used as a Soil Conditioner (0-15cm layer)



Source: G. Sharma and A. Campbell (2003) Life Cycle Inventory and Life Cycle Assessment for Windrow Composting Systems, Report for Recycled Organics Unit, University of New South Wales and NSW Dept. for Environment and Conservation, October 2003

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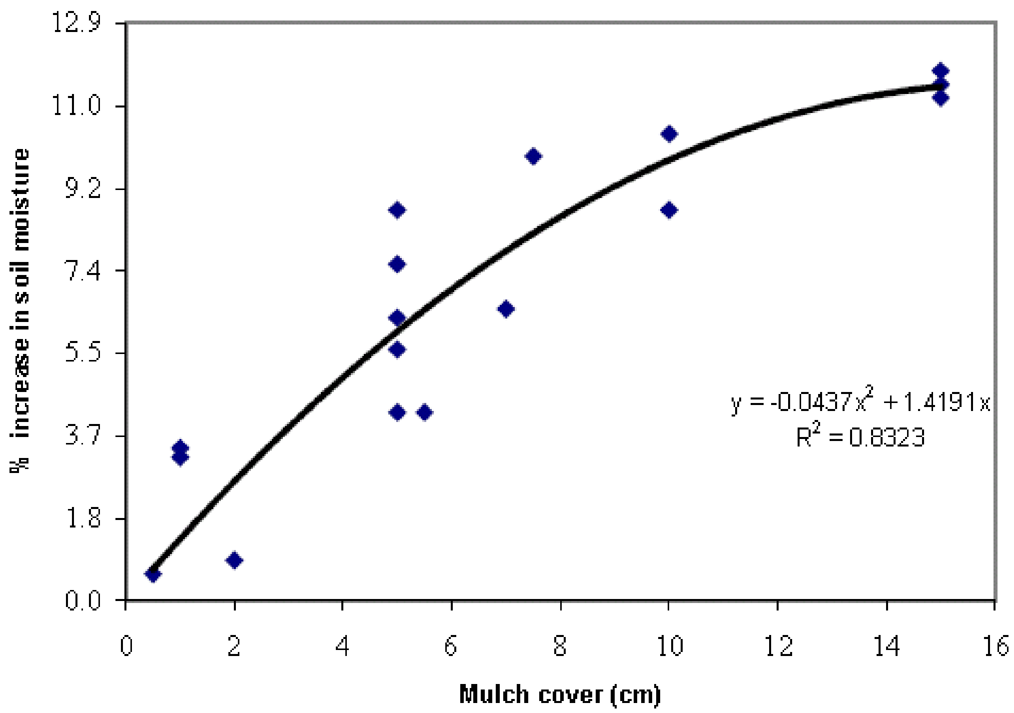
[117] See http://www.snh.org.uk/publications/on-line/advisorynotes/14/14.htm

[118] G. Sharma and A. Campbell (2003) Life Cycle Inventory and Life Cycle Assessment for Windrow Composting Systems, Report for Recycled Organics Unit, University of New South Wales and NSW Dept. for Environment and Conservation, October 2003

Figure 7: Effect of Compost Used as Mulch on Soil Moisture (0-15 cm layer)



Source: G. Sharma and A. Campbell (2003) Life Cycle Inventory and Life Cycle Assessment for Windrow Composting Systems, Report for Recycled Organics Unit, University of New South Wales and NSW Dept. for Environment and Conservation, October 2003.

A study undertaken by Defra suggested that where irrigation is applied, it is applied at a rate of 131,300,000 m^3 over an area of 147,270 ha. In dry years, the figures are estimated at 439,470,000 m^3 over 282,960 ha.[119] An average of these figures gives an estimated 1,222 m^3 of water used per hectare. The Defra study assumed that the application of compost reduces this figure by 2%, or 24 m^3. However rain water was assumed to supply some of the plant available water. If this is assumed to be 60% of the total, then the 2% increase in availability implies a reduced demand of 61 m^3 of water (corresponding to a reduced water requirement of 5%).

The application of compost in agriculture clearly leads to benefits in respect of both the quantity of irrigation water required, and in terms of the quality of local water courses, by reducing run-off.

10.7.5 Reduced Risk of Flooding from Compost Application

Compost improves soil quality and increases the capacity to hold moisture which, all things being equal, should help to reduce the risk of flooding. However, the degree to which compost reduces any risks, and associated costs, of flooding would be difficult to discern in anything other than a location-specific context.

[119] E. K Weatherhead and K. Danert (2002) Survey Of Irrigation Of Outdoor Crops in 2001 – England, Research for Defra's Climate Change and Demand for Water (CCDeW) project, October 2002

The issue of reduced flood risk is another area where benefits from compost utilisation could be high, and where they may (as with water savings) increase in value over time. However, there is at present a lack of strong evidence to identify the extent of this potential benefit.

10.7.6 Water Use in Incineration

Major water uses in incineration plants are:

- Gas scrubbing – particularly wet scrubbing;
- Ash discharge quench baths; and
- Evaporation from wet cooling towers.

Other uses include boiler water make up and wash down operations. The Environment Agency notes that: [120]

1. Dry scrubbing systems do not consume significant quantities of water, with only a little required for ash quench and conditioning;
2. Semi dry gas scrubbing typically consumes 250-350kg/tonne of waste incinerated;
3. Municipal waste incinerators using wet scrubbing can consume up to 850kg/tonne of waste incinerated, although this should be reduced by scrubber liquor recirculation.
4. The nature of wastes treated in hazardous waste incinerators means that higher levels of water consumption (up to 1100kg/tonne of waste) may be justified to ensure emissions to air are controlled.
5. Most chemical waste incinerators employ dry scrubbing and therefore consume relatively little water.
6. There is little data available for other incineration plant types. In general the more variable the waste feed (e.g. drum incineration) the greater the justification for the use of wet scrubbing techniques that have higher levels of water consumption if they are not of the closed loop type.

10.7.7 Leachate from Composting

The potential for leachate to be produced in significant quantities is dependent upon the nature of the process, most notably, whether it is enclosed or in-vessel. In enclosed facilities, it is perhaps more common for problems to arise in keeping the material moist rather than it producing excessive, and potentially problematic, leachate. Hence, leachate is commonly recirculated.

Komilis and Ham note, in their review, that varying amounts of leachate have reportedly been produced in MSW and garden waste composting facilities starting from 0 to approximately 490 litres / tonne.[121] They took the view that:

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[120] Environment Agency (2009) How to Comply with your Environmental Permit – Additional Guidance for: The Incineration of Waste (EPR 5.01). Available at: http://publications.environment-agency.gov.uk/PDF/GEHO0209BPIO-E-E.pdf

[121] Dimitris P. Komilis and Robert K. Ham (2004) Life-Cycle Inventory of Municipal Solid Waste and Yard Waste Windrow Composting in the United States, Journal of Environmental Engineering, Vol. 130, No. 11, November 1, 2004, p.1394

Given the limitations in the available data, this aspect of leaching emissions from MSW and yard wastes during and after composting was not included in this LCI. The LCI includes, however, all waterborne emissions associated with diesel and electricity pre-combustion and combustion processes.

Where biofilters are operated, some processes generate a liquid associated with the deployment of a heat exchanger on the exhaust air prior to its entering the biofilter. The rationale for this is to condense some of the compounds responsible for the generation of odours, so that the liquid contains some of the odorous emissions from the process.

Given the potential problems associated with maintaining moist conditions, the recirculation of leachate in the composting process may be beneficial. In addition, the recirculation can reduce issues associated with nitrogen in the leachate (though it might increase the rate of volatilisation of ammonia), and may make this available to the microbes giving rise to the degradation of material.

10.7.8 Leachate from Landfills

Leaching occurs when soluble components are dissolved (leached) out of a solid material by percolating water. Leaching may also carry insoluble liquids (such as oils) and small particles in the form of suspended solids.[122] Landfill leachate is a potentially polluting liquid, which unless managed and/or treated, and eventually returned to the environment in a carefully controlled manner, may cause harmful effects on the groundwater and surface water that surround a landfill site.

The quality of leachate is determined primarily by the composition and solubility of the waste constituents. This is particularly the case in landfills that contain non-hazardous local authority collected waste. Landfills may produce leachate that has elevated concentrations of contaminants, such as ammoniacal nitrogen, heavy metals and organic compounds. Even inert waste landfills can, if not managed correctly, generate uncontrolled run-off, which could contain high loads of suspended solids that could affect surface water quality and therefore such sites still require some monitoring of surface and groundwater quality.[123]

Evidently, the management of modern landfills is designed to avoid pollution incidents. However, such incidents are unlikely to be eliminated completely.

10.7.9 Impact on Water Quality from Waste Treatment Methods

One way in which impacts on water quality from waste management can be assessed is using life cycle assessment. We present below an assessment carried out by Eunomia on the basis of impacts associated with 1 tonne of residual waste sent to the following treatment facilities:

- Chineham incinerator, generating electricity only (Incin Elec C in the graphs);

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[122] Environment Agency (undated) Guidance on monitoring of Landfill Leachate, Groundwater and Surface Water. Available at: http://www.environment-agency.gov.uk/static/documents/Business/report_1_533191.pdf

[123] Ibid

- Dundee incinerator, generating electricity only (Incin Elec D);
- Billingham incinerator, generating electricity only (Incin Elec B);
- Coventry incinerator, generating electricity and heat (Incin CHP C);
- Grimsby incinerator, generating electricity and heat (Incin CHP G).

The Environment Agency WRATE model used for this assessment includes two categories of Mechanical Biological Treatment (MBT) process[124] – the "generic" process is modelled using data obtained through literature published on MBT processes – and the proprietary process (e.g. the Ecodeco process) is compiled using data provided by facility operators wherever possible. Alongside the two generic processes we have included two additional facilities within the analysis that follows:

- The Arrowbio Anaerobic Digestion-based MBT plant;
- The Ecodeco MBT facility (producing an SRF which is sent to the Chineham incinerator, generating electricity only).

In each case, the performance of the MBT and incineration facilities is compared to that of landfill.

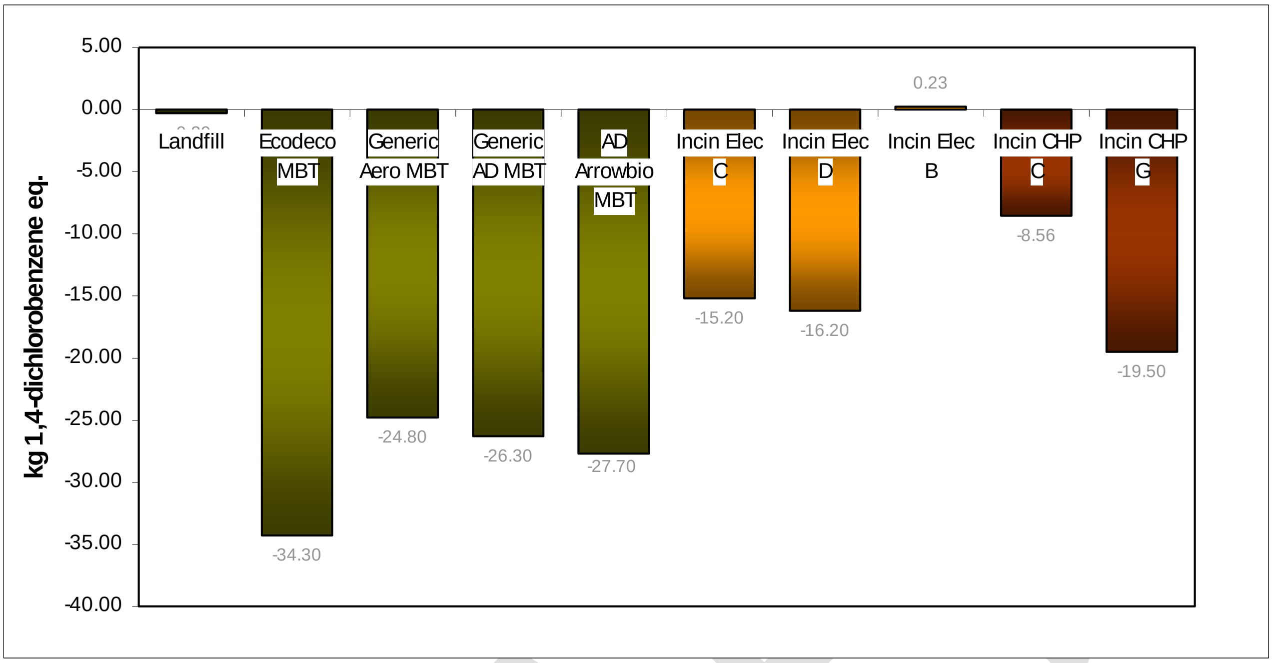
We report below using the default impact assessment method within WRATE the performance of technology options against the following criteria:

1. Freshwater Aquatic Eco-Toxicity; and
2. Eutrophication.

The Freshwater Aquatic Eco-Toxicity index is intended to measure the toxicity of a chemical to aquatic life. Impacts are also considered in terms of kg 1,4 dichlorobenzene equivalent.

[124] MBT processes treat residual waste, and involve a mechanical sorting stage where recyclable elements such as glass, paper, metals and plastics are removed, followed by a biological treatment stage for biodegradable elements which might typically involve composting. Alternatively a biodrying approach can be used to create a solid recovered fuel (SRF).

Figure 8: Freshwater Aquatic Eco-toxicity



The results are shown in Figure 8. In the Figure, a negative number indicates a net reduction in the level of pollution (because of the emissions which are avoided when either materials are recovered, or energy is generated). The results indicate that the MBT treatments are the most favourable options with regard to this assessment criterion whilst landfill and the Billingham incinerator perform worst.

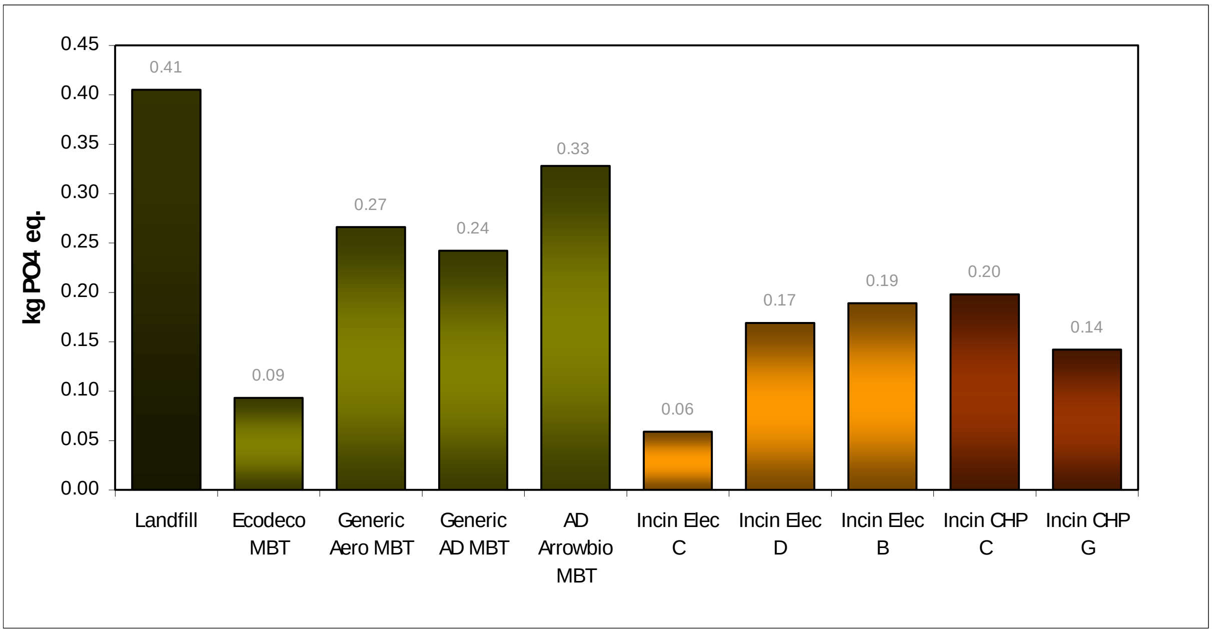
Closer inspection highlights the fact that this assessment is driven strongly by a small number of key factors. Using this assessment method, two influences exert a particularly strong effect:

- Avoided vanadium emissions to water as a result of recycling ferrous metal; and
- Emissions of copper to water from the landfilling of combustion residues.

The Eutrophication indicator measures the potential for pollutants to stimulate excessive plant growth through their release into water courses (principally nitrogen and phosphate). Impacts are considered in terms of kg PO_4 equivalent within the default assessment method.

The results displayed in Figure 9 indicate that the Arrowbio AD-based MBT facility is the least favourable option in terms of the Eutrophication assessment, and that the majority of MBT facilities (with the exception of the Ecodeco plant) fare less well than the thermal treatments.

Figure 9: Eutrophication (EP1992)



For the MBT treatment technologies, eutrophication impacts are assumed to be caused by ammonia emissions to water resulting from the landfilled fraction - there is a direct correlation between the amount of material sent to landfill and the performance of MBT systems against this assessment criterion. Of the MBT treatments considered here, the Arrowbio AD-based MBT facility has most material (69% of the initial mass) sent to landfill, as no part of the stabilised material is subsequently thermally treated. In contrast, the Ecodeco process sends only 16% of the input waste to landfill.

It is not entirely clear whether this modelling properly accounts for the reduction in nitrogen content that would occur as a result of the biological treatment part of the MBT process, although emissions of nitrogenous compounds are also assumed to occur during the treatment stage.

The different performance of the incineration facilities against this assessment criterion principally relates to atmospheric emissions of NOx from the plant.

Based on the evidence in this WRATE assessment it is not possible to state unequivocally that MBT is favourable to incineration in terms of impacts on water resources and quality, based on the two indicators used in the assessment (eutrophication and freshwater aquatic eco-toxicity). As is shown in Figure 8 and Figure 9 both MBT and incineration technologies exhibit variation in their impacts on eutrophication and freshwater aquatic eco-toxicity.

10.7.10 Summary

Direct impacts on water resource and quality are often site-specific, and can include the abstraction of water for incineration, composting and anaerobic digestion, and potential adverse impacts associated with poor management of leachate from landfill and other (e.g. composting) facilities. Direct, positive impacts include the benefits associated with the application of compost, derived from food and garden waste, to agricultural land which can improve water retention through improved soil structure, leading to a reduced requirement for irrigation. Indirect impacts on water, often associated with overseas supply chains, relate to the avoided requirements to use water in primary production of materials as a result of undertaking waste prevention, reuse and recycling.

10.8 Landscape

There is very little published evidence regarding the influence of waste management on landscape at a national scale. This is partly because landscape impacts have a local character. Impacts relate to siting decisions, and for waste management activity these are considered as part of the planning process at the local level. In the planning context, the impact of waste management on the surrounding landscape is taken into account in the development of local development frameworks and, for waste disposal sites, through Environmental Impact Assessment (EIA) through landscape and visual impact assessment (LVIA).

The significance of any landscape impact is dependent on a number of site specific issues, including, but not limited to:[125]

- Direct effects on landscape fabric, i.e. greenfield versus brownfield, removal of landscape features such as trees, hedges, buildings etc;
- Proximity of landscape designations;
- Site setting;
- Proximity of sensitive viewpoints;
- Presence of existing large, built structures;
- Existing landform and nature of existing landscape; and
- Presence/absence of screening features (trees, hedges, banks etc).

To put the impact on landscape of waste management facilities into some sort of context it is worth noting that within its main findings of a report entitled *Planning for Waste Management Facilities: A Research Study*, Defra concluded that:[126]

> *"While visual intrusion might be expected to be a significant issue for most or all kinds of waste management facilities, we did not find literature evidence to support this."*

As such, a summary within the report of the key environmental issues associated with different waste management activities did not include landscape or visual impact. This is in contrast to, for example, wind turbines, for which the impact on the landscape is by far the most dominant factor in determining community acceptance.[127] One of the reasons for the view that waste management does not exert such an impact may relate to the fact that many such facilities are in urban

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[125] ODPM (2004) Planning for Waste Management Facilities: A Research Study, August 2004. Available at: http://www.communities.gov.uk/archived/publications/planningandbuilding/planningwaste

[126] Defra (2004) Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes, March 2004. Available at: http://archive.defra.gov.uk/environment/waste/statistics/documents/health-report.pdf

[127] Wolsink, M (2007) Planning of renewable schemes: Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation, *Energy Policy*, Vol 35, Issue 5

locations, and have the character of general industrial use buildings. At the national level, relatively few facilities can be expected to create major concerns in respect of landscape (which is not to say that nothing can be done to reduce any impact that might arise).

As the Plan to which this Environment Report relates does not identify specific facility types, scales or locations for their setting it is not possible to assess in quantifiable terms the impact the Plan might have on the landscape. The intention in this section is, therefore, to discuss, at a strategic level, what waste management activities are likely to be prominent under the plan and the likely dimensions of facilities linked to these activities.

10.8.1 Impacts of Litter & Flytipping

Whilst the greatest impact on landscape is likely to come from those waste facilities of significant scale, there are also less direct impacts that should not be ignored from actions at a smaller scale. For example, an ineffective household waste collection infrastructure may lead to a greater prevalence of fly-tipping, which can, of course, impact on the surrounding landscape. In addition, policies that seek enforcement action aimed at reducing/eliminating such practice can be expected to have a positive impact on landscape amenity. Indeed a Mori poll undertaken in July 2007 found the public more concerned about litter than they were about climate change.[128] Furthermore, evidence suggests there may be a link between an absence of litter and a greater sense of pride in the character of communities, with potential indirect benefits in terms of neighbourhood regeneration.[129]

It should also be noted that there are interactions here between landscape impacts, this historic environment and biodiversity.

10.8.2 Scale of Key Waste Management Facilities

To enable some discussion around the impact of waste management facilities on landscape it is necessary to firstly get a feel for a sense of scale of the facilities that are likely to be included in delivering the Plan. Table 20 shows the principal waste management facilities, by broad typology, that are currently deployed in England, and those likely to play a continuing role in delivering the Plan, along with their key characteristics in terms of wider site area requirement, approximate building dimensions and lifetime of facilities.

It should be noted that in reality waste management sites/facilities vary according to local requirements, with two facilities rarely being the same. Thus this summary of facilities is necessarily high-level in nature and should be treated as an indicative means of comparing the impacts on landscape character in a relative sense. This summary will start with consideration of landfill, which is fairly unique in its characteristics when compared with other more 'enclosed' facilities.

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[128] http://www.cpre.org.uk/what-we-do/energy-and-waste/litter-and-fly-tipping/the-issues?qh=YTo1OntpOjA7czo2OiJsaXR0ZXIiO2k6MTtzOjk6ImxpdHRlcmluZyI7aToyO3M6ODoibGl0dGVyZWQiO2k6MztzOjc6IidsaXR0ZXIiO2k6NDtzOjg6ImxpdHRlcmVyIjt9

[129] State University System of Florida (1999) *The Florida Litter Study: Economic Impacts of Litter on Florida's Businesses*, report for the Florida Department of Environmental Protection

In terms of overall footprint landfills are by far the largest waste management facilities. Table 20 suggests that landfills tend to range from 5 to 50 hectares in size based on a yearly waste throughput of 250,000 tonnes. Landfill sites tend to be located where existing ‘void’ is available, such as mineral extraction sites. As such landfill sites tend to be located in rural areas.

Clearly there may be significant direct impacts on the landscape, with considerable changes to natural features.

An obvious indirect impact on landscape from landfill sites is litter (see above). This can be spread from poorly sheeted vehicles or purely from the surface of the landfill when windy. Whilst litter can be controlled through mitigation measures to a significant degree (e.g. waste compaction, use of daily cover, peripheral fencing, litter picking, buffer zones), it is estimated that around 8% of complaints regarding landfills are linked to litter (and although it is not known to what extent these complaints are linked specifically to landscape impacts, it seems reasonable to assume that many will be related to some form of perceived disamenity).[130]

For the remaining key waste facilities shown in Table 20 the fundamental characteristics are similar with respect to the principal impact on landscape. All involve a wider site area (up to 5 hectares), with building infrastructure taking up a significant footprint (ranging from 563m² for small scale anaerobic digestion to 7,200m² for large scale thermal treatment), corresponding building heights (from 4 to 30 metres, excluding stacks) with expected lifetimes in the 10 – 25 year range. The possible exception to this is open air windrow, which may not require building infrastructure. With such shared characteristics the impacts on landscape will be similar, though those of a larger scale are likely to have a proportionally greater impact. The following landscape impacts therefore refer to all of these facility types, with any further notable impacts for specific facilities being discussed.

[130] ODPM (2004) Planning for Waste Management Facilities: A Research Study, August 2004. Available at: http://www.communities.gov.uk/archived/publications/planningandbuilding/planningwaste

Table 20: 'Typical' Characteristics of Key Waste Management Facilities

Facility	Waste Treated (pa)	Typical Site Area (Hectares)	Building Footprint (Metres)	Building Height (Metres)	Expected Lifetime of Facility (Years)
Landfill	250,000	5-50	25 x 25 (gas treatment)	10 (gas treatment)	5 – 20
Thermal Treatment (small scale)	50,000	<1 – 2	80 x 40	15 – 25, stack 30 – 70	20 – 25
Thermal Treatment (large scale)	250,000	2 – 5	120 x 60	25 – 30, stack 60 – 80	20 – 25
MBT	50,000	1 – 2	100 x 30	10 – 20	20 – 25
Pyrolysis and Gasification	50,000	1 – 2	60 x 60	15 – 25, stack 30 – 70	20 – 25
Anaerobic Digestion (small scale)	5,000	0.15	30 x 15, plus 4 circular tanks at 6 – 10 diameter	7 (tanks 10)	25
Anaerobic Digestion (large scale)	40,000	0.6	40 x 25, plus 2 circular tanks at 15 diameter	7 (tanks 6)	25
In-vessel Composting	25,000	1 – 2	25 x 30	4 – 5	10 – 25
Open Air Windrow	25,000	2 – 3	None necessary	3 – 4 (if any)	20 – 25
Waste Transfer Station	120,000	0.7	70 x 30	12	20
Recyclables Processing Facility	50,000	1 – 2	70 x 40	12	20

Source: Adapted from ODPM (2004) Planning for Waste Management Facilities: A Research Study, August 2004 and Enviros (2009) Catalogue of Waste Treatment Facilities, May 2009

10.8.2.1 Landscape Impacts

For the largest waste management facilities, namely large thermal treatment plant, pyrolysis and gasification, it is unlikely that they could blend into the surrounding landscape unless sited within heavy industrial areas due to the boiler house elements of the plant and height of the stack (30 to 80 metres) and associated plume. Such is the potential scale of these sites that mitigation measures such as screening and cladding are of limited benefit and the design approach is therefore one of producing a building seen as a prominent landmark feature with sensitivity to the local vernacular.[131] These larger scale waste management facilities tend to be located closer to the areas of greater waste generation, i.e. urban centres.

This suggests that, other things being equal, and given that height of such features would appear to have the potential to impact negatively on landscape, fewer such facilities would lead to less intrusion on the landscape.

A number of the facilities in Table 20 tend to be housed in large warehouse type structures (i.e. waste transfer stations (WTS), recyclable processing facilities) or having a similar appearance (i.e. in-vessel composting (IVC) and mechanical biological treatment (MBT)). Such facilities, if sited in an industrial setting, remote from residential areas are likely to have minimal impacts on landscape.

With regards to the potential restoration of non-landfill waste facility sites to previous land-use (and therefore landscape character) this is less transparent than in the case of landfill. In some sensitive areas there may be planning conditions attached to the development requiring the site to be returned to its previous condition, though in practice this is unlikely given the economic cost of such restorative work. In reality the precedent set by affording the site consent to develop waste infrastructure and the need for future waste related infrastructure is likely to mean that the site is used for the same or similar use beyond the lifetime of the incumbent facility.

10.8.3 Summary

In conclusion the impacts of waste management activities on landscape are not expected to be significant at the national level. There are, however, likely to be impacts at the local level, most prominently where new large-scale facilities are to be developed.

10.9 Cultural Heritage & the Historic Environment

The impacts of waste management activities on the historic environment will primarily be on tangible assets such as buildings, monuments and landscapes although some impacts on subterranean archaeological sites could potentially be experienced. There are, therefore, likely to be strong overlaps with the landscape impacts described in Section 10.8 and these are not, therefore, duplicated here. The majority of the potential impacts arising from waste management on the historic environment are very site specific, with the nature of the impact depending almost entirely on the location of both the historic site and the waste management site. These impacts include those arising from noise, dust, hydrological impacts and vehicle movements. Whilst these impacts are therefore acknowledged, these are not impacts that can be meaningfully quantified at the national scale in relation to the Waste Management Plan for England, which does not consider any locational aspects (these being reserved for the land-use planning system). As such this section will focus on the

[131] ODPM (2004) Planning for Waste Management Facilities: A Research Study, August 2004. Available at: http://www.communities.gov.uk/archived/publications/planningandbuilding/planningwaste

potential broader impacts from air borne pollutants on buildings and monuments. Thus there is a strong link to broader air pollution impacts covered in Section 10.3, though this discussion relates to specific properties of some pollutants. Cultural heritage and the historic environment will also be affected by wider, less direct, climate change impacts covered in Section 10.2 for example increased potential for flooding which could damage coastal heritage sites.

Because of the strong links between cultural heritage and landscape as they relate to waste management in the context of this Waste Management plan, these two topics will be covered by the same evaluation matrix.

The loss of amenity and cultural value caused by damage to buildings due to air pollutants specifically associated with waste management activities is extremely difficult to quantify. To begin with loss of amenity is not a market good and involves highly subjective perception. As such there are essentially no studies that allow us to estimate the value of amenity loss due to building damage.[132] Secondly it is impossible to disaggregate air pollutant impacts at the national scale on buildings specific to waste management activities from wider industrial, commercial and household activities. This assessment will therefore identify the relative impacts upon the built environment of corrosive emissions from waste management operations.

Waste management activity is considered as part of the planning process at the local / site specific level, where its impact on cultural heritage, including buried archaeology and subterranean remains, is taken into account through the local planning process, including in local development frameworks, and in some cases (for example in relation to landfill sites) the Environmental Impact Assessment process.

Whilst air pollution continues to damage the built environment, there has been a drastic reduction in the concentration of corrosive primary pollutants in the atmosphere over the past century as this damage has become better understood, regulation has tightened and abatement technology has improved. It should be noted, however, that this trend has been largely driven by the impacts on human health of air pollution, with the reduced impacts on the built environment something of an associated outcome.

10.9.1 Corrosive Effect of Atmospheric Pollutants

The phenomena of the degradation of buildings and monuments is complex due to the numerous interrelated factors that intervene, including type and age of materials, natural weathering forces and synergistic effects of pollutants. The principle impact on buildings is the effect of acid deposition on corrosion. Acid deposition covers both the direct effects of SO_2 and the effects of acid deposition resulting from both SO_2 and NOx emissions. To give an indication of the broad impact of air pollutants on building materials, measured deterioration rates are a factor of 10 to 100 higher when present.[133]

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[132] Watkiss, P et al (2000) *Impacts of Air Pollution on Building Materials*, September 2000. Available at: http://arirabl.org/Publications_files/Buildings-PollAtmos.pdf

[133] Watkiss, P et al (2000) *Impacts of Air Pollution on Building Materials*, September 2000. Available at: http://arirabl.org/Publications_files/Buildings-PollAtmos.pdf

Watkiss *et al* suggests that for a number of materials the dry deposition of SO_2 exerts the strongest corrosive effect of atmospheric pollutants, with NO_2 having a strong synergistic effect in observed laboratory studies, though this has not been evidenced in field studies.[134] A list of materials commonly used in the construction industry (including historic materials) is presented in Table 21, along with their susceptibility to airborne pollution. This shows that natural materials frequently found in historic buildings and monuments, principally sandstone, limestone and marble, are severely affected by SO_2, with a large stock of such structures of cultural value. Other high sensitivity materials to SO_2 pollution include certain types of steel (unalloyed, galvanised and nickel-plated), nickel and zinc, though the stock-at-risk of these impacts is relatively limited.

Table 21: Sensitivity of Materials to Air Pollution and the Stock-at-Risk in England

Material	Sensitivity to Air Pollution	Stock-at-Risk
Brick	Very low	Very large
Mortar	Moderate to high	Very large
Concrete	Low	Very large
Natural Stone (sandstone, limestone, marble)	High (severely affected by SO_2)	Large (particularly objects of cultural value)
Unalloyed Steel	High (severely affected by SO_2)	Very small
Stainless Steel	Very low	Medium
Nickel and Nickel-plated Steel	High (especially in SO_2-polluted environment)	Very low
Zinc and Galvanised Steel	High (especially in SO_2-polluted environment)	Medium
Aluminium	Very low	Medium
Copper	Low	Low
Lead	Very Low	Low

Source: Adapted from Watkiss, P et al (2000) Impacts of Air Pollution on Building Materials, September 2000

10.9.2 Waste Management Activities Producing Harmful Air Pollutants

An extensive review into the health impacts of waste management facilities was undertaken on behalf of Defra in 2004.[135] The review reported that evidence exists to allow emissions to air to be quantified for the majority of modern waste management operations. This allowed comparisons of emissions to air between waste management options, whilst acknowledging some gaps in the evidence base, with the

[134] Ibid

[135] Enviros / University of Birmingham / Open University / M Thurgood (2004) Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes

following high-level conclusions in relation to air pollutants most likely to impact building corrosion:

- SO_2 emissions per tonne of waste processed are similar for all combustion-based processes. Transport of waste is not a significant source of SO_2;
- Incineration generates the greatest NOx emissions, followed by pyrolysis/gasification and landfill with energy generation; and
- Energy generation from waste management generally gives rise to reductions in overall emissions of SO_2 when emissions from fossil fuel power stations are taken into account.

The relative impacts of the principal waste management facilities on building damage can also be derived from the impacts of local air emissions as discussed in Section 10.3. This shows typical values for the annual external costs (excluding avoided electricity generation impacts), which include impacts on materials including buildings, of waste treatment facilities for both source separated organic waste and residual waste.

As one would expect given the above commentary on NOx and SOx emissions, incineration has the highest annual external cost of pollution, followed by landfill and the variants of MBT. Organic waste treatments are all shown to have minor impacts.

As described in Section 10.3 the local air pollution benefits associated with recycling activities requires consideration of the relative locations of both primary and secondary manufacturing activities, though Table 11 clearly shows that the overall grams of SOx and NOx are significantly reduced for the range of dry recyclable materials shown. Similarly for waste prevention and preparing for reuse the impact of these activities is dependent on the location of the avoided primary manufacture, i.e. waste prevention may not have a direct influence on air pollution in England, but may bring about pollution reduction in a global context.

Air pollution mitigation measures for the various waste facilities are also discussed in detail in Section 12.0. Clearly the impacts on buildings and monuments with cultural heritage attached will be affected as long as waste management facilities are operational, with expected lifetimes up to 25 years as shown in Table 20. In reality, however, the precedent set by affording the site consent to develop waste infrastructure and the need for future waste related infrastructure is likely to mean that the site is used for the same or similar use beyond the lifetime of the incumbent facility.

10.9.3 Summary

In conclusion the impacts of waste management activities on cultural heritage are not expected to be significant at the national level. There are likely to be impacts at the local level, most prominently where new facilities are to be developed. One of the key reasons for this is the relatively low level of emissions of SOx, emissions of which are declining more generally, and of NOx.

11.0 Appraisal Results: Impacts of Plan & Alternatives

11.1 Introduction

Following on from the general review of the impacts of waste management on the various elements of the environment, focus now switches to the impacts of the Plan itself and the alternatives as presented in Table 2. The section looks at each objective in turn and looks at how the plan and alternatives might impact on the elements considered by the Objective, focussing on each level of the waste hierarchy in turn.

11.2 Important Note on the Impacts

11.2.1 Impacts of the Plan

As already discussed, the Plan is being developed in order to comply with the requirements of the Waste Framework Directive. It effectively is designed to bring together current plans and policies already in place. Thus the introduction of the Plan itself is not considered to have any **significant** impact on the environment as defined by the objectives. Putting it another way, the Government considers that appropriate measures are already in place to manage waste effectively in England. The Plan (which is what this Environmental Report is assessing) is not changing this landscape and no changes to policy are being made by it. As a result the Plan will not impact on the environment over and above the impacts implied by the elements which make up the Plan, and which were already introduced.

Given this throughout this assessment the Plan impacts are assessed as 'no or negligible' impact.

11.2.2 Impacts of the Alternatives

It is important to recognise that the alternatives are set relative to the effects of the Plan. The implementation of the elements that make up the Plan (although not introduced by it) will have positive impacts going forward. The alternatives are set against this trajectory already implied – i.e. they are based on the improvements over and above (or below depending on the alternative in question) what is already happening. This is not intended to reflect any specific quantified limit for 'above' or 'below' the baseline, but merely to reflect the fact that if the Plan were to go further, then these are the impacts that might occur.

11.2.3 Interactions between Levels of the Hierarchy

When considering relative benefits, is important to note that there will be some interaction between the relative benefits of activities occurring at the different levels of the hierarchy. For example, as the amount of recycling increases, the potential environmental benefits that may be obtained through increased waste prevention and reuse will decrease. These interactions will occur for a number of the objectives considered within the analysis including global and local emissions as well as water use.

11.2.4 Impacts Relating to Spatial Aspects

It should also be noted that when considering the impacts of waste management of facilities on SEA topics where there is strong local specificity, for example landscape and historic environment, there is a great deal of uncertainty as to the types of facilities that will be required, let alone the number. It might be that a smaller number of large facilities are developed, or a greater number of smaller facilities. Each of these scenarios would have implications for the impact on landscape and historic environment, though given the high level of uncertainty as to how waste facilities are likely to be developed over the plan period this cannot be covered as part of this appraisal.

11.2.5 Note on the Categories of Waste

As discussed in Section 8.0 this ER considers waste according to the basic categorisation of:

- Household waste;
- Commercial and industrial waste; and
- Construction and demolition waste.

11.3 Objective 1: Protect Natural Material Assets

11.3.1 Introduction

The matrices in Section 0 through to Section 11.3.6 present the results of the assessment of the performance of the plan on natural material assets. The assessment is focused on the impact upon natural material assets, according to the changes that may occur in TMR. The sections take each level of the hierarchy in turn, starting from waste prevention in Section 0 and finishing in Section 11.3.6 with disposal impacts. While there are differences in composition between the sectors (household, commercial & industrial, and construction & demolition), with the tonnage of C&D waste being greater than household and C&I combined, there is expected to be significant potential across all sectors to reduce TMR via changes to waste management practices, as well as through upstream influences on product design.

For each sector, increases in waste prevention (including reuse), preparation for reuse, and recycling have the potential to deliver major positive impacts through reducing total material requirements. However, the extent of the impact depends upon the treatment route that is otherwise being displaced. For example, if preparation for reuse displaces recycling, then the marginal benefit is less than if disposal had been displaced. Or, indeed if recycling of items displaces their reuse, the move down the waste hierarchy is likely to lead to an increase in total material requirement.

For recovery operations, the picture is less clear. Anaerobic digestion of food waste, a form of recovery, could have the effect of reducing requirements for the primary manufacture of fertiliser (via the application of digestate), and through reducing the requirement for fossil fuel derived electricity and/or gas. However, for other forms of recovery, such as R1 energy from waste facilities, while there may be some offset of fossil fuel generation, much will depend on what could otherwise have happened to the materials being incinerated. If they could otherwise have been recycled, this move down the waste hierarchy is likely to lead to an increase in total material requirement.

Where materials are disposed of, there is a continuing demand for primary production. Therefore, as a reduction in levels of disposal should lead to a decrease in total material requirements. However, the extent of the decrease will depend upon the alternative route taken, be it waste prevention, preparation for reuse, recycling or recovery.

Generally, therefore, the alternatives could assist in the delivery of an improvement in the situation in respect of material assets. Measures to increase the extent of waste prevention / eco-design activity, those encouraging reuse, and those enhancing recycling would most likely have the most beneficial impacts.

For this objective, the timescales in all cases are marked as Long Term. This means, in this instance that the effects will become evident straight away, and will endure for many years. Whilst enduring for many years the impacts cannot be considered permanent. All impacts are therefore considered temporary.

11.3.2 Impacts on Material Assets: Waste Prevention

	Waste Prevention		
	Effect	Timescale	Reason for Score
Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	On a per unit basis, waste prevention (including reuse) is arguably the most effective way of protecting material assets through reducing total material requirements, as indicated in Section **Error! Reference source not found.**
A2 Household Waste: Below Baseline		L	As waste prevention is such an effective way of reducing total material requirements, a reduction in waste prevention would tend to increase total material requirements as indicated in Section **Error! Reference source not found.**
A3 C&I Waste: Above Baseline		L	On a per unit basis, waste prevention (including reuse) is arguably the most effective way of reducing total material requirements as indicated in Section **Error! Reference source not found.**
A4 C&I Waste: Below Baseline		L	As waste prevention is such an effective way of reducing total material requirements, a reduction in waste prevention would tend to increase total material requirements as indicated in Section **Error! Reference source not found.**
A5 C&D Waste: Above Baseline		L	On a per unit basis, waste prevention (including reuse) is arguably the most effective way of reducing total material requirements as indicated in Section **Error! Reference source not found.**
A6 C&D Waste: Below Baseline		L	As waste prevention is such an effective way of reducing total material requirements, a reduction in waste prevention would tend to increase total material requirements as indicated in Section **Error! Reference source not found.**

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.3.3 Impacts on Material Assets: Preparation for Reuse

	Preparation for Re-use		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	On a per unit basis, preparation for reuse can be almost as effective as waste prevention in reducing total material requirements, as indicated in Section **Error! Reference source not found.**
A2 Household Waste: Below Baseline		L	As preparation for reuse can be an effective way of reducing total material requirements, a reduction in preparation for reuse would tend to increase total material requirements, as indicated in Section **Error! Reference source not found.**
A3 C&I Waste: Above Baseline		L	On a per unit basis, preparation for reuse can be almost as effective as waste prevention in reducing total material requirements, as indicated in Section **Error! Reference source not found.**
A4 C&I Waste: Below Baseline		L	As preparation for reuse can be an effective way of reducing total material requirements, a reduction in preparation for reuse would tend to increase total material requirements, as indicated in Section **Error! Reference source not found.**
A5 C&D Waste: Above Baseline		L	On a per unit basis, preparation for reuse can be almost as effective as waste prevention in reducing total material requirements, as indicated in Section **Error! Reference source not found.**
A6 C&D Waste: Below Baseline		L	As preparation for reuse can be an effective way of reducing total material requirements, a reduction in preparation for reuse would tend to increase total material requirements, as indicated in Section **Error! Reference source not found.**

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.3.4 Impacts on Material Assets: Recycling

	Recycling		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	Recycling can be a very effective way of reducing total material requirements, as is made clear in Section 10.6.2. While on a per unit basis the reduction would typically be less than for waste prevention or preparation for reuse, the large potential (in terms of the proportion of the waste stream that can be recycled) means that the overall effect on total material requirements associated with changes in levels of recycling is significant.
A2 Household Waste: Below Baseline		L	As recycling is an effective way of reducing total material requirements, a reduction in recycling would tend to increase total material requirements (see Section 10.6.2).
A3 C&I Waste: Above Baseline		L	Recycling can be a very effective way of reducing total material requirements, as is made clear in Section 10.6.2. While on a per unit basis the reduction would typically be less than for waste prevention or preparation for reuse, the large potential (in terms of the proportion of the waste stream that can be recycled) means that the overall effect on total material requirements associated with changes in levels of recycling is significant.
A4 C&I Waste: Below Baseline		L	As recycling is an effective way of reducing total material requirements, a reduction in recycling would tend to increase total material requirements (see Section 10.6.2).
A5 C&D Waste: Above Baseline		L	Recycling can be a very effective way of reducing total material requirements, as is made clear in Section 10.6.2. While on a per unit basis the reduction would typically be less than for waste prevention or preparation for reuse, the large potential (in terms of the proportion of the waste stream that can be recycled) means that the overall effect on total material requirements associated with changes in levels of recycling is significant.
A6 C&D Waste: Below Baseline		L	As recycling is an effective way of reducing total material requirements, a reduction in recycling would tend to increase total material requirements (see Section 10.6.2).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.3.5 Impacts on Material Assets: Other Recovery

	Other Recovery		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement but the opposite would be the case if the increase in recovery occurred at the expense of landfill (see section 10.6.2).
A2 Household Waste: Below Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement but the opposite would be the case if the increase in recovery occurred at the expense of landfill (see section 10.6.2).
A3 C&I Waste: Above Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement but the opposite would be the case if the increase in recovery occurred at the expense of landfill (see section 10.6.2).
A4 C&I Waste: Below Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement but the

	Other Recovery		
	Effect	Timescale	Reason for Score
			opposite would be the case if the increase in recovery occurred at the expense of landfill (see section 10.6.2).
A5 C&D Waste: Above Baseline	?	L	For recovery such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement but the opposite would be the case if the increase in recovery occurred at the expense of landfill (see section 10.6.2).
A6 C&D Waste: Below Baseline	?	L	For recovery such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement but the opposite would be the case if the increase in recovery occurred at the expense of landfill (see section 10.6.2).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.3.6 Impacts on Material Assets: Disposal

	Disposal		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	Increased disposal would lead to an overall increase in total material requirement, due to the increased demand for primary production (see section 10.6.2).
A2 Household Waste: Below Baseline		L	A reduction in disposal would lead to an overall decrease in total material requirement. The decrease in total material requirement would be greater if the reduction were attributable to an increase in waste prevention, preparation for reuse and recycling, than if it were entirely due to a shift to recovery operations (see section 10.6.2)..
A3 C&I Waste: Above Baseline		L	Increased disposal would lead to an overall increase in total material requirement, due to the increased demand for primary production (see section 10.6.2).
A4 C&I Waste: Below Baseline		L	A reduction in disposal would lead to an overall decrease in total material requirement. The decrease in total material requirement would be greater if the reduction were attributable to an increase in waste prevention, preparation for reuse and recycling, than if it were entirely due to a shift to recovery operations (see section 10.6.2)..
A5 C&D Waste: Above Baseline		L	Increased disposal would lead to an overall increase in total material requirement, due to the increased demand for primary production (see section 10.6.2).
A6 C&D Waste: Below Baseline		L	A reduction in disposal would lead to an overall decrease in total material requirement. The decrease in total material requirement would be greater if the reduction were attributable to an increase in waste prevention, preparation for reuse and recycling, than if it were entirely due to a shift to recovery operations (see section 10.6.2)..

Note: ‘Above’ Baseline implies more material is dealt with at this level of the hierarchy. ‘Below’ Baseline implies less material is deal with at this level of the hierarchy.

11.4 Objective 2: Reduce Air Emissions Contributing to Global Problems

The assessment of the impacts of the Plan and alternatives on air emissions which have a global impact is focused on the climate change impacts using the data presented in Section 10.2.

The matrices identify significant benefits associated with increasing the waste prevention and recycling of household waste above the Baseline. Benefits are less significant for the waste prevention of commercial and industrial waste, although there is still considered to be scope for increasing recycling. In contrast, there is anticipated to be little impact on climate change impacts associated with C&D wastes as a significant proportion of waste arisings consists of inert materials.

There is considerable variation in the impacts associated with waste treated at plant designated as 'Other Recovery' facilities. This category potentially includes plant treating source separated biowaste (where the relevant PAS certification is not met) as well as higher performance incineration facilities and some specialist treatment routes for industrial materials. Impacts depend not only on the type of facility but the type of material. Whilst there will be a climate change benefit associated with moving food waste out of landfill and into a recovery facility, a shift in the treatment of waste streams rich in plastic from landfill to an R1 incineration facility may result in a contribution to climate change impacts.

All impacts shown in the matrices below (Sections 11.4.1 to 0) are considered to be long term due to the length of time with which greenhouse gases remain resident in the atmosphere.[136] Whilst enduring for many years the impacts cannot be considered permanent. All impacts are therefore considered temporary.

[136] Carbon dioxide may remain in the atmosphere for up to 200 years. The residence time for methane is considerably less than this, but is still likely to result in an impact beyond 2020. See: IPCC (2007) *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Metz B, Davidson O R, Bosch PR, Dave R, and Meyer L A (eds)), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA., pp 600*

11.4.1 Impacts on Global Emissions: Waste Prevention

	Waste Prevention		
	Effect	Timescale	Reason for Score
Baseline		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Food waste prevention has significant climate change benefits as does resale of textiles through charity shop / internet (as indicated in Section 10.2.1). Some scope for reducing packaging through eco-design resulting in prevention of packaging waste (reducing plastic, glass and metal arisings) although this is expected to be less significant.
A2 Household Waste: Below Baseline		L	Impacts associated with a reduction in waste prevention will depend on what happens to the waste arisings. Climate change impacts will be more significant if there is increased disposal (see Sections 10.2.6 and 10.2.7). Impacts will be less significant if waste is recovered or recycled (see Sections 10.2.3 and 10.2.4).
A3 C&I Waste: Above Baseline		L	More limited scope for food waste prevention particularly amongst industrial producers; also less textile waste. Eco-design activities may result in reduced packaging waste arisings.
A4 C&I Waste: Below Baseline		L	As with household waste, impacts will depend on what happens to the waste arisings. Climate change impacts will be more significant if there is increased disposal (see Sections 10.2.6 and 10.2.7). Impacts will be less significant if waste is recovered or recycled (see Sections 10.2.3 and 10.2.4).
A5 C&D Waste: Above Baseline		L	A significant quantity of C&D waste is relatively inert, thus less impact from prevention activities than for household waste (see Sections 10.1.4.3 and 10.1.4.5).
A6 C&D Waste: Below Baseline		L	A significant quantity of C&D waste is relatively inert, thus less impact from prevention activities than for household waste.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.4.2 Impacts on Global Emissions: Preparing for Re-use

	Preparation for Re-use		
	Effect	Timescale	Reason for Score
Baseline		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Resale of textiles has significant climate change benefit; however charity shop / eBay resale comes under waste prevention, and many items collected through kerbside will be unsuitable for resale (see Section 10.2.2). Benefits through reuse of WEEE and other large household items dependent on extent to which avoided manufacture occurs (see Section 10.2.1). Items do not contribute significantly to total waste quantities, limiting the scope for additional impact.
A2 Household Waste: Below Baseline		L	Relatively small amounts of waste involved, a proportion of which will not degrade in landfill (e.g. metal furniture; WEEE), limiting scope for additional impact. Some climate change contribution from textiles disposal (see Sections 10.2.3 and 10.2.4).
A3 C&I Waste: Above Baseline			Although there is some scope for additional reuse of furniture, arisings are small and benefits relatively minor.
A4 C&I Waste: Below Baseline			Limited potential thus impacts are not so significant.
A5 C&D Waste: Above Baseline			Very few items in the C&D stream suitable for preparing for reuse. In addition, a significant quantity of C&D waste is relatively inert, thus little impact from preparing for reuse activities (see Sections 10.1.4.3 and 10.1.4.5).
A6 C&D Waste: Below Baseline			Few suitable items for reuse, and a significant quantity of C&D waste is relatively inert, thus little impact from preparing for reuse activities

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.4.3 Impacts on Global Emissions: Recycling

	Recycling		
	Effect	Timescale	Reason for Score
Baseline		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Is still scope for additional recycling of food waste, plastics and textiles - all activities with significant climate change benefits assuming compost / digestate meet the relevant PAS standards (see Section 10.2.3).
A2 Household Waste: Below Baseline		L	Lower rates of recycling likely to lead to increased climate change impacts from disposal for many materials (see Sections 10.2.6 and 10.2.7). Impacts will be reduced if the waste is instead sent to a recovery facility but some contribution to climate change still likely from the combustion of plastics even where this is the case (see Section 10.2.7).
A3 C&I Waste: Above Baseline		L	Scope for recycling food waste and plastics particularly from smaller commercial premises (see Section 10.2.3).
A4 C&I Waste: Below Baseline		L	Lower rates of recycling lead to increased climate change impacts from disposal particularly from food waste
A5 C&D Waste: Above Baseline		L	Benefits associated with recycling smaller than for household and C&I (see Sections 10.1.4.3 and 10.1.4.5).
A6 C&D Waste: Below Baseline		L	Unrecycled C&D waste is typically landfilled. Most C&D waste is relatively inert, thus only a relatively minor impact from decrease in recycling activities.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.4.4 Impacts on Global Emissions: Other Recovery

	Other Recovery		
	Effect	Timescale	Reason for Score
Baseline		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline	?	L	Benefits depend on recovery route and material – they may be relatively significant for recovery of food waste to either a non PAS110 AD plant or an R1 incineration facility (see Sections 10.2.4 and. 10.2.7). Where R1 incineration facilities are concerned, the impact will depend on the composition of waste being treated (see Sections 10.2.7 and 10.2.8).
A2 Household Waste: Below Baseline	?	L	Impacts depend on material and its fate - recycling will result in climate change benefits whilst disposal typically results in a contribution to climate change impacts particularly in the case of materials rich in fossil material sent to low performance incineration and wastes rich in biogenic materials sent to landfill (see Sections 10.2.6 and 10.2.7).
A3 C&I Waste: Above Baseline	?	L	Benefits depend on recovery route and material – they may be relatively significant if includes recovery of food waste to AD or an R1 incinerator. Where R1 incineration facilities are concerned, the impact will depend on the composition of waste being treated. There is little data on the climate change impacts of specialist recovery routes for industrial waste streams (see Section 10.2.5) so these impacts are highly uncertain.
A4 C&I Waste: Below Baseline	?	L	Impacts depend on material and its fate - recycling will result in climate change benefits whilst disposal will generally result in a contribution to climate change impacts

A5 C&D Waste: Above Baseline	?	L	As above, impacts dependent upon the material and fate. However most C&D waste is relatively inert thus little climate change impact anticipated (see Sections 10.1.4.3 and 10.1.4.5)
A6 C&D Waste: Below Baseline	?	L	As above, impacts dependent on material and fate. However most C&D waste is relatively inert thus little climate change impact

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.4.5 Impacts on Global Emissions: Disposal

	Disposal		
	Effect	Timescale	Reason for Score
Baseline		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Both landfill and low performance incineration have the potential to contribute to climate change impacts - depending on the waste composition (and the associated level of recycling) there may be relatively little to choose between either option (see Sections 10.2.6 and 10.2.7).
A2 Household Waste: Below Baseline		L	A reduction in landfill and/or low performance incineration is anticipated to result in a significant climate change benefit for most materials particularly where the alternative is a waste prevention activity or recycling (see Sections 10.2.1 and 10.2.3).
A3 C&I Waste: Above Baseline		L	Both landfill and low performance incineration have the potential to contribute to climate change impacts - depending on the waste composition there may be relatively little to choose between either option
A4 C&I Waste: Below Baseline		L	A reduction in landfill and/or low performance incineration results in significant climate change benefits, particularly if the alternative is a waste prevention activity or recycling.
A5 C&D Waste: Above Baseline		L	Most C&D waste is relatively inert thus little climate change impact anticipated.
A6 C&D Waste: Below Baseline		L	Most C&D waste is relatively inert thus little climate change impact.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.5 Objective 3 – Reduce Air Emissions of Local Relevance

The assessment of the impact of the Plan and alternatives on emissions of air pollutants which have a local impact includes the assessment of the impact on human health from air pollution, with the matrices taking each level of the hierarchy in turn (starting with waste prevention).

The impacts upon local emissions associated with increasing waste prevention, reuse and recycling are assessed as uncertain, in part as these are dependent upon the relative location of the primary and (in the case of dry recycling) secondary manufacturing facilities. This is not known with certainty for the majority of the product streams that subsequently become waste. Some benefit is anticipated in respect of food waste prevention as WRAP data suggests a significant proportion of the avoidable food waste is manufactured within the UK; however, much less data is available in respect of the avoided air pollution impacts associated with waste prevention than is the case with the climate change impacts.

There is more certainty in respect of the local air pollution benefits that are anticipated to occur through avoided disposal, and some benefit is also anticipated for source segregated biowaste treated through either composting or AD. Impacts are considered to be long term as many of the air pollutants can have a long term impact on human health.

All impacts shown in the matrices below (Sections 11.4.1 to 0) are considered to be long term due to the length of time over which health impacts resulting from local pollution are anticipated to occur. Whilst enduring for many years the impacts cannot be considered permanent. All impacts are therefore considered temporary.

11.5.1 Impacts on Local Emissions: Waste Prevention

	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Benefits potentially significant in a global context although local impact will depend on the location of primary manufacture (see Section 10.3.1). Although a significant proportion of the manufacturing of consumed products occurs overseas, some benefit is likely to result from avoided English food manufacture.
A2 Household Waste: Below Baseline	?		Impacts will depend on the fate of the waste materials - there may be little impact if the waste is recycled overseas, but disposal will result in a contribution to air pollution (see Sections 10.3.4 and 10.3.5).
A3 C&I Waste: Above Baseline			Likely to be less scope for impact than for household waste. Local impact will depend on the location of primary manufacture.
A4 C&I Waste: Below Baseline	?		Impacts will depend on the fate of the waste materials - there may be little impact if the waste is recycled overseas, but disposal will result in a contribution to air pollution.
A5 C&D Waste: Above Baseline	?		A significant quantity of C&D waste is relatively inert, thus less impact from prevention activities than for household waste.
A6 C&D Waste: Below Baseline	?		A significant quantity of C&D waste is relatively inert, thus less impact from prevention activities than for household waste.

Note: ‘Above’ Baseline implies more material is dealt with at this level of the hierarchy. ‘Below’ Baseline implies less material is deal with at this level of the hierarchy.

11.5.2 Impacts on Local Emissions: Preparation for Re-use

	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline			Benefits potentially significant in a global context but local impact will depend on the location of primary manufacture (see Section 10.3.1). Little impact expected in England as most manufacture of potentially reusable products occurs overseas.
A2 Household Waste: Below Baseline	?		Impacts will depend on the type of material and its fate. There may be little local impact if the waste is recycled overseas although such activities may affect air quality in other countries (see Sections 10.3.2 and 10.4.4). Disposal may result in a contribution to air pollution for some materials (e.g. landfilled furniture or textiles) but impacts likely to be very small for non biodegradable wastes landfilled (e.g. WEEE), see Section 10.3.4.
A3 C&I Waste: Above Baseline			Less scope for impact than for household waste. Local impact will depend on the location of primary manufacture. Little impact expected in England as most manufacture occurs overseas.
A4 C&I Waste: Below Baseline	?		Impacts will depend on the type of material and its fate. There may be little impact if the waste is recycled overseas, but disposal may result in a contribution to air pollution.
A5 C&D Waste: Above Baseline			Limited scope for impact with C&D wastes given the composition of the waste – i.e. mostly inert.
A6 C&D Waste: Below Baseline			Limited scope for impact with C&D wastes given the composition of the waste – i.e. mostly inert.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.5.3 Impacts on Local Emissions: Recycling

	Effect	Timescale	Reason for Score

The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline	?		Benefits potentially significant in a global context but local impact will depend on the location of primary and secondary manufacture. Development of English reprocessing plant for dry recyclate would result in a contribution to local air pollution impacts although impacts uncertain (see Section 10.3.2). Facilities treating source separated biowaste also contribute to local air pollution impacts albeit impacts are relatively smaller than treatment through disposal (see Sections 10.3.3 through to 10.3.5).
A2 Household Waste: Below Baseline		L	Increased disposal will result in a contribution to local air pollution (see Sections 10.3.4 and 10.3.5). Local impacts may be less significant if the waste is treated through other recovery methods such as composting / digestion producing non PAS compliant compost /digestate, or where waste is treated overseas at an R1 designated incinerator (the latter would, however result in overseas pollution impacts) – see Sections 10.3.3 and 10.3.5.
A3 C&I Waste: Above Baseline	?		Less scope than for household waste. Local impact will depend on the location of primary and secondary manufacture. Development of English reprocessing plant would result in a contribution to local air pollution impacts.
A4 C&I Waste: Below Baseline		L	Increased disposal will result in a contribution to local air pollution. Impacts less significant if the waste is treated through other recovery methods.
A5 C&D Waste: Above Baseline	?		Benefits of recycling assumed to be relatively small as a significant proportion of the waste stream is aggregate where energy demands for extraction are relatively low (see Section 10.3.2).
A6 C&D Waste: Below Baseline		L	Unrecycled C&D waste is typically landfilled. Most C&D waste is relatively inert, thus only a relatively minor impact from decrease in recycling activities.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.5.4 Impacts on Local Emissions: Other Recovery

	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Contribution to air pollution from R1 incineration facilities will be slightly reduced in comparison to lower performance incineration if heat is also recovered, but all such facilities result in some local impact (see Section 10.3.5). Some benefit would result from treatment of food waste through AD where digestate does not meet PAS 110 (see Section 10.3.3). Long term impacts on human health anticipated from the pollution impacts (see Section 0).
A2 Household Waste: Below Baseline	?		Impacts will be dependent on what happens to the material that is not sent for recovery - may be little impact on local air pollution if the material is recycled and reprocessed overseas or does not become waste (see Sections 10.3.1 and 10.3.2); however disposal will typically result in an increased contribution to air pollution (see Sections 10.3.4 and 10.3.5).
A3 C&I Waste: Above Baseline	?		Wide range of specialist recovery activities undertaken for industrial wastes - air pollution impact of these activities is highly uncertain. Situation for commercial wastes is similar to that of the household wastes as described above.
A4 C&I Waste: Below Baseline	?		Impacts will be dependent on what happens to the material that is not sent for recovery - may be little impact on air pollution if the material is recycled or does not become waste, however disposal impacts would result in an increased contribution to air pollution.
A5 C&D Waste: Above Baseline			As above, impacts dependent upon the material and fate. However most C&D waste is relatively inert thus little climate change impact anticipated.
A6 C&D Waste: Below Baseline	?		As above, impacts dependent on material and fate. However most C&D waste is relatively inert thus little climate change impact.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.5.5 Impacts on Local Emissions: Disposal

	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Landfill and low performance incineration both contribute significantly to local pollution impacts (see Sections 10.3.4 and10.3.5). The pollution emitted from both types of facilities is likely to result in long term impacts on human health (see Section 0); in addition, landfill gas continues to be emitted for decades after the initial deposition of waste.
A2 Household Waste: Below Baseline		L	Air pollution benefits likely from avoided disposal. Most reprocessing activities not based in England so relatively little contribution from these activities and impacts of source segregated biowaste treatment are less than for disposal (see Section 10.3.3). Prevention results in negligible local air pollution impacts where production occurs overseas, although food waste prevention may result in air quality benefits (albeit these are highly uncertain due to lack of data).
A3 C&I Waste: Above Baseline		L	Landfill and low performance incineration both contribute significantly to local pollution impacts. Impacts are more uncertain for industrial wastes due to the lack of waste composition data but relatively less industrial waste is landfilled. The pollution emitted from both types of facilities is likely to result in long term impacts on human health and buildings. In addition, landfill gas continues to be emitted for decades after the initial deposition of waste.
A4 C&I Waste: Below Baseline		L	Air pollution benefits from avoided disposal. Most reprocessing activities not based in the UK so relatively little contribution from these activities. Prevention results in negligible local air pollution impacts.
A5 C&D Waste: Above Baseline			A significant proportion of C&D waste is relatively inert thus only a minor air pollution impact anticipated
A6 C&D Waste: Below Baseline			A significant proportion of C&D waste is relatively inert thus only a minor air pollution impact anticipated

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.6 Objective 4 – Protect & Enhance Biodiversity

11.6.1 Introduction

The matrices in Section 11.6.2 through to Section 11.6.6 present the results of the assessment of the performance of the plan on biodiversity. The assessment is focused on the impact upon biodiversity, according to the changes that may occur in TMR (see Section 10.6). The sections take each level of the hierarchy in turn (starting from waste prevention in Section 11.6.2 and finishing in Section 11.6.6 with disposal impacts. While there are differences in composition between the sectors (household, commercial & industrial, and construction & demolition), with the tonnage of C&D waste being greater than household and C&I combined, there is expected to be significant potential across all sectors to reduce impacts on biodiversity via changes to waste management practices.

Across all sectors, increases in waste prevention (including reuse), preparation for reuse, and recycling have the potential to deliver major positive impacts on biodiversity, through reducing total material requirements. These impacts are directly associated with the changes in total material requirement identified in Section 10.6.

Where materials are disposed of, there is a continuing demand for primary production as new materials are generally required to replace those disposed. A reduction in levels of disposal should lead to a decrease in total material requirements, and hence a reduction in pressure on biodiversity at a global scale. However, the extent of the decrease will depend upon the alternative route taken, be it waste prevention, preparation for reuse, recycling or recovery.

The impacts relating to recovery are less clear. Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement. The impact on biodiversity is therefore unclear.

While there may be localised impacts associated with specific sites these will be covered by DCLG as they are a planning issue. We therefore do not take account of such impacts in this analysis. There may also be inter-linkages between biodiversity issues and landscape issues, as considered in Section 11.9.

For this objective, the timescales in all cases are marked as Long Term. This means, in this instance that the effects will become evident straight away, and will endure for many years. Whilst enduring for many years the impacts cannot be considered permanent. All impacts are therefore considered temporary.

11.6.2 Impacts on Biodiversity: Waste Prevention

	Waste Prevention		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	On a per unit basis, waste prevention (including reuse) is arguably the most effective way of reducing total material requirements with an associated positive impact on biodiversity (see Sections 10.6 and 10.1)
A2 Household Waste: Below Baseline		L	As waste prevention is such an effective way of reducing total material requirements, a reduction in waste prevention would tend to increase total material requirements, with an associated negative effect on biodiversity (see Sections 10.6 and 10.1)
A3 C&I Waste: Above Baseline		L	On a per unit basis, waste prevention (including reuse) is arguably the most effective way of reducing total material requirements with an associated positive impact on biodiversity (see Section 10.1)
A4 C&I Waste: Below Baseline		L	As waste prevention is such an effective way of reducing total material requirements, a reduction in waste prevention would tend to increase total material requirements, with an associated negative effect on biodiversity (see Sections 10.6 and 10.1)
A5 C&D Waste: Above Baseline		L	As waste prevention is such an effective way of reducing total material requirements, a reduction in waste prevention would tend to increase total material requirements, with an associated negative effect on biodiversity (see Sections 10.6 and 10.1)
A6 C&D Waste: Below Baseline		L	As waste prevention is such an effective way of reducing total material requirements, a reduction in waste prevention would tend to increase total material requirements, with an associated effect on biodiversity (see Sections 10.6 and 10.1)

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.6.3 Impacts on Biodiversity: Preparation for Reuse

	Preparation for Re-use		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	On a per unit basis, preparation for reuse can be almost as effective as waste prevention in reducing total material requirements with an associated impact on biodiversity (see Section **Error! Reference source not found.**)
A2 Household Waste: Below Baseline		L	As preparation for reuse can be an effective way of reducing total material requirements, a reduction in preparation for reuse would tend to increase total material requirements with an associated impact on biodiversity (see Section **Error! Reference source not found.**)
A3 C&I Waste: Above Baseline		L	On a per unit basis, preparation for reuse can be almost as effective as waste prevention in reducing total material requirements with an associated impact on biodiversity (see Section **Error! Reference source not found.**)
A4 C&I Waste: Below Baseline		L	As preparation for reuse can be an effective way of reducing total material requirements, a reduction in preparation for reuse would tend to increase total material requirements with an associated impact on biodiversity (see Section **Error! Reference source not found.**)
A5 C&D Waste: Above Baseline		L	On a per unit basis, preparation for reuse can be almost as effective as waste prevention in reducing total material requirements with an associated impact on biodiversity (see Section **Error! Reference source not found.**)
A6 C&D Waste: Below Baseline		L	As preparation for reuse can be an effective way of reducing total material requirements, a reduction in preparation for reuse would tend to increase total material requirements with an associated impact on biodiversity (see Section **Error! Reference source not found.**)

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.6.4 Impacts on Biodiversity: Recycling

	Recycling		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	Recycling can be a very effective way of reducing total material requirements. While on a per unit basis the reduction would typically be less than for waste prevention or preparation for reuse, the large potential (in terms of the proportion of the waste stream that can be recycled) means that the overall effect on total material requirements associated with changes in levels of recycling is significant, with an associated positive effect on biodiversity. (see Section **Error! Reference source not found.**)
A2 Household Waste: Below Baseline		L	As recycling is an effective way of reducing total material requirements, a reduction in recycling would tend to increase total material requirements, with an associated negative effect on biodiversity (see Section **Error! Reference source not found.**)
A3 C&I Waste: Above Baseline		L	Recycling can be a very effective way of reducing total material requirements. While on a per unit basis the reduction would typically be less than for waste prevention or preparation for reuse, the large potential (in terms of the proportion of the waste stream that can be recycled) means that the overall effect on total material requirements associated with changes in levels of recycling is significant, with an associated positive effect on biodiversity. (see Section **Error! Reference source not found.**)
A4 C&I Waste: Below Baseline		L	As recycling is an effective way of reducing total material requirements, a reduction in recycling would tend to increase total material requirements, with an associated negative effect on biodiversity (see Section **Error! Reference source not found.**)
A5 C&D Waste: Above Baseline		L	Recycling can be a very effective way of reducing total material requirements. While on a per unit basis the reduction would typically be less than for waste prevention or preparation for reuse, the large potential (in terms of the proportion of the waste stream that can be recycled) means that the overall effect on total material requirements associated with changes in levels of recycling is significant, with an associated positive effect on

			biodiversity. (see Section **Error! Reference source not found.**)
A6 C&D Waste: Below Baseline		L	As recycling is an effective way of reducing total material requirements, a reduction in recycling would tend to increase total material requirements, with an associated negative effect on biodiversity (see Section **Error! Reference source not found.**)

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.6.5 Impacts on Biodiversity: Other Recovery

	Other Recovery		
	Effect	**Timescale**	**Reason for Score**
The Plan			The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement. The impact on biodiversity is therefore unclear. (see Section 10.6.2)
A2 Household Waste: Below Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement. The impact on biodiversity is therefore unclear. (see Section 10.6.2)

	Other Recovery		
	Effect	Timescale	Reason for Score
A3 C&I Waste: Above Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement. The impact on biodiversity is therefore unclear. (see Section 10.6.2)
A4 C&I Waste: Below Baseline	?	L	Taking recovery to include anaerobic digestion of food waste, this may have the effect of reducing total material requirements, as the digestate could displace the primary manufacture of liquid fertiliser in agricultural applications. However, for other recovery operations, such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement. The impact on biodiversity is therefore unclear. (see Section 10.6.2)
A5 C&D Waste: Above Baseline	?	L	For recovery such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement. The impacts on biodiversity are therefore unclear. (see Section 10.6.2)
A6 C&D Waste: Below Baseline	?	L	For recovery such as R1 energy from waste, the impact would depend upon the treatment/disposal route from which the materials switched. If an increase in incineration led to a reduction in recycling, this would likely lead to an overall increase in total material requirement. The impacts on biodiversity are therefore unclear. (see Section 10.6.2)

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.6.6 Impacts on Biodiversity: Disposal

	Disposal		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	Increased disposal would lead to an overall increase in total material requirement, due to the increased demand for primary production, with an associated negative impact on biodiversity. (see Section 10.6.2)
A2 Household Waste: Below Baseline		L	A reduction in disposal would lead to an overall decrease in total material requirement. The decrease in total material requirement would be greater if the reduction were attributable to an increase in waste prevention, preparation for reuse and recycling, than if it were entirely due to a shift to recovery operations. A reduction in levels of disposal should lead to a positive impact on biodiversity. (see Section 10.6.2)
A3 C&I Waste: Above Baseline		L	Increased disposal would lead to an overall increase in total material requirement, due to the increased demand for primary production, with an associated negative impact on biodiversity. (see Section 10.6.2)
A4 C&I Waste: Below Baseline		L	A reduction in disposal would lead to an overall decrease in total material requirement. The decrease in total material requirement would be greater if the reduction were attributable to an increase in waste prevention, preparation for reuse and recycling, than if it were entirely due to a shift to recovery operations. A reduction in levels of disposal should lead to a positive impact on biodiversity. (see Section 10.6.2)
A5 C&D Waste: Above Baseline		L	Increased disposal would lead to an overall increase in total material requirement, due to the increased demand for primary production, with an associated negative impact on biodiversity. (see Section 10.6.2)
A6 C&D Waste: Below Baseline		L	A reduction in disposal would lead to an overall decrease in total material requirement. The decrease in total material requirement would be greater if the reduction were attributable to an increase in waste prevention, preparation for reuse and recycling, than if it were entirely due to a shift to recovery operations. A reduction in levels of disposal should lead to a positive impact on biodiversity. (see Section 10.6.2)

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy

11.7 Objective 5 – Conserve Water Resources & Water Quality

11.7.1 Introduction

The matrices in Section 11.7.2 through to Section 11.7.6 present the results of the assessment of the performance of the plan on water resources and quality. The assessment is focused on the impact upon water resources and quality according to the changes in waste management practices that may occur. The sections take each level of the hierarchy in turn (starting from waste prevention in Section 11.7.2 and finishing in Section 11.7.6 with disposal impacts.

Waste prevention is an effective way of reducing both water use, and negative impacts on water quality, particularly in respect of textiles (see section 10.7.1) and food (see Section 10.7.2). Preparation for reuse has a more limited potential for reducing impacts on water resources and quality than waste prevention, largely because food waste cannot be prepared for reuse.

Across all sectors (household, commercial & industrial, and construction & demolition), there is expected to be great potential.to reduce impacts on water resources and quality via changes to waste management practices. However, as construction and demolition waste does not typically contain food or textiles, opportunities for reducing impacts on water will be slightly reduced in this sector.

Recycling also tends to lead to reduced impacts on water quality, and an overall reduction in use, compared with primary manufacture, as outlined in Section 10.7.3. This is an area where there is potential for significant positive impacts across all sectors.

The impacts of recovery on water quality and quantity depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of eutrophication although the impact on freshwater aquatic eco-toxicity is less clear cut.(see Section 10.7.9) However, if incineration prevents materials from being reused or recycled, this could lead to greater impacts associated with primary manufacture.

Landfill scores poorly on freshwater aquatic eco-toxicity and eutrophication (see Section 10.7.9), and disposal means that there will be a continued requirement for primary manufacture, with associated impacts on water quantity and quality. Any increase in disposal therefore could have a major negative impact on water. While it is recognised direct impacts should be regulated through Environmental Permit conditions, all things being equal an increase in landfill will lead to an increased risk to water resources and quality (see 10.7.8).

While there may be direct impacts from facilities, which can affect water bodies (including protected water bodies), such impacts will be largely site specific. Given the high level nature of the plan and the fact that it does not set the planning framework for waste management such impacts cannot be considered to any detailed way here.

For this objective, the timescales in all cases are marked as Long Term. This means, in this instance that the effects will become evident straight away, and will endure for many years. Whilst enduring for many years the impacts cannot be considered permanent. All impacts are therefore considered temporary.

11.7.2 Impacts on Water Resources: Waste Prevention

	Waste Prevention		
	Effect	Timescale	Reason for Score
The Plan			The introduction of the Plan will have no impact on the current baseline.
A1 Household Waste: Above Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on water, both in terms of the quantity used, and impacts on water quality (see Sections 10.7.1 and 10.7.2). Therefore an increase in waste prevention will impact positively on water resources and quality.
A2 Household Waste: Below Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on water, both in terms of the quantity used, and impacts on water quality (see Sections 10.7.1 and 10.7.2).. Therefore a reduction in waste prevention will impact negatively on water resources and quality.
A3 C&I Waste: Above Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on water, both in terms of the quantity used, and impacts on water quality (see Sections 10.7.1 and 10.7.2).. Therefore an increase in waste prevention will impact positively on water resources and quality.
A4 C&I Waste: Below Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on water, both in terms of the quantity used, and impacts on water quality (see Sections 10.7.1 and 10.7.2).. Therefore a reduction in waste prevention will impact negatively on water resources and quality.
A5 C&D Waste: Above Baseline		L	Construction and demolition waste will not typically contain food or textiles, therefore, prevention in this sector will have a more limited, albeit positive impact on water resources and quality.
A6 C&D Waste: Below Baseline		L	Construction and demolition waste will not typically contain food or textiles, therefore, a reduction in prevention in this sector will have a more limited, albeit negative impact on water resources and quality.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.7.3 Impacts on Water Resources: Preparation for Reuse

	Preparation for Re-use		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	The impacts on water resources and quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, where preparation for reuse reduces the requirement for primary production, or indeed for recycled materials e.g. steel, aluminium etc. this will have a positive impact (see Section 10.7.3).
A2 Household Waste: Below Baseline		L	The impacts on water resources and quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, a reduction in preparation for reuse may lead to an increased requirement for primary production, and an associated negative impact on water resources and quality.
A3 C&I Waste: Above Baseline		L	The impacts on water resources and quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, where preparation for reuse reduces the requirement for primary production, or indeed for recycled materials e.g. steel, aluminium etc. this will have a positive impact (see Section 10.7.3).
A4 C&I Waste: Below Baseline		L	The impacts on water resources and quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, a reduction in preparation for reuse may lead to an increased requirement for primary production, and an associated negative impact on water resources and quality.
A5 C&D Waste: Above Baseline		L	Where preparation for reuse reduces the requirement for primary production, or indeed for recycled materials e.g. steel, aluminium etc. this will have a positive impact (see Section 10.7.3).
A6 C&D Waste: Below Baseline		L	A reduction in preparation for reuse may lead to an increased requirement for primary production, and an associated negative impact on water resources and quality.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy

11.7.4 Impacts on Water Resources: Recycling

	Recycling		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	Recycling of materials such as paper, steel and aluminium leads to a reduced impact on water quality, and overall reduction in use, compared with primary manufacture. Increased levels of recycling therefore lead to major positive impacts (see Section 10.7.3).
A2 Household Waste: Below Baseline		L	All things being equal, reduced levels of recycling will lead to an increase in negative impacts on water quality, and an increase in the overall amount of water required (for primary production) (see Section 10.7.3).
A3 C&I Waste: Above Baseline		L	Recycling of materials such as paper, steel and aluminium leads to a reduced impact on water quality, and overall reduction in use, compared with primary manufacture. Increased levels of recycling therefore lead to major positive impacts (see Section 10.7.3).
A4 C&I Waste: Below Baseline		L	All things being equal, reduced levels of recycling will lead to an increase in negative impacts on water quality, and an increase in the overall amount of water required (for primary production) (see Section 10.7.3).
A5 C&D Waste: Above Baseline		L	Recycling of materials such as steel and aluminium leads to a reduced impact on water quality, and overall reduction in use, compared with primary manufacture. Increased levels of recycling therefore lead to major positive impacts (see Section 10.7.3).
A6 C&D Waste: Below Baseline		L	All things being equal, reduced levels of recycling will lead to an increase in negative impacts on water quality, and an increase in the overall amount of water required (for primary production) (see Section 10.7.3).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy

11.7.5 Impacts on Water Resources: Other Recovery

	Other Recovery		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline	?	L	The impacts of recovery on water quality and quantity depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of eutrophication although the impact on freshwater aquatic eco-toxicity is less clear cut (see Section 10.7.9). However, if incineration prevents materials from being reused or recycled, this could lead to greater impacts associated with primary manufacture (see Section 10.7.3.
A2 Household Waste: Below Baseline	?	L	The impacts of recovery on water quality and quantity depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of eutrophication although the impact on freshwater aquatic eco-toxicity is less clear cut (see Section 10.7.9). However, if incineration prevents materials from being reused or recycled, this could lead to greater impacts associated with primary manufacture (see Section 10.7.3.
A3 C&I Waste: Above Baseline	?	L	The impacts of recovery on water quality and quantity depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of eutrophication although the impact on freshwater aquatic eco-toxicity is less clear cut (see Section 10.7.9). However, if incineration prevents materials from being reused or recycled, this could lead to greater impacts associated with primary manufacture (see Section 10.7.3.
A4 C&I Waste: Below Baseline	?	L	The impacts of recovery on water quality and quantity depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of eutrophication although the impact on freshwater aquatic eco-toxicity is less clear cut (see Section 10.7.9). However, if incineration prevents materials from being reused or recycled, this could lead to greater impacts associated with primary manufacture (see Section 10.7.3.

	Other Recovery		
	Effect	Timescale	Reason for Score
A5 C&D Waste: Above Baseline	?	L	The impacts of recovery on water quality and quantity depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of eutrophication although the impact on freshwater aquatic eco-toxicity is less clear cut (see Section 10.7.9).. However, if incineration prevents materials from being reused or recycled, this could lead to greater impacts associated with primary manufacture (see Section 10.7.3.
A6 C&D Waste: Below Baseline	?	L	The impacts of recovery on water quality and quantity depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of eutrophication although the impact on freshwater aquatic eco-toxicity is less clear cut (see Section 10.7.9).. However, if incineration prevents materials from being reused or recycled, this could lead to greater impacts associated with primary manufacture (see Section 10.7.3.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy

11.7.6 Impacts on Water Resources: Disposal

	Disposal		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline.
A1 Household Waste: Above Baseline		L	Landfill scores poorly on freshwater aquatic eco-toxicity and eutrophication (see Section 10.7.9), and disposal means that there will be a continued requirement for primary manufacture, with associated impacts on water quantity and quality. An increase in disposal therefore has a major negative impact on water.
A2 Household Waste: Below Baseline		L	Landfill scores poorly on freshwater aquatic eco-toxicity and eutrophication (see Section 10.7.9), and disposal means that there will be a continued requirement for primary manufacture, with associated impacts on water quantity and quality. A reduction in disposal therefore has a major positive impact on water.
A3 C&I Waste: Above Baseline		L	Landfill scores poorly on freshwater aquatic eco-toxicity and eutrophication (see Section 10.7.9), and disposal means that there will be a continued requirement for primary manufacture, with associated impacts on water quantity and quality. An increase in disposal therefore has a major negative impact on water.
A4 C&I Waste: Below Baseline		L	Landfill scores poorly on freshwater aquatic eco-toxicity and eutrophication (see Section 10.7.9), and disposal means that there will be a continued requirement for primary manufacture, with associated impacts on water quantity and quality. A reduction in disposal therefore has a major positive impact on water.
A5 C&D Waste: Above Baseline		L	Ref Section 10.7.9, landfill scores poorly relating to water quality where appropriate controls not in place although the impacts are less so for C&D waste where the materials are largely inert. Increased disposal means that there will be a continued requirement for primary manufacture, with associated impacts on water quantity and quality. An increase in disposal therefore has a major negative impact on water.
A6 C&D Waste: Below Baseline		L	Ref Section 10.7.9), landfill scores poorly relating to water quality where appropriate controls are not in place although the impacts are less for C&D waste where the material is largely inert. Increased disposal means that there will be a continued requirement for primary manufacture, with associated impacts on water quantity and quality. A reduction in disposal therefore

	Disposal		
	Effect	Timescale	Reason for Score
			has a major positive impact on water.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy

11.8 Objective 6 – Conserve & Improve Soil Quality

The matrices in Section 11.8.1 through to Section 11.8.5 present the results of the assessment of the performance of the plan on soil quality. The assessment is focused on the impact upon soil quality according to the changes in waste management practices that may occur. The sections take each level of the hierarchy in turn starting with waste prevention.

While there may be direct impacts from facilities, which can affect soils, such impacts will be site specific (see Section 10.5.1.1) and therefore cannot be assessed in relation to the Plan.

On a per unit basis, waste prevention, notably in respect of textiles and food, is expected to have significant potential to reduce impacts on soil quality (See Sections 10.5.1.2 and 10.5.1.3). Preparation for reuse presents more limited opportunities for reducing impacts, largely because food waste cannot be prepared for reuse. However, where preparation for reuse reduces the need for primary production of crops such as cotton, this is likely to have a positive impact.

Across all sectors (household, commercial & industrial, and construction & demolition), there is great potential.to reduce impacts on soil quality via changes to waste management practices. However, as construction and demolition waste does not typically contain food or textiles, opportunities for reducing impacts on soil quality will be slightly reduced in this sector.

Composting of food waste and the application of the compost to land can lead to positive impacts on the physical and biological properties of soil, while displacing the requirement for peat use, as explained in Section 10.5.1.4.

The impacts of recovery on soil quality depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of landfill leachate (see section 10.5.1.11). However, if incineration prevents food waste from being composted, this could lead to greater impacts through an increased demand for peat, and/or a decline in the physical and biological structure of soil (see Sections 10.5.1.4 and 10.5.1.9).

Any increase in disposal carries with it an increased likelihood of leaching. An increase in food waste landfilled means lost opportunities to displace peat use and/or a decrease in the biological and physical properties of soil.

For this objective, the timescales in all cases are marked as Long Term. This means, in this instance that the effects will become evident straight away, and will endure for many years. Whilst enduring for many years the impacts cannot be considered permanent. All impacts are therefore considered temporary.

11.8.1 Impacts on Soil Quality: Waste Prevention

	Waste Prevention		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline
A1 Household Waste: Above Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on soil quality (see Sections 10.5.1.2 and 10.5.1.3) . Therefore an increase in waste prevention will impact positively on water resources and quality.
A2 Household Waste: Below Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on soil quality (see Sections 10.5.1.2 and 10.5.1.3). Therefore a reduction in waste prevention will impact negatively on soil quality.
A3 C&I Waste: Above Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on soil quality (see Sections 10.5.1.2 and 10.5.1.3). Therefore an increase in waste prevention will impact positively on water resources and quality.
A4 C&I Waste: Below Baseline		L	On a per unit basis, waste prevention, notably in respect of textiles and food, has considerable potential to reduce impacts on soil quality (see Sections 10.5.1.2 and 10.5.1.3). Therefore a reduction in waste prevention will impact negatively on soil quality.
A5 C&D Waste: Above Baseline		L	Construction and demolition waste will not typically contain food or textiles, therefore, prevention in this sector will have a more limited (albeit positive) impact on soils, largely related to avoided disposal (see Section 10.5.1.11).
A6 C&D Waste: Below Baseline		L	Construction and demolition waste will not typically contain food or textiles, therefore, a reduction in prevention in this sector will have a more limited, albeit negative impact on soils, largely related to avoided disposal (see Section 10.5.1.11).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy

11.8.2 Impacts on Soil Quality: Preparation for Reuse

	Preparation for Re-use		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline.
A1 Household Waste: Above Baseline		L	The impacts on soil quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, where preparation for reuse reduces the requirement for primary production of crops such as cotton, this will have a positive impact (see Section 10.5.1.2).
A2 Household Waste: Below Baseline		L	The impacts on soil quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, a reduction in preparation for reuse may lead to an increased requirement for primary production of crops such as cotton, and an associated negative impact on soil quality (see Section 10.5.1.2).
A3 C&I Waste: Above Baseline		L	The impacts on soil quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, where preparation for reuse reduces the requirement for primary production of crops such as cotton, this will have a positive impact (see Section 10.5.1.2).
A4 C&I Waste: Below Baseline		L	The impacts on soil quality associated with preparation for reuse will be more limited as food waste cannot be subject to preparation for reuse. However, a reduction in preparation for reuse may lead to an increased requirement for primary production of crops such as cotton, and an associated negative impact on soil quality (see Section 10.5.1.2).
A5 C&D Waste: Above Baseline		L	Preparation for reuse in this sector will have a more limited (albeit positive) impact on soils, largely related to avoided disposal (see Section 10.5.1.11).
A6 C&D Waste: Below Baseline		L	A reduction in preparation for reuse in this sector will have a more limited, albeit negative impact on soils, largely related to avoided disposal (see Section 10.5.1.11).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy

11.8.3 Impacts on Soil Quality: Recycling

	Recycling		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline.
A1 Household Waste: Above Baseline		L	Increased composting of food waste, and the subsequent application of the compost to land, can lead to major positive impacts on the physical and biological properties of soil (see Section 10.5.1.4) and/or displace the requirement for peat use (see Section 10.5.1.9).
A2 Household Waste: Below Baseline		L	A reduction in composting of food waste, and the subsequent application of the compost to land, can lead to major negative impacts on the physical and biological properties of soil (see Section 10.5.1.4), and/or an increasing demand for peat (see Section 10.5.1.9).
A3 C&I Waste: Above Baseline		L	Increased composting of food waste, and the subsequent application of the compost to land, can lead to major positive impacts on the physical and biological properties of soil (see Section 10.5.1.4) and/or displace the requirement for peat use (see Section 10.5.1.9).
A4 C&I Waste: Below Baseline		L	A reduction in composting of food waste, and the subsequent application of the compost to land, can lead to major negative impacts on the physical and biological properties of soil (see Section 10.5.1.4), and/or an increasing demand for peat (see Section 10.5.1.9).
A5 C&D Waste: Above Baseline		L	Recycling in this sector will have a more limited (albeit positive) impact on soils, largely related to avoided disposal (see Section 10.5.1.11).
A6 C&D Waste: Below Baseline		L	A reduction in recycling in this sector will have a more limited, albeit negative impact on soils, largely related to avoided disposal (see Section 10.5.1.11).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.8.4 Impacts on Soil Quality: Other Recovery

	Other Recovery		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline.
A1 Household Waste: Above Baseline	?	L	The impacts of recovery on soil quality depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of landfill leachate (see Section 10.5.1.11). However, if incineration prevents food waste from being composted, this could lead to greater impacts through an increased demand for peat (see Section 10.5.1.9), and/or a decline in the physical and biological structure of soil (see Section 10.5.1.4).
A2 Household Waste: Below Baseline	?	L	The impacts of recovery on soil quality depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of landfill leachate (see Section 10.5.1.11). However, if incineration prevents food waste from being composted, this could lead to greater impacts through an increased demand for peat (see Section 10.5.1.9), and/or a decline in the physical and biological structure of soil (see Section 10.5.1.4).
A3 C&I Waste: Above Baseline	?	L	The impacts of recovery on soil quality depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of landfill leachate (see Section 10.5.1.11). However, if incineration prevents food waste from being composted, this could lead to greater impacts through an increased demand for peat (see Section 10.5.1.9), and/or a decline in the physical and biological structure of soil (see Section 10.5.1.4),
A4 C&I Waste: Below Baseline	?	L	The impacts of recovery on soil quality depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of landfill leachate (see Section 10.5.1.11). However, if incineration prevents food waste from being composted, this could lead to greater impacts through an increased demand for peat (see Section 10.5.1.9), and/or a decline in the physical and biological structure of soil (see Section 10.5.1.4).

	Other Recovery		
	Effect	Timescale	Reason for Score
A5 C&D Waste: Above Baseline	?	L	The impacts of recovery on soil quality depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of landfill leachate (see Section 10.5.1.11). However, if incineration prevents food waste from being composted, this could lead to greater impacts through an increased demand for peat (see Section 10.5.1.9), and/or a decline in the physical and biological structure of soil (see Section 10.5.1.4).
A6 C&D Waste: Below Baseline	?	L	The impacts of recovery on soil quality depend upon the treatment routes from which the waste has switched. If the switch is to incineration from landfill, this should lead to lower impacts in terms of landfill leachate (see Section 10.5.1.11). However, if incineration prevents food waste from being composted, this could lead to greater impacts through an increased demand for peat (see Section 10.5.1.9), and/or a decline in the physical and biological structure of soil (see Section 10.5.1.4).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.8.5 Impacts on Soil Quality: Disposal

	Disposal		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no impact on the current baseline.
A1 Household Waste: Above Baseline		L	An increase in disposal carries with it an increased likelihood of leaching (see Section 10.5.1.11). An increase in food waste landfilled means lost opportunities to displace peat use (see Section 10.5.1.9) and/or a decrease in the biological and physical properties of soil (see Section 10.5.1.4).
A2 Household Waste: Below Baseline		L	A reduction in disposal means a reduced likelihood of leaching (see Section 10.5.1.11). A reduction in food waste landfilled, if composted, or if food waste has been avoided, will lead to a major positive impact
A3 C&I Waste: Above Baseline		L	An increase in disposal carries with it an increased likelihood of leaching (see Section 10.5.1.11). An increase in food waste landfilled means lost opportunities to displace peat use (see Section 10.5.1.9) and/or a decrease in the biological and physical properties of soil (see Section 10.5.1.4).
A4 C&I Waste: Below Baseline		L	A reduction in disposal means a reduced likelihood of leaching (see Section 10.5.1.11). A reduction in food waste landfilled, if composted, or if food waste has been avoided, will lead to a major positive impact.
A5 C&D Waste: Above Baseline		L	An increase in disposal carries with it an increased likelihood of leaching (see Section 10.5.1.11). A lack of food waste in this stream means that the impacts are less significant than for household and C&I waste.
A6 C&D Waste: Below Baseline		L	A reduction in disposal carries with it a reduced likelihood of leaching (see Section 10.5.1.11). A lack of food waste in this stream means that the impacts are less significant than for household and C&I waste.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.9 Objective 7 – Protect & Enhance Landscape & Historic Environment

For many of the elements of the waste hierarchy, especially in relation to waste prevention and preparation for re-use, the impacts are likely to be negligible as the marginal impacts of waste prevention and preparation for re-use on the number and type of facilities is likely to be insignificant.

That said, there are inherent limitations of the existing system whereby there is little to prevent the delivery of over-capacity by the market of waste management facilities at a national level. Indeed this has been the experience in other European countries, notably the Netherlands and Germany, where over capacity in these countries has led to the development of a rapidly emerging export market for certain waste streams, particularly SRF and RDF.

Whilst it is recognised that people living close to facilities may have strong views about the development of a specific site, the location of sites is steered by planning policy rather than the Plan being consulted on here. Thus the impacts of the plan and the alternatives in relation to landscape and the historic environment are argued to be minimal.

Given the similarity of impacts relating to landscape and the historic environment (see Sections 10.8 and 10.9), the two elements are considered together under the same objective and same set of matrices presented below.

All impacts shown in the matrices below (Sections 11.9.1 to 11.9.5) are considered to be long term due to the expected lifetime of waste management facilities being 20-25 years (see Table 21). Whilst enduring for many years the impacts cannot be considered permanent. All impacts are therefore considered temporary.

11.9.1 Impacts on Landscape & Cultural Heritage: Waste Prevention

	Waste Prevention		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Reducing the need for waste treatment throughput capacity at the national scale, therefore reducing the scale and/or quantity of facilities
A2 Household Waste: Below Baseline		L	Increasing the need for waste treatment throughput capacity at the national scale, therefore increasing the scale and/or quantity of facilities
A3 C&I Waste: Above Baseline		L	Likely to be less scope than for household waste
A4 C&I Waste: Below Baseline		L	Increasing the need for waste treatment throughput capacity at the national scale, therefore increasing the scale and/or quantity of facilities
A5 C&D Waste: Above Baseline		L	Likely to be less scope than for household waste
A6 C&D Waste: Below Baseline		L	Increasing the need for waste treatment throughput capacity at the national scale, therefore increasing the scale and/or quantity of facilities

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.9.2 Impacts on Landscape & Cultural Heritage: Preparation for Re-use

	Preparation for Re-use		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Reducing the need for waste treatment throughput capacity at the national scale, therefore reducing the scale and/or quantity of facilities
A2 Household Waste: Below Baseline		L	Increasing the need for waste treatment throughput capacity at the national scale, therefore increasing the scale and/or quantity of facilities
A3 C&I Waste: Above Baseline		L	Likely to be less scope than for household waste
A4 C&I Waste: Below Baseline		L	Increasing the need for waste treatment throughput capacity at the national scale, therefore increasing the scale and/or quantity of facilities
A5 C&D Waste: Above Baseline		L	Likely to be less scope than for household waste
A6 C&D Waste: Below Baseline		L	Increasing the need for waste treatment throughput capacity at the national scale, therefore increasing the scale and/or quantity of facilities

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.9.3 Impacts on Landscape & Cultural Heritage: Recycling

	Recycling		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline	?	L	Reducing the need for disposal and recovery facilities (landfill and combustion processes) with greatest impact on landscape and cultural heritage, yet increasing the need for recycling facility capacity
A2 Household Waste: Below Baseline	?	L	Potentially increasing the need for disposal and recovery facilities (landfill and combustion processes) with greatest impact on landscape and cultural heritage, yet reducing the need for recycling facility capacity
A3 C&I Waste: Above Baseline	?	L	Reducing the need for disposal and recovery facilities (landfill and combustion processes) with greatest impact on landscape and cultural heritage, yet increasing the need for recycling facility capacity
A4 C&I Waste: Below Baseline	?	L	Potentially increasing the need for disposal and recovery facilities (landfill and combustion processes) with greatest impact on landscape and cultural heritage, yet reducing the need for recycling facility capacity
A5 C&D Waste: Above Baseline	?	L	Reducing the need for disposal facilities, yet increasing the need for recycling facility capacity
A6 C&D Waste: Below Baseline	?	L	Potentially increasing the need for disposal facilities, yet reducing the need for recycling facility capacity

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.9.4 Impacts on Landscape & Cultural Heritage: Other Recovery

	Other Recovery		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline	?	L	Impacts will depend on the type of treatment from which the waste has been switched, or if more facilities are required overall. For example, if the switch is from landfill to incineration this may lead to greater impacts in terms of building corrosion and landscape (though this is highly subjective and location specific). However, other recovery options may be less visually intrusive and/or less damaging to buildings in terms of air pollutants
A2 Household Waste: Below Baseline	?	L	Impacts will depend on the type of treatment from which the waste has been switched, or if more facilities are required overall. For example, if the switch is from landfill to incineration this may lead to greater impacts in terms of building corrosion and landscape (though this is highly subjective and location specific). However, other recovery options may be less visually intrusive and/or less damaging to buildings in terms of air pollutants
A3 C&I Waste: Above Baseline	?	L	Impacts will depend on the type of treatment from which the waste has been switched, or if more facilities are required overall. For example, if the switch is from landfill to incineration this may lead to greater impacts in terms of building corrosion and landscape (though this is highly subjective and location specific). However, other recovery options may be less visually intrusive and/or less damaging to buildings in terms of air pollutants
A4 C&I Waste: Below Baseline	?	L	Impacts will depend on the type of treatment from which the waste has been switched, or if more facilities are required overall. For example, if the switch is from landfill to incineration this may lead to greater impacts in terms of building corrosion and landscape (though this is highly subjective and location specific). However, other recovery options may be less visually intrusive and/or less damaging to buildings in terms of air pollutants

	Other Recovery		
	Effect	Timescale	Reason for Score
A5 C&D Waste: Above Baseline	?	L	Impacts will depend on the type of treatment from which the waste has been switched, or if more facilities are required overall. For example, if the switch is from landfill to incineration this may lead to greater impacts in terms of building corrosion and landscape (though this is highly subjective and location specific). However, other recovery options may be less visually intrusive and/or less damaging to buildings in terms of air pollutants.
A6 C&D Waste: Below Baseline	?	L	Impacts will depend on the type of treatment from which the waste has been switched, or if more facilities are required overall. For example, if the switch is from landfill to incineration this may lead to greater impacts in terms of building corrosion and landscape (though this is highly subjective and location specific). However, other recovery options may be less visually intrusive and/or less damaging to buildings in terms of air pollutants.

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.9.5 Impacts on Landscape & Cultural Heritage: Disposal

	Disposal		
	Effect	Timescale	Reason for Score
The Plan		L	The introduction of the Plan will have no significant effect.
A1 Household Waste: Above Baseline		L	Greater national disposal need is likely to lead over time to more facilities which have relatively greater impacts on cultural heritage and landscape (i.e. landfill and incineration).
A2 Household Waste: Below Baseline		L	Reduced national disposal need is likely to lead over time to less facilities which have relatively greater impacts on cultural heritage and landscape (i.e. landfill and incineration).
A3 C&I Waste: Above Baseline		L	Greater national disposal need is likely to lead over time to more facilities which have relatively greater impacts on cultural heritage and landscape (i.e. landfill and incineration).
A4 C&I Waste: Below Baseline		L	Reduced national disposal need is likely to lead over time to less facilities which have relatively greater impacts on cultural heritage and landscape (i.e. landfill and incineration).
A5 C&D Waste: Above Baseline		L	Greater national disposal need is likely to lead over time to more facilities which have relatively greater impacts on cultural heritage and landscape (i.e. landfill and incineration).
A6 C&D Waste: Below Baseline		L	Reduced national disposal need is likely to lead over time to less facilities which have relatively greater impacts on cultural heritage and landscape (i.e. landfill and incineration).

Note: 'Above' Baseline implies more material is dealt with at this level of the hierarchy. 'Below' Baseline implies less material is deal with at this level of the hierarchy.

11.10 Summary

A summary of the impacts associated with the plan and the alternatives is presented in Figure 10.

Figure 10: Summary of Impacts

		Environmental Objectives						
		1	2	3	4	5	6	7
		Protect natural material assets	Reduce air emissions contributing to global problems	Reduce air emissions of local relevance	Protect & enhance biodiversity	Protect water resources & water quality	Preserve and improve soil quality	Protect and enhance landscape
The Plan	Waste Prevention							
	Preparation for Re-use							
	Recycling							
	Other Recovery							
	Disposal							
Alternative 1 (HH Waste Above the Baseline)	Waste Prevention							
		L	L	L	L	L	L	
	Preparation for Re-use							
		L	L		L	L	L	
	Recycling			?				?
		L	L		L	L	L	L
	Other Recovery	?	?		?	?	?	?
		L	L	L	L	L	L	L
	Disposal							
		L	L	L	L	L	L	L

		Environmental Objectives						
		1	2	3	4	5	6	7
		Protect natural material assets	Reduce air emissions contributing to global problems	Reduce air emissions of local relevance	Protect & enhance biodiversity	Protect water resources & water quality	Preserve and improve soil quality	Protect and enhance landscape
Alternative 2 (HH Waste Below the Baseline)	Waste Prevention			?				
		L	L		L	L	L	
	Preparation for Re-use			?				
		L	L		L	L	L	
	Recycling							?
		L	L		L	L	L	L
	Other Recovery	?	?	?	?	?	?	?
		L	L		L	L	L	L
	Disposal							
		L	L	L	L	L	L	L
Alternative 3 (C&I Waste Above the Baseline)	Waste Prevention							
		L	L		L	L	L	
	Preparation for Re-use							
		L			L	L	L	
	Recycling			?				?
		L	L		L	L	L	L
	Other Recovery	?	?	?	?	?	?	?
		L	L		L	L	L	L
	Disposal							
		L	L	L	L	L	L	L
Alternative 4 (C&I Waste Below the Baseline)	Waste Prevention			?				
		L	L		L	L	L	
	Preparation for Re-use			?				
		L			L	L	L	
	Recycling							?
		L	L		L	L	L	L

		Environmental Objectives						
		1	2	3	4	5	6	7
		Protect natural material assets	Reduce air emissions contributing to global problems	Reduce air emissions of local relevance	Protect & enhance biodiversity	Protect water resources & water quality	Preserve and improve soil quality	Protect and enhance landscape
	Other Recovery	?	?	?	?	?	?	?
		L	L		L	L	L	L
	Disposal							
		L	L	L	L	L	L	L
Alternative 5 (C&D Waste Above the Baseline)	Waste Prevention			?				
		L	L		L	L	L	
	Preparation for Re-use							
		L			L	L	L	
	Recycling			?				?
		L	L		L	L	L	L
	Other Recovery	?	?		?	?	?	?
		L			L	L	L	L
	Disposal							
		L	L	L	L	L	L	L
Alternative 6 (C&D Waste Below the Baseline)	Waste Prevention			?				
		L	L		L	L	L	
	Preparation for Re-use							
		L			L	L	L	
	Recycling							?
		L	L	L	L	L	L	L
	Other Recovery	?	?	?	?	?	?	?
		L			L	L	L	L
	Disposal							
		L	L	L	L	L	L	L

As can be seen, where the alternatives lead to an increase in waste prevention, preparation for re-use, recycling or recovery, or a reduction in the amount of disposal the overwhelming impact is positive. Conversely the opposite is true where alternatives lead to increased disposal, or reduced waste prevention, preparation for re-use, recycling or recovery. In all cases where impacts are projected the impacts are estimated to be long term (which generally includes short and medium term).

11.11 Discussion of Cumulative Impacts

As discussed in Section 9.0, most impacts are likely to be cumulative.

Impacts of a particular type are likely to be cumulative unless they are such that they have a character which is likely to lead to some form of 'saturation' in the impact. In theory, if a large number of waste facilities were located close together, the additional impact of another facility on landscape, for example, could be minimal. However, to reach this point, a large number would need to be clustered together.

In terms of how impacts across the impact areas combine, it is not straightforward to see how one form of impact offsets, in some way, another form of impact.

For these reasons, all impacts discussed would appear to be cumulative.

11.12 Discussion of Synergistic Impacts

As discussed in Section 9.0, synergistic impacts arise where specific pollutants, whose effect when emitted in isolation is limited, are emitted in combination, and because of the combination, their impact is magnified (the effect could also happen in reverse). There may be synergies between the impacts on cultural heritage and those on landscape in the sense that the same activity can give rise to both. Beyond this (if indeed this can be considered as a synergistic effect), however, synergistic effects have not been identified as significant in this work. That does not mean such effects cannot arise. Where, for example, facilities producing ammonia are co-located with those emitting SOx and NOx, then to the extent that one or other of these may be a limiting factor in the formation of secondary particulate matter, this could lead to additional health effects.

Synergistic effects have not been widely identified in the literature regarding waste management, but as already mentioned, this does not mean they do not arise, or that effects may arise that have not been identified. The nature of synergistic effects is such that they are not always readily identified or understood.

12.0 Mitigation of Impacts

The SEA Directive only requires a description of *'the measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan'*.

As stated in Section 11.2.1 the introduction of the Plan itself is not considered to have any significant impact on the environment relative to the current situation since the Plan implies a continuation of existing policies. As such, strictly speaking, no description of additional mitigation measures would appear necessary.

That having been said, for completeness, we consider a range of possible approaches to address impacts against the criteria used to evaluate the Plan.

12.1 Mitigation Relating to Objective 1 (Material Assets)

There are no straightforward approaches to mitigating impacts associated with material assets because much of the extraction of materials for primary production occurs overseas. Potentially, more efficient resource extraction processes may lead to a reduction in ancillary and excavated material flow. While there may be potential to increase the efficiency of extractive industries in England, this is generally out of the control of Central Government in respect of overseas operations. Voluntary agreements may have an impact on supply chains in this regard.

12.2 Mitigation Relating to Objective 2 (Global Air Emissions)

In many cases it will be difficult to avoid those climate change impacts at the level of the individual waste management facility which arise through direct emissions to air of the greenhouse gases. There may, however, be some scope for mitigating the impacts of facilities which produce energy through improving energy generation efficiency (including the utilisation of heat), as well as improving the efficiency with which materials are recovered for recycling from residual waste facilities.

Further potential for reducing the climate change impacts exists through the targeting of specific materials known to have a significant impact. Thus increasing the separation of plastics from the residual waste stream – either at the kerbside, or through the use of some form of pre-treatment such as occurs at an MBT facility – would result in a reduction in the climate change impacts associated with residual waste incineration, as this element of the waste stream contributes significantly to the overall climate change impacts associated with the latter method of waste treatment.

12.3 Mitigation Relating to Objective 3 (Local Air Emissions)

There is likely to be some potential for mitigating the air pollution impacts of waste management through an increase in recycling and waste prevention. In many cases it is difficult to determine the local benefits associated with waste prevention initiatives as these will be dependent in part upon the location of primary manufacture of the product concerned. In the case of food waste prevention, however, evidence from WRAP cited in Section 10.3.1 suggests that a significant proportion of avoidable food waste relates to goods manufactured in England, suggesting local benefits are likely to result from increased food waste prevention. An increase in organic waste recycling is similarly likely to reduce local air pollution impacts.

For dry recyclate, local benefits will depend on the relative locations of the primary and secondary manufacturing facilities. In many cases both will be located overseas. Where this is the case, there may still be some benefit from the avoided disposal of the material, although this will be dependent upon the material and the disposal route.

The use of MBT may also allow for the mitigation of local air pollution and health impacts associated with disposal, even where the fuel produced by the MBT process is used locally (as opposed to being shipped to a designated R1 facility overseas).

Where local air pollution is concerned, mitigation of the impacts is also influenced by the type of abatement equipment installed and the discharge conditions of any emission. This is particularly the case for incineration facilities, where use of SCR rather than SNCR offers opportunities to further reduce NOx emissions.

12.4 Mitigation Relating to Objective 4 (Biodiversity)

Mitigation of negative impacts on biodiversity, both in England, elsewhere in the UK, and overseas (by reducing total material requirement) can best be achieved through moving towards the top of the waste hierarchy. Across all sectors, increases in waste prevention (including reuse), preparation for reuse, and recycling have the potential to deliver major positive impacts.

However, if this cannot be achieved, an alternative is to consider offsetting enhancements for biodiversity, which might include habitat restoration. In order to mitigate the direct impacts on biodiversity that may be associated with specific facilities, sites should be selected with due consideration of biodiversity impacts – this will generally be an issue to be considered by the local planning authorities.

12.5 Mitigation Relating to Objective 5 (Water Resources)

Impacts on water resources and quality can best be mitigated through treating waste at the highest possible point on the hierarchy. Across all sectors, increases in waste prevention (including reuse), preparation for reuse, and recycling have the potential to deliver major positive impacts.

Where this is not possible, offsetting enhancements, such as wetland creation could be considered. These are more likely to be developed in response to a specific facility. However, most of the negative impacts on water are overseas, so wetland creation in England would be likely to only partially mitigate wider impacts.

Ensuring that conditions in a facility's Environmental Permit are sufficiently rigorous would appear to be the best way to mitigate localised impacts on water resources and quality.

12.6 Mitigation Relating to Objective 6 (Soil Quality)

Many of the impacts on soils associated with consumption of goods in England occur overseas. However, by managing waste in line with the hierarchy, negative impacts, largely associated with primary production, can be mitigated. Across all sectors, increases in waste prevention (including reuse), preparation for reuse, and recycling have the potential to deliver major positive impacts.

Where this is not possible, offsetting enhancements, such as further protection of peat bogs could be considered. However, most of the negative impacts on soil are overseas, so peat bog protection in England would be likely to only partially mitigate wider impacts.

The most appropriate way to mitigate localised impacts on soil quality would be to ensure that conditions in a facility's Environmental Permit are sufficiently rigorous.

12.7 Mitigation Relating to Objective 7 (Landscape and Historic Environment)

The impact on landscape and the historic environment from the plan and alternatives are largely attributed to the design of the individual waste management facilities and the location of siting. The local planning frameworks will be critical to providing sufficient controls to ensure that any negative effects on landscape and the historic environment are minimised.

Mitigation against negative impacts in these circumstances could include adapting the topographical design to reflect the local landform, landscape planting, fencing and earth bunds, appropriate use of cladding and colour treatments.

Conditions within planning permissions/ Environmental Permits granted could include measures to ensure that site restoration, particularly in the case of landfill, will complement the surrounding landscape.

Policies at a national level to reduce littering (for example through enforcement of anti-littering legislation and the provision of adequate bins etc) could also help to reduce the level of littering which has a negative impact on landscape and the historic environment.

13.0 Monitoring

The sections below set out possible approaches to monitoring the effects of the Plan against the objectives against which the Plan and alternatives have been appraised.

13.1 Monitoring Approach for Objective 1 (Material Assets)

The UK's Environmental Accounts[137] report material flows, i.e. the total mass of natural resources and products used by the UK. It will therefore be possible to monitor the trend in UK material flows year on year. While a separate breakdown is not presented for the individual countries, an estimate for material flows for England could possibly be derived on the basis of population, or regional GVA.

13.2 Monitoring Approach for Objective 2 (Climate Change)

Defra funds the annual UK greenhouse gas inventory which considers emissions from all sectors of the economy, including emissions from waste treatment facilities. This will assist in measuring performance against the government's carbon budgets. It is important to note that this only considers climate change impacts that occur within the UK – thus impacts relating to products consumed by UK citizens that were manufactured outside of the UK are not included. Benefits from waste prevention, product reuse, or recycling activities are unlikely to be fully captured by current monitoring arrangements where the associated reduction in primary manufacture occurs overseas. The use of a consumption-based approach to emissions accounting would however enable such improvements in performance to be monitored.

13.3 Monitoring Approach for Objective 3 (Air Pollution and Health Impacts)

Local air pollution monitoring networks are operated on behalf of Defra, and measure emissions to air of key pollutants including NOx and PM emitted by some waste treatment facilities. This monitoring activity is not specific to the waste sector but monitors local air pollution in general. Environmental Permits also include controls on emissions and breaches in these controls will be monitored by the Environment Agency.

The level of monitoring of these impacts through both general and site specific monitoring should be sufficient for the purpose of the Plan.

It will be extremely difficult to properly consider local air pollution benefits associated with waste prevention, reuse and recycling activities as a result of the highly dispersed nature of the manufacturing activity that results in the production of goods consumed in the UK. Given the nature of the impacts, and the difficulty of monitoring, it is likely that attempting to monitor such activities specifically will be disproportionate.

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[137] Office for National Statistics (2012) *UK Environmental Accounts 2012*, 27 June 2012. Available at: http://www.ons.gov.uk/ons/rel/environmental/uk-environmental-accounts/2012/stb-ukea-2012.html

13.4 Monitoring Approach for Objective 4 (Biodiversity)

The UK's Environmental Accounts[138] report material flows, i.e. the total mass of natural resources and products used by the UK. It will therefore be possible to monitor the trend in UK material flows year on year, which can act as a proxy for the impact on biodiversity.

While a separate breakdown is not presented for the individual countries, an estimate for material flows for England could possibly be derived on the basis of population, or regional GVA.

13.5 Monitoring Approach for Objective 5 (Water)

The UK's Environmental Accounts report the amounts of ground water and non-tidal surface water used by Industrial Sector in England and Wales for 2006-07. However, this does not account for the embodied water in food and items such as textiles that are imported, and is therefore not an appropriate indicator for measuring progress in respect of food waste prevention and textiles reuse.

A more appropriate approach might be to derive a fuller understanding of the overall level of food consumed (and wasted) in England, and also of the level of consumption and reuse of textiles. The water resource and quality impacts can then be attributed directly to these flows.

Similar calculations could also be made in respect of the consumption of primary and secondary materials such as paper, steel and aluminium and attribute the associated water use.

Details on the subsequent application of composted food and garden waste to land could also be used to estimate changes in impact on water resource and quality.

13.6 Monitoring Approach for Objective 6 (Soil)

The Countryside Survey measures long-term changes in physical, chemical and biological soil quality in the UK, taking four core samples from each of the Survey's 629 (1km) squares. The last survey was in 2007, and cores were taken from plots adjacent to past sample locations in 1978 and 1998, to ensure compatibility with previous results.[139]

However, as approximately eight years elapse between surveys, this is not an especially useful method of monitoring changes in waste management practices, notably in respect of waste prevention for food and textiles. Furthermore, such a survey does not account for the impacts on soils overseas. It is therefore not an appropriate indicator for measuring progress in respect of food waste prevention and textiles reuse.

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[138] Office for National Statistics (2012) *UK Environmental Accounts 2012*, 27 June 2012. Available at: http://www.ons.gov.uk/ons/rel/environmental/uk-environmental-accounts/2012/stb-ukea-2012.html

[139] Centre for Ecology and Hydrology (2010) *Countryside Survey: Soils Report from 2007*, 1 January 2010

A more appropriate approach might be to derive a fuller understanding of the overall level of food consumed (and wasted) in England, and also of the level of consumption and reuse of textiles. The soil quality impacts can then be attributed directly to these flows.

13.7 Monitoring Approach for Objective 7 (Landscape & Historic Environment)

The monitoring of impacts on landscape and historic environment from the Plan and alternatives will be extremely difficult since the impacts are almost entirely related to the specific location of the facility. That said the number of licenced facilities of each various type could be monitored, with this being used as a proxy indicator for impact on landscape and the historic environment. Indeed this data is already being captured by the Environment Agency for some waste facilities. Some information on land-take and the main dimensions of buildings could also be used.

14.0 Consultation

Comments are welcomed on this Environment Report. Comments received will be taken on board as appropriate before the Environment Report is finalised and published.

We would be grateful if you could provide a response to the following questions:

Question 1: Do you agree with the results of the appraisal?

If not why not?

Question 2: Do you consider that there is any important information that has not been addressed in the appraisal?

14.1 How to Respond

Comments on this Environment Report should be sent to:

[XXXXXXXX]

Alternatively responses can be emailed to XXXXXXX

The closing date for responses is [xxxxx].

14.2 Confidentiality and Data Protection

Your response may be made public by Defra. If you do not want all or part of your response or name made public, please state this clearly in the response. Any confidentiality disclaimer that may be generated by your organisations' IT system or included as a general statement in your fax cover sheet will be taken to apply only to information in your response for which confidentiality has been specifically requested.

Information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the access to information regimes (these are primarily the Freedom of Information Act 2000 (FOIA), the Data Protection Act 1998 (DPA) and the Environmental Information Regulations 2004).

If you want other information that you provide to be treated as confidential, please be aware that, under the FOIA, there is a statutory Code of Practice with which public authorities must comply and which deals, amongst other things, with obligations of confidence.

In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

The Department will process your personal data in accordance with the DPA and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties.

A.1.0 Other Plans & Programmes

Table 22 shows the relevant plans and programmes and key legislation considered for the Scoping Report and subsequent Environmental Report. Please note that this list is not intended to be an exhaustive list of all existing documents relevant to waste. Instead it is intended to highlight the key relevant issues and objectives.

Table 22: Relevant Plans and Programmes

Plan/Programme/ Legislation	Relevance to Plan
International Plans\Programmes\ Legislation	
Revised Waste Framework Directive 2008/98/EC	Provides overarching legislative framework for the collection, transport, recovery and disposal of waste, and includes common terminology and a definition of waste. Sets the 'Relevant Objectives' of protecting human health and the environment against harmful effects caused by the collection, transport, treatment, storage and tipping of waste. Establishes the waste hierarchy as a principle for waste management. The following targets have been specified: household recycling rate of 50% by 2020, construction and demolition recovery 70% by 2020. Article 28 of the Directive dictates that Member States *'must establish waste management plans that sets out an analysis of the current waste management situation… as well as the measures to be taken to improve environmentally sound preparing for re-use, recycling, recovery and disposal of waste and an evaluation of how the plan will support the implementation of the objectives and provisions of this Directive.'*
Landfill Directive 1999/31/EC	Aims to prevent or reduce the negative environmental effects of landfilling waste, by introducing stringent technical requirements for waste and landfills. Introduces targets for the reduction of Biodegradable Municipal Waste sent to landfill. These are: ➢ 75% of 1995 levels by 2010; ➢ 50% of 1995 levels by 2013; and ➢ 35% of 1995 levels by 2020. Requires landfill gas recovery where viable. These measures are implemented in England and Wales through the Environmental Permitting Regulations 2010, with landfill targets being dealt with under the Waste and Emissions Trading Act 2003.

Plan/Programme/ Legislation	Relevance to Plan
Incineration of Wastes Directive 2000/76/EC	Aims to prevent or limit as far as practicable the negative effects of incineration/co-incineration of waste. Specifies that heat generated during the process is recovered as far as practicable and that residues will be minimised and recycled where appropriate (Article 4) Introduces stringent emission limits and process requirements. Transposed into law (England and Wales) through the Environmental Permitting Regulations 2010.
Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC, 2003/108/EC, and 2008/34/EC	The aims of the Directive (as amended) include: ➢ reduce waste arising from EEE; ➢ make producers of EEE responsible for the environmental impact of their products, especially when they become waste; ➢ encourage separate collection and subsequent treatment, reuse, recovery, recycling and sound environmental disposal of EEE; ➢ improve the environmental performance of all those involved during the lifecycle of EEE. A rate of separate collection of at least 4 kg on average per inhabitant per year of waste electrical and electronic equipment from private households must be achieved. Transposed into law by the Environmental Permitting (England and Wales) Regulations 2010 and the Waste Electrical and Electronic Equipment Regulations 2006.
Batteries Directive 2006/66/EC	Seeks to improve environmental performance of batteries and accumulators and the activities of all economic operators involved in their life cycle. Collection target of 25% for waste portable household batteries to be met by 2012 (45% by 2016). All identifiable separately collected batteries must be recycled. The directive introduces an immediate ban on the final disposal of automotive and industrial batteries into landfill and incineration. Recycling efficiency targets are introduced and must have been met by 2011 – 65% by average weight of lead-acid batteries and accumulators (75% nickel-cadmium, 50% other). Transposed into law by the Environmental Permitting (England and Wales) Regulations 2010 and the Waste Batteries and Accumulators Regulations 2009.

Plan/Programme/ Legislation	Relevance to Plan
Hazardous Waste Directive 2008/98/EC	The EC revised its list of hazardous waste and incorporated it into the European Waste Catalogue. The revised list includes a number of waste streams not previously considered to be hazardous, including televisions, computer monitors, fluorescent lighting and end-of-life vehicles. Includes a requirement for most producers of hazardous waste to notify their premises to the Environment Agency.
Animal By-Products Regulations EC 1069/2009	Controls the disposal of animal by-products containing meat. Prescribes specific treatment requirements including composting, anaerobic digestion, rendering and incineration.
Water Framework Directive 2000/60/EC	Provides protection and objectives for the quality enhancement of natural water sources in the EU. These include surface freshwater; groundwater; estuaries; and coastal waters out to one mile from low water. Objective to achieve 'good status' for all EU waters, including surface and groundwater by 2015, extended to 2027 with six yearly reviews for a phased achievement approach. Transposed into law by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.
Habitats Directive 92/43/EEC	Provides protection for animal and plant species, and habitats of European importance. The directive establishes the Natura 2000 network; a network of protected nature sites within the EU. Transposed into law by The Conservation of Habitats and Species Regulations 2010.
Birds Directive 2009/147/EC	Provides protection for all wild bird species naturally occurring within the EU. Transposed into law by the Wildlife and Countryside Act 1981 (as amended); the Conservation of Habitats and Species Regulations 2010; and the Offshore Marine Conservation (Natural Habitats, etc.) Regulations 2007.

Plan/Programme/ Legislation	Relevance to Plan
The European Landscape Convention (Florence Convention) 2000	International treaty concerned with the protection and management of European landscape. Applies to participating parties' entire territory. Contracting parties' are obligated to introduce policy instruments to manage, plan and protect landscapes. Quality objectives are to be identified following public consultation. Signed by the UK government in 2006.
The Industrial Emissions Directive 2010/75/EU	The IED coalesces seven existing directives into one – The Waste Incineration Directive (WID), the Large Combustion Plant Directive (LCPD), the Integrated Pollution Prevention and Control Directive (IPPCD), the Solvent Emissions Directive (SED) and three directives on Titanium dioxide concerning its monitoring, reduction and disposal. In the directive employs an integrated approach with permits requiring assessment of the entire environmental performance. Changes to the WID include a lowering of NOx Emission Limit Values for cement kilns co-incinerating waste. Transposition into UK law has a deadline of 6th Jan 2013 for new installations, 2014 for existing installations (before 2013) and 2015 for activities not subject to the IPPC.
National Plans\ Programmes\ Legislation	

Plan/Programme/ Legislation	Relevance to Plan
Waste Review 2011	The main aim for this strategy is to prioritise efforts to manage waste in line with the waste hierarchy and reduce the carbon impact of waste. The key emphasis is on developing voluntary approaches to improving waste management and to work closely with business sectors and the waste and material resources industry to achieve strategic aims. Other points as set out in the strategy are: ➢ Consult on the case for higher packaging recovery targets for some key materials; ➢ Support energy from waste where appropriate, and for waste which cannot be recycled; ➢ Work to overcome the barriers to increasing the energy from waste which anaerobic digestion provides, as set out in the new AD strategy; ➢ Consult on restricting wood waste from landfill and review the case for restrictions on sending other materials to landfill. Councils are to be encouraged to reward and recognise people who do the right thing to reduce, reuse and recycle their waste, to increase the frequency and quality of rubbish collections, and to sign the new Recycling & Waste Services Commitment. Councils will be stopped from criminalising householders for bin offences, while ensuring that stronger powers exist to tackle those responsible for fly-tipping and serious waste crime. Similarly enforcement regulation is to be reduced for small businesses, concentrating on serial offenders. The Waste Review commits to the following: ➢ Meet or exceed EU household recycling targets of 50% by 2020; ➢ EU Landfill Directive targets for 2013 and 2020; ➢ The target for 15% of energy coming from renewable sources will in part be expected to be taken up by the waste industry, especially through AD technologies; ➢ EU Waste Framework target 70% of the recovery of construction and demolition waste by 2020; ➢ A range of producer responsibility targets (WEEE, ELV, batteries).

Plan/Programme/ Legislation	Relevance to Plan
Waste Review Action Plan 2011	The action plan outlines the direct actions Government will take to follow through the strategy set out in the Waste Review. It contains 62 actions, covering the following headings: ➢ Public Sector Leading by Example – providing guidance and best practice advice; ➢ Modernising waste regulation and its enforcement; ➢ Energy from Waste; ➢ Helping and Rewarding (incentive schemes etc); ➢ Preventing waste; and ➢ Responsibility deals with business.
Environmental Protection Act 1990 as amended	This Act defines the fundamental structure and authority for waste management and the control of emissions into the environment. This sets out a regime for managing controlled waste and its disposal. The Act confers a duty of care on those who deal with waste, and set out (through secondary legislation) what is defined as household, commercial and industrial waste and the roles of waste collection and waste disposal areas in two tier local authority areas. It was amended by the Household Waste Recycling Act 2003 to require all local authorities to collect at least two types of recyclable waste separate from the rest of the household waste (unless the cost of doing so is unreasonably high or where comparable alternative arrangements are available).

Plan/Programme/ Legislation	Relevance to Plan
Waste (England and Wales) Regulations 2011	This is the main piece of legislation which implements the revised WFD. There are a number of changes that were made through these regulations. These include: ➢ Placing greater emphasis on the waste hierarchy to encourage more waste prevention, re-use and recycling. The hierarchy will have to be applied by businesses transferring waste and by environmental permit holders whose operations generate waste. The waste producer has the most important role in this. ➢ Excluding from waste controls some types of waste, notably animal by-products, as these are controlled now by other legislation. ➢ Some amendment to obligations under duty of care to take account of the waste hierarchy, such as a declaration on transfer notes and hazardous waste consignment notes. ➢ Introducing a two-tier carrier and broker registration system, including an obligation on waste producers carrying their own (non-construction/demolition) waste to register by end of 2013, and a new concept of 'dealer'. ➢ Minor amendments to the assessment of hazardous waste and to the consignment note procedures and record keeping requirements. ➢ Bringing certain categories of radioactive waste under waste control[140].
Environmental Permitting Regulations 2007 and 2010 (as amended)	The Environmental Permitting regulations provide a single framework for a number of activities relating to the environment including waste management. The regulations transpose elements of the WEEE Directive, Batteries Directive, Mining Waste Directive, End of Life Vehicles Directive, and the Ozone Depletion Directive. The regulations include the Pollution, Prevention and Control regime, which transposes the requirements of the 2008 IPPC Directive.

140 See http://www.environment-agency.gov.uk/business/regulation/129220.aspx

Plan/Programme/ Legislation	Relevance to Plan
Producer Responsibility Obligations (Packaging Waste) Regulations 2007	The regulations set a statutory producer responsibility system for those companies with a turnover in excess of £2m per year and who handle more than 50 tonnes of packaging per year. The system involves the provision by the producer of Packaging Waste Recovery Notes (PRNs), as evidence that the appropriate level of recycling and reprocessing is taking place. The packaging regulations set annual business targets for recovery and recycling of packaging waste, which for 2012 as 68.1% for recycling although the Waste Review has stated targets are to be reassessed.
Hazardous Waste Strategy 2010	The Strategy for Hazardous Waste Management 2010 underpins the practical application of the revised EC Waste Framework Directive (2008/98/EC) (WFD) in relation to hazardous waste. It aims to clarify how the requirements of the revised WFD should be implemented, particularly the revised waste hierarchy with respect to the management of hazardous waste. The Strategy is also intended to facilitate the provision of infrastructure for the management of hazardous waste.
Hazardous Waste National Policy Statement 2011	This policy statement which has been subject to consultation in 2011, sets out policy and restrictions relating to new waste infrastructure.
Hazardous Waste (England and Wales) Regulations 2005	These regulations make provision for the controlled management of hazardous waste from the point of production to the final point of disposal or recovery. The regulations were implemented to transpose, as from 2005, the Waste Framework Directive.
List of Waste (England) Regulations 2005	These regulations also were driven by the Waste Framework Directive, and set out a national list of the categories of hazardous waste subject to the regulation.
Transfrontier Shipment of Waste Regulations 2007 (SI 2007 No 1711)	It sets out the rules for exporting waste and creates offences and penalties for non-compliance and designates the competent authorities responsible for enforcement in the UK.

Plan/Programme/ Legislation	Relevance to Plan
AD Strategy and Action Plan 2011	This document is the first step towards a road map for achieving the Government's commitment to increasing energy from waste through anaerobic digestion. This reflects the high level priority given to anaerobic digestion in the Waste Review. Although there is no specific target set for energy yields from AD, it is estimated in this strategy that AD might produce between 3 and 5 Terawatt Hours by 2020. (To give this some context, total renewable energy output in the third quarter of 2011 was 7.85TWh, 9.6% of total energy generation, according to DECC's quarterly reports).
Guidance on Applying the Waste Hierarchy to Hazardous Waste 2011	The guidance is produced under regulation 15(1) of the Waste (England and Wales) Regulations 2011 and any person subject to the regulation 12 duty must have regard to it (regulation 15(2)). It provides guidance to those dealing with hazardous waste as to how to apply the waste hierarchy.
Waste and Emissions Trading Act 2003	Part one of this Act allowed for the implementation of the Landfill Allowance Trading Scheme, which is about to be removed from the statute books in April 2012. Part two of the Act places on a statutory footing the method by which participants in the Emission Trading Scheme (ETS) can be given penalties for non-compliance in the scheme.
Waste Batteries and Accumulators Regulations 2009	These regulations partially implement the Batteries Directive. The deadline for reaching the Directive's 25% collection target is 2012, (45% by 2016).
Finance Act 1996 and Landfill Tax Regulations 1996	The Landfill Tax regulations introduced a charge on the tonnage accepted by all licensed landfill sites. This tax has been subject to a planned escalator over the years and has become a primary economic instrument for the prevention of landfill waste. The tax for 2012-13 is £56 per tonne, and will continue to rise until 2014-15 when it will become £80 per tonne.
UK Plan for Shipments 2007	This sets out Government policy on shipments of waste to and from the United Kingdom.
The Climate Change Act 2008	The Climate Change Act 2008 (the Act) commits the Government to binding cuts in greenhouse gas emissions, of at least 80 per cent by 2050 from 1990 level. This includes setting and achieving five-year budgeted targets within that timeframe.

Plan/Programme/ Legislation	Relevance to Plan
The Air Quality Standards Regulations 2010	Divides England into Zones and Agglomerations for the purposes of measuring air quality. Specifies the type of pollutants that must be measured and how this is to be achieved. Links back to the requirements of the two main EU directives on air pollution: 2008/50/EC and 2004/107/EC
Mainstreaming Sustainable Development 2011	The latest in a series of SD strategies first published in 1995. The 2011 strategy puts forward a series of 'Growth Reviews' with which to measure progress. A review of progress for year 1 has been published in 2012. The concept of mainstreaming is to embed sustainability in other policy areas of Government. The new measures in the strategy include: ➢ The Environment Secretary to sit on key domestic policy Cabinet committees ➢ Reducing the Government's waste generation by 25% the end of the current Parliament ➢ A more responsible procurement policy ➢ Defra to review departmental business plans ➢ Develop measurable indicators for improvements in sustainability, including monitoring by the Environmental Audit Committee and better reporting of results.
PPS10: Planning for Sustainable Waste Management **ODPM 2011**	Sets out the requirement to manage waste as sustainably and safely as possible in line with the waste hierarchy, without risk to health or environment, and close to source. Policies should enable timely and sufficient provision of sites to meet local needs. All Local Planning Authorities should consider impact of non-waste development on existing waste infrastructure or proposals. This is under a currently being revised. Once this process is complete, the revised PPS10 will form part of the Plan.

Plan/Programme/ Legislation	Relevance to Plan
National Planning Policy Framework 2012	The framework, published on 27th March 2012, is intended to make the planning system both simpler and fairer by applying a consolidated set of priorities that are clear and easy to understand, that provides a benchmark across all regions, communities, and authorities. The framework defines its overall purpose to be the achievement of sustainable development (as defined within a social, economic and environmental context), and commits to the principle of 'presumption in favour' of sustainable development. There is also specific attention paid to local decision-making, and the reuse of land or 'brownfield' development. The framework does not contain specific waste policies, ceding this responsibility to the Plan. However local authorities making decisions surrounding waste are advised to take heed of the policies therein. The Waste Planning Policy Statement will remain in place until the Plan is set up to replace it.
Localism Act 2011	The Localism Act contains five key measures: ➢ Community powers to take over land and buildings ➢ Neighbourhood plans to influence local planning decisions ➢ Localised decision making for housing issues ➢ Extra powers afforded to cities to develop their areas ➢ Granting local authorities 'general power of competence', i.e. Powers equivalent to what any individual has. The Act also provides for a 'duty to co-operate' in relation to planning of sustainable development outlined in Part 6, Chapter 1, Section 110, This will apply to planning for strategic waste management.
National Infrastructure Plan NIP 2 2011	This document contains analysis of over 500 key projects in the pipeline and their relative strengths and weaknesses, provides details of how projects will be financed, and finally further action is promised to strengthen government control of achieving strategic objectives, including the appointment of a new Cabinet Committee to ensure planned infrastructure is delivered on time.

Plan/Programme/ Legislation	Relevance to Plan
Bio Energy Strategy 2012	The UK bioenergy strategy, published jointly by DECC, Defra, DfT sets a framework of principles to guide UK bioenergy policy in a way that secures its benefits, while managing these risks. The strategy's overarching principle is that bioenergy must be produced sustainably and that there is a role for UK Government to steer sustainable development of bioenergy in the UK and as far as possible internationally.
Renewable Energy Directive 2009	Sets a target for the UK to achieve 15% of its energy consumption from renewable sources by 2020.
The Conservation of Habitats and Species Regulations 2010	Provides protection for animal and plant species, and habitats of European importance. The directive establishes the Natura 2000 network; a network of protected nature sites within the EU. The Regulations provide control of potentially damaging operations within or adjacent to a protected site. Country agencies are to provide consent for such operations following appropriate assessments to establish any adverse effects on the site. A review of consents granted under the Wildlife and Countryside Act 1981 for land within a protected site are required by country agencies, which may result in the modification or withdrawal of those not aligned with the conservation objectives of the site. National legislation transposed from the European Habitats Directive.
PPS9 – Biodiversity and Geological Conservation ODPM 2005 (including ODPM Circular 06/2005)	Sets out planning policies for the protection of biodiversity and geological conservation. Policies aim to maintain, restore, enhance or add to biodiversity and geological conservation interests. Policies required to be taken into account by regional planning bodies in the preparation of regional spatial strategies and local development documents. Circular 06/2005 provides administrative guidance on the impact of legislation relating to planning and nature conservation.

Plan/Programme/ Legislation	Relevance to Plan
Town and Country Planning Act 1990	Controls and consents development which is defined as building, engineering, mining or other operations in. on, over or under land, or the making of any material change in the use of any building or land. Under the act a development plan is produced by the local planning authority which has two parts; a structure plan, drawn up by the county council; and a local plan, drawn up by the district council. This plan provides a detailed basis for development control and brings planning issues before the public. In metropolitan areas with no county council, a unitary plan is drawn up which resembles the structure and local plans.
Planning (Listed Buildings and Conservation Areas) Act 1990	Relates controls with regard to buildings and special sites of historical or architectural interest. Part 1 concerns listed buildings with the introduction of building preservation notices, and development authorisation procedures. It also outlines the legal rights of owners. Part 2 introduces the power to designate areas of special architectural or historic interest as conservation areas which are desirable to preserve or enhance.
The Planning and Compulsory Purchase Act 2004	Introduced reforms to the planning system with amendments and replacements of sections of the Town and Country Planning Act 1990. The Local Development Framework formed the majority of reforms replacing unitary, local and structure plans with regional spatial strategies. Within these regions, local planning authorities will comprise the policies in local development documents, aiming to make the process quicker.
Planning Act 2008	Introduces a system for consenting applications to develop nationally significant infrastructure projects (NSIPs). The Act also creates an independent Infrastructure Planning Commission (IPC) to implement the consenting of such projects. Policy on which projects to be included is outlined in National Policy Statements (NSPs) and applications are to be considered by the Infrastructure Planning Commission (IPC) based on these statements.

Plan/Programme/ Legislation	Relevance to Plan
National Policy Statement for Waste Water 2012	Sets out policy for the provision of major waste water infrastructure and forms the primary basis for decision making with regard to the consenting of developments falling within the definition of NSIPs. The definition of NSIP in the context of waste water is given as: ➢ Construction of waste water treatment plants which are expected to have a capacity exceeding a population equivalent of 500,000 when constructed; or ➢ alterations to waste water treatment plants where the effect of the alteration is expected to be to increase the capacity of the plant by more than a population equivalent of 500,000. Of particular relevance to the Waste Management Plan is the requirement for hazardous substances consent for any establishment holding stocks of certain hazardous substances. This consenting alongside the development consent is implemented by the Health and Safety Executive (HSE).
National Policy Statement for Ports	Provides the framework for decisions on proposals for new port development and associated development such as road and rail links which fall within the definition of NSIPs. In the context of ports, and NSIP is defined as a development with an estimated incremental annual capacity that exceeds: ➢ 0.5 million twenty-foot equivalent unit (teu) for a container terminal; ➢ 250,000 movements for roll-on roll-off; ➢ 5 million tonnes for other (bulk and general) traffic; or ➢ A weighted sum equivalent to these figures taken together. Of particular relevance to the Waste Management Plan is the requirement for hazardous substances consent for any establishment holding stocks of certain hazardous substances. This consenting alongside the development consent is implemented by the Health and Safety Executive (HSE).

Plan/Programme/ Legislation	Relevance to Plan
The Natural Environment White Paper 2011	This statement outlines the Government's strategy for the natural environment of the next 50 years with actions to reach an outlined objective of natural assets contributing to robust and resilient ecosystems, providing goods and services in order for increasing numbers of people to enjoy the benefits of a healthier natural environment by 2060. Actions to achieve this objectives include: ➢ Giving local people more involvement in the natural environment and helping them to realise the benefits. ➢ Helping to develop a thriving green economy, developing payments for ecosystem services and addressing barriers to using green infrastructure to promote sustainable growth. ➢ Helping to deliver the Government's ambitions for resilient ecological networks, biodiversity recovery, sustainable agriculture, healthy woods and forests, an improved water environment and a better protected marine environment. ➢ Taking action to address the risks and consequences of climate change and other pressures. ➢ Delivering conservation at the landscape scale, including through Nature Improvement Areas. ➢ Further improving how we monitor progress and provide access to environmental information.
National Character Area Profiles	Based on ecosystem data and analysis, these documents provide identification of key environmental opportunities, recent landscape changes and trends, detail of the supporting data and analysis, and context for local decision making and action. Currently six profiles have been published with no timescale provided for any further additions.
The Ancient Monuments and Archaeological Areas Act 1979	Protects sites of national importance as ancient monuments. These ancient monuments can be either scheduled or any other monument deemed of public interest by reason of historic, architectural, traditional, artistic or archaeological interest attached to it.

Plan/Programme/ Legislation	Relevance to Plan
Water Resources Act 2003	Controls the regulation of the impoundment and abstraction of water from natural sources. This act amends the Water Resources Act 1991 and aims to improve long term water resource management by reforming the licensing structure and process for impoundment and abstraction.

In addition to the plans and programmes listed above, the recent revocation of the regional spatial strategies will have an impact on how waste is managed at a more local scale, with cross border working across regions being potentially less formal. The focus for delivering spatial waste plans and implementing the directive lies more at the local authority level. In the absence of the Regional Spatial Strategies waste planning authorities are expected to continue to take forward their waste plans to provide land for waste management facilities to support the sustainable management of waste.

A.2.0 Baseline Information

A.2.1 Biodiversity

Given that the Plan does not take into account or provide guidance on the location of specific waste management activities, the local biodiversity impacts are outside the control of the Plan and will be dealt with in the waste plans at a local level. Therefore baseline information relating to biodiversity, flora and fauna have not been collected in any detail. It is, however, useful for contextual purposes to provide a brief summary of key points.

England's range of habitats and species have national and international importance. Some examples of particularly important habitats and species given by Natural England include:

- Breeding seabirds, wintering waders and wildfowl, with 18% of the world's heathland;
- Bats;
- Oceanic lichens;
- Ancient woodland;
- Chalk rivers and coasts; and
- Nearly 20% of Europe's Atlantic and North Sea estuaries.

England is experiencing a net loss of biodiversity, which needs to be reversed. Over 40% of priority habitats and 30% of priority species are in decline.[141] There is some debate over the general trends in the loss of biodiversity and whether we are entering a period of mass extinction, but long term industrialisation, urbanisation and population increase has been proven to have had a direct effect on the number and population of plant and animal species in the past 200 years. A clear example of this is the extinction of large mammals such as wild boar and lynx. Since 1700 on average 1 plant species is lost every two years, with the highest losses being incurred in the 20th Century and having increased further since the 1960s. There is a similar trend for invertebrates.

Conservation efforts in the past 15 years have resulted in a revival of a number of priority species which have experienced stabilisation or recovery in numbers. These include 45 species which have enjoyed an increase, and 128 species which have stabilised. Examples of expanding numbers include, otters and certain varieties of bats, butterflies, spiders and birds.[142]

The response to the threat to habitats and species at an international and national level is as follows: October 2010: over 190 countries signed an historic global agreement at the Convention of Biological Diversity in Nagoya, to build a framework for national plans for biodiversity protection. In June 2011, the Government published 'The Natural Choice'[143] –

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[141] Biodiversity 2020 Strategy 2011 (Defra)

[142] Lost Life: England's Lost and Threatened Species (Natural England 2010)

[143] The Natural Choice: Securing the Value of Nature (2011) HM Government White Paper

the first Natural Environment White Paper for 20 years, responding to the global commitments made at Nagoya. In June 2011, EU Member States endorsed the European Commission's EU Biodiversity Strategy. English strategy in relation to biodiversity has been set out in the Government paper 'Biodiversity Strategy 2020' which was published in 2012. This paper sets out how the Government is implementing its EU and international commitments, for land, rivers, lakes and the sea. The strategy is designed to conform to the framework for national plans established by the Convention on Biological Diversity (CBD) Strategic Plan.

Biodiversity 2020 [144] outlines a Vision for England:

> *By 2050 our land and seas will be rich in wildlife, our biodiversity will be valued, conserved, restored, managed sustainably and be more resilient and able to adapt to change, providing essential services and delivering benefits for everyone.*

The associated '2020 Mission' is described as follows:

> *Our mission is to halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people.*

The four related outcomes are:

- Outcome 1 – Habitats and ecosystems on land: By 2020 we will have put in place measures so that biodiversity is maintained and enhanced, further degradation has been halted and where possible, restoration is underway, helping deliver more resilient and coherent ecological networks, healthy and well-functioning ecosystems, which deliver multiple benefits for wildlife and people;
- Outcome 2 – Marine habitat, ecosystems and fisheries: By 2020 we will have put in place measures so that biodiversity is maintained, further degradation has been halted and where possible, restoration is underway, helping deliver good environmental status and our vision of clean, healthy, safe productive and biologically diverse oceans and seas'
- Outcome 3 – Species: By 2020, we will see an overall improvement in the status of our wildlife and will have prevented further human-induced extinctions of known threatened species; and
- Outcome 4 – People: By 2020, significantly more people will be engaged in biodiversity issues, aware of its value and taking positive action.

Protected Sites

Over a quarter of land in England is protected either because of its biodiversity importance or because it is a high quality landscape.[145] Areas known to have special importance in

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[144] Department for Environment Food and Rural Affairs (2011) *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*, 2011

[145] Natural England. See http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/englands/default.aspx

relation to biodiversity are protected under both national and international law. Some of these areas, known as Special Protection Areas (SPAs) for Birds and Special Areas of Conservation (SACs), are designated as being of international importance. They have been created under the EC Birds Directive and Habitats Directive. In the UK they form part of a larger European network called Natura 2000. In addition, the UK and its Overseas Territories and Crown Dependencies also contribute to global networks of protected sites created under the Ramsar, World Heritage and OSPAR Conventions. Table 23 shows the areas given protected status in England.

Table 23 Designated Areas in England[146]

Designation	Description	Legal Framework	Sites in England
Areas of Special Protection (AoSP)	Designation aims to prevent the disturbance and destruction of the birds for which the area was identified, by making it unlawful to damage or destroy either the birds or their nests and in some cases by prohibiting or restricting access to the site	Sanctuary Areas, originally designated under the Protection of Birds Acts 1954, were amended to AoSPs under the Wildlife and Countryside Act 1981.	No data
Ramsar Sites	Ramsar sites are designated under the Convention on Wetlands of International Importance, agreed in Ramsar, Iran, in 1971. Originally intended to protect sites of importance especially as waterfowl habitat, the Convention has broadened its scope over the years to cover all aspects of wetland conservation and wise use, recognizing wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities	Ramsar Convention	73 plus 2 proposed sites
Sites of Special Scientific Interest (SSSI)	The SSSI/ASSI series has developed since 1949 as the national suite of sites providing statutory protection for the best examples of the UK's flora, fauna, or geological or physiographical features. These	Wildlife and Countryside Act 1981. Improved provisions for the protection and management of SSSIs	>4000

146 Statistics from Joint Nature Conservation Committee

Designation	Description	Legal Framework	Sites in England
	sites are also used to underpin other national and international nature conservation designations. SSSI condition assessments data is particularly useful in looking at the likely impacts of any plan or programme. These show that only 37% of SSSIs are in a favourable condition. A detail of the condition breakdown is as follows[147]: • Favourable – 37.31% • Unfavourable recovering – 59.32% • Unfavourable no change – 2.21% • Unfavourable declining – 1.13% • Destroyed/part destroyed – 0,03%	were introduced by the Countryside and Rights of Way Act 2000 (in England and Wales)	
Special Areas of Conservation (SAC) and Sites of Community Importance (SCI)	SACs are areas which have been identified as best representing the range and variety within the European Union of habitats and (non-bird) species listed on Annexes I and II to the Habitat's Directive. SCIs are sites that have been adopted by the EC but not yet formally designated by the Government.	SACs are designated under the EU Habitats Directive. SACs in terrestrial areas and territorial marine waters out to 12 nautical miles are designated under the Conservation of Habitats and Species Regulations 2010. Along with SPAs they make up the Natura 2000 network of sites.	251 existing sites plus 10 candidate sites
Special Protection Areas (SPA)	SPAs are areas of the most important habitat for rare (listed on Annex I to the Birds Directive) and migratory birds within the European	SPAs are classified by the UK Government under the EU Birds Directive. SPAs in	84 current sites plus 1

[147] Natural England. See http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?Report=sdrt15&Category=N&Reference=0

Designation	Description	Legal Framework	Sites in England
	Union.	terrestrial areas and territorial marine waters out to 12 nautical miles are classified under the Wildlife and Countryside Act 1981. Along with SACs they make up the Natura 2000 network of sites.	potential site
National Nature Reserves (NNR)	NNRs are a selection of the best SSSI and are established to protect sensitive features (e.g. rare species, geology and habits) and provide areas for research.	It is their designation as a SSSI under Wildlife and Countryside Act 1981 that gives NNR their legal protection.	224
Local Nature Reserves (LNR)	LNR's are sites that are of importance to wildlife, geology, education or public enjoyment. They are declared at district and county council level.	Section 21 of the National Parks and Access to the Countryside Act 1949, and amended by Schedule 11 of the Natural Environment and Rural Communities Act 2006	<35,000
Nature Improvement Areas (NIA)	NIAs aim to deliver and improve ecological networks that are of benefit to wildlife and people	2011 Natural Environment White Paper	12

A.2.2 Landscape

There are currently 10 National Park Authorities in England which are protected areas because of their beautiful countryside, wildlife and cultural heritage. The English National Park Authorities Association have a number of policy statements that set out broad over-arching policy objectives for which impacts of the Plan should be considered against. The statements of some relevance to the Plan relate in particular to climate change, transport and renewable energy. The main themes that emerge from these policy statements are:

- Monitoring, mitigating and adapting to Climate Change
- Creation of 'carbon neutral' National Parks by promoting energy conservation, efficiency and small scale renewable energy project

- Tailoring of traffic to exiting road networks and creation of sustainable transport networks.

Areas of Outstanding Natural Beauty (AONBs) are distinctive landscapes of outstanding quality and value. They are designated in recognition of their national importance and to provide a mechanism to ensure their character and qualities are protected. Designated under the National Parks and Access to the Countryside Act 1949 (amended in the Environment Act 1995) and the Countryside and Rights of Way Act 2000, there are currently 33 ½ AONBs covering a total of 18% of the English countryside[148]. It is outside the scope of the Plan to consider impacts on individual AONB management plans and therefore this information has not been collected in detail. However is useful in this case to consider the boarder common objectives of the AONB family:

- Conserve and enhance the natural and cultural heritage of the UK's Areas of Outstanding Natural Beauty, ensuring they can meet the challenges of the future

- Support the economic and social well-being of local communities in ways which contribute to the conservation and enhancement of natural beauty

- Promote public understanding and enjoyment of the nature and culture of Areas of Outstanding Natural Beauty and encourage people to take action for their conservation

- Value, sustain, and promote the benefits that the UK's Areas of Outstanding Natural Beauty provide for society, including clean air and water,

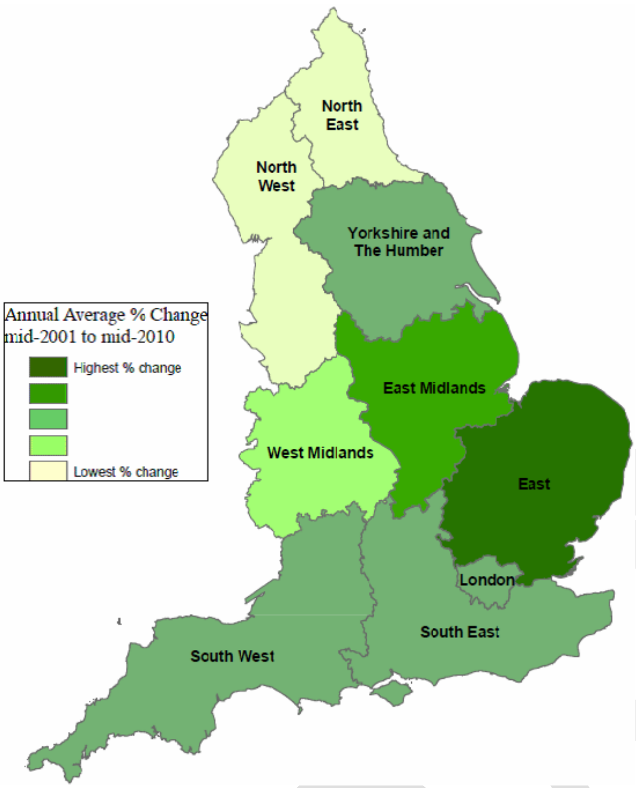
A.2.3 Population & Households

The number of residents living within an area and the average household size are key factors influencing waste generation and collection. England has the fastest growing population in the United Kingdom, which, as at 2010, stands at 52,234,000. The population rose by 0.8% between 2009 and 2010, with regional variations being shown in Figure 11. The population of England is expected to rise to 60.4 million by 2030. The age structure is projected to be ageing with the median age for the United Kingdom increasing from 39.7 years in 2010 to 42.2 years in 2035. Population density, an important factor in waste management planning, shows significant variations between regions and continues to rise most steeply in the South East. Overall density is rising as the population rises (UK: 252 people/km^2 in 2007 rising to 257 people/km^2 in 2010).[149]

[148] National Association of AONBs. See http://www.aonb.org.uk

[149] World Bank

Figure 11 Population change for English Regions mid-2002 to mid-2010[150]



In the UK as a whole there are 26 million households, with the most notable long term trend being that more and more households have only a single occupant, currently 29% of all households.

A.2.4 Human Health

As mentioned in the main text, most studies suggest that the health impacts associated with waste management are small. The principle contributions to those health impacts for which waste management is responsible are the air pollutants released through both the treatment processes themselves and the transport of material, whilst some offsetting benefits can be derived from the recycling of materials of the generation of energy (avoiding pollution from the extraction and processing of primary materials, or from generation of energy from alternative sources). Poor outdoor air quality can be a contributing factor to health problems as well as damaging ecosystems, biodiversity and valued habitats.

The adverse health effects from short and long-term exposure to marginal increases in air pollution range from reduced life expectancy caused by heart and lung disease to worsening of asthmatic conditions, which often leads to a reduced quality of life and increased costs of

[150] Office for National Statistics

hospital admissions. Despite improvements over recent decades, air pollution is still expected to reduce life expectancy of every person in the UK by an average of six months with an estimated annual cost to society of up to £19 billion.[151] However, the contribution of waste management to this overall impact may be relatively small.

The following general indicators of health status are of interest in the context of the issue, but as noted above, the contribution of waste management to these impacts is believed to be very small:

- In England life expectancy, at 78.0 for males, and 82.1 for females is slightly higher than the UK averages (77.0 and 81.9) (2007-9). Around 80% would expect to live a healthy life. At the age of 65 English males and females would expect a somewhat longer healthy life expectancy that other parts of the UK.[152]
- The prevalence of lifetime doctor-diagnosed asthma was 16% among men (17% for boys) and 17% among women (12% for girls), and decreased with age for both sexes. 9% of men and 10% of women currently had asthma, having experienced symptoms of asthma, or with their symptoms controlled by medication, in the last 12 months. Those living in lower income households are more likely to suffer from Asthma than those in higher income households.[153]
- In the UK 5.4 million people receive treatment for asthma – a condition which can be exacerbated by local pollution, including vehicle emissions.[154] The NHS Health Survey for England 2010[155] estimates that Asthma causes around 1,000 deaths per year and the direct cost of dealing with Asthma in the UK as £1bn per year.
- In the UK, proportions of life spent disability-free increased for women but mostly fell for men at age 65 between 2004–06 and 2007–09.[156]
- 19% of the working population in the UK which are classified as disabled, equating to 10 million people, of which 5 million are over the state pension age. This has roughly stayed the same from 2002 to 2008, which would represent a slight fall in overall percentage of the total population.[157]

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[151] Defra. See http://www.defra.gov.uk/environment/quality/air/air-quality/eu/

[152] Office of National Statistics. See http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-222911

[153] The Health Survey for England 2010 (Respiratory Health). NHS Information Centre 2010.

[154] See http://www.asthma.org.uk/news_media/media_resources/for_journalists_key.html

[155] The Health Survey for England 2010 (Respiratory Health). NHS Information Centre 2010.

[156] Office of National Statistics

[157] Family Resources Survey (FRS) Disability prevalence estimates 2007/8

A.2.5 Fauna and Flora

These criteria, and therefore baseline information relating to them, are not directly relevant to the Plan which is not location specific. Impacts upon Fauna and Flora are discussed in the wider context of biodiversity will be considered at a global scale as described above.

A.2.6 Soil

Soils in England continue to be degraded by human actions including intensive agriculture, historic levels of industrial pollution and urban development, making them vulnerable to erosion (by wind and water), compaction and loss of organic matter. The impacts of climate change are likely to mean that England will become warmer, summers will be hotter and drier, and winters milder and wetter. We will also experience more extreme weather events such as heat waves and winter precipitation. These changes are likely to impact on the capacity for soil to provide food yields due to changes in moisture balance, and the length of growing seasons. The soil available is under pressure from land use due to more housing and infrastructure (include waste management infrastructure) associated with population growth, and the need to utilise more arable land for food production in response to climate change.

A Soil Strategy for England was published in September 2009, which sets out the current policy context for soil management.[158] As part of this strategy the following supporting evidence is attached, which can be related to the Plan.

The key functions provided by our soils are:

- support of food, fuel and fibre production;
- environmental interaction functions (e.g. regulating the flow of and filtering;
- substances from water, emitting and removing atmospheric gases, storing carbon;
- support of habitats and biodiversity;
- protection of the historic environment and archaeology;
- providing a platform (for construction); and
- providing raw materials.

In 2008, the value of total agricultural output for the UK (at market prices) was £19.8 billion. Whilst many other factors contribute to this level of output, we are reliant on good soil quality for these high outputs.[159]

Industry can leave behind land contaminated by chemicals or radiological materials that can leach through soil and rock and pollute groundwater. It is estimated that over 3,000,000 sites have been used for activities that could cause contamination. Of these, 33,000 sites

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[158] See http://www.defra.gov.uk/food-farm/land-manage/soil/

[159] Defra Evidence Paper. See http://archive.defra.gov.uk/environment/quality/land/soil/documents/evidence-paper.pdf

require action with 21,000 sites having received some action to remove contamination or prevent harm from contamination[160].

The relationship between soil and waste[161]

In 2005, over 4 million tonnes of soil were recovered from construction, demolition and excavation waste. Some of this screened soil is sold as an alternative to natural topsoil for use in landscaping developments. However, it is often a mixture of topsoil, subsoil, clay and numerous fragments of building waste materials – brick, concrete, mortar, ash, clinker and, to a lesser extent, glass, metal, wood and plastic. In terms of its physical and chemical properties, the material may often be extremely alkaline, saline, infertile, and contain elevated levels of chemical contaminants (heavy metals and hydrocarbons) and 'sharps', e.g. shards of glass or ceramics.

Finding building rubble or other physical contaminants within soils in built environment gardens and green spaces containing is all too common. A survey of ten urban centres in England, Scotland and Wales by the British Geological Survey found visible signs of contamination in over 50% of the samples.

There has been increasing interest in the potential of reduced tillage (also known as non-inversion tillage) and organic matter additions to mitigate climate change by increasing the levels of carbon in the soil. A recent study critically reviewed the extent to which both reduced tillage practices (including zero tillage) and organic matter returns (farm manures, biosolids, composts, paper waste, etc.) could increase the carbon content of arable soils under English and Welsh conditions.

Organic matter from waste treatment processes such as windrow and in-vessel composting and digestate from Anaerobic Digestion processes are a source for improving soil and mitigating the effects of erosion and intensive agricultural use.

Applying sewage sludge (biosolids) to land provides valuable plant nutrients and maintains soil organic matter which plays a key role in retaining good soil structure and water holding capacity. Application of sludge and other organic materials to land, for agricultural benefit or ecological improvement, is likely to be the preferred environmental option in most circumstances, and when carried out in accordance with good practice. However, recent results from long term field experiments have indicated that metal-rich sewage sludges applied at vastly accelerated loading rates can have detrimental impacts on some fractions of the soil microbiota.

A.2.7 Water

Water use and conservation is an important factor when considering waste in terms of pollution into water courses, abstraction for industrial use, and the management of liquid wastes. Current Met Office projections estimate that we might have ten times as many significant droughts (like that experienced in 1976) by 2100 with on average a significant

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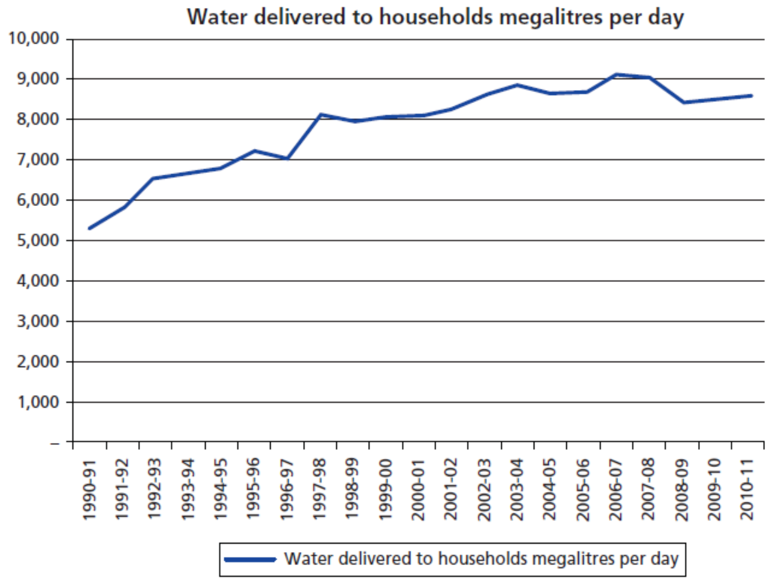
[160] Environment Agency. See http://publications.environment-agency.gov.uk/PDF/GEHO0906BLDB-E-E.pdf

[161] Ibid

drought every ten years. In combination with rising demand (see Figure 12), from a population expected to rise to over 60 million by 2030, it is clear that there are huge global challenges to the way we use and manage water.

Figure 12 Household Water Demand



Much of the population growth is likely to take place in the south-east, already the driest part of the country. At the same time, climate change may alter the seasonal reliability of our weather, making it more difficult to capture and store the water we need to meet our needs[162].The Environment Agency has taken into account such current and forecast per capita demand for water and resources availability in classifying areas of water stress throughout England. These areas are shown in Figure 13[163].

The total Water Footprint (WF)[164] of the UK is 102 billion cubic metres per year, of which 62% is accounted for by water used in other nations.[165] The WF is made up of agricultural products (73%), industrial products (24%) and household use (3%). This equates to, on average, 4,645 litres per person per day, broken down as follows:

- Agricultural products – 3,400 litres per person per day (with cotton alone representing 211 litres per person per day);

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162 Water for Life. See http://www.official-documents.gov.uk/document/cm82/8230/8230.pdf

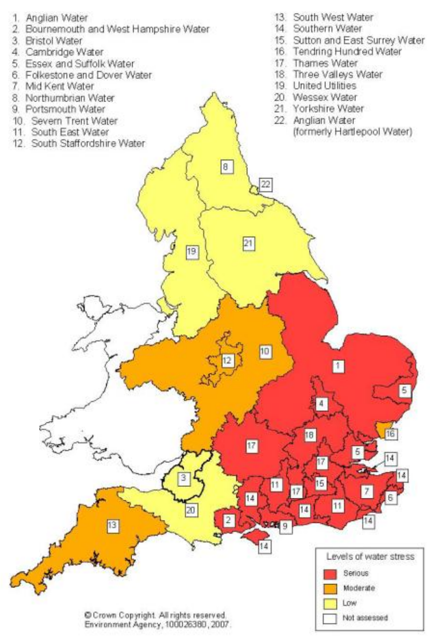
163 Environment Agency (2007) Areas of water stress: final classification. Available at: http://publications.environment-agency.gov.uk/PDF/GEHO1207BNOC-E-E.pdf

164 The water footprint of a person, a business or nation is the sum of water use (direct and indirect) to produce goods and services consumed.

165 Chapagain, A. and Orr, S. (2008) *UK Water Footprint: The Impact of the UK's Food and Fibre Consumption on Global Water Resources - Volume One*, Report for WWF, 1 August 2008

- Industrial products – 1,095 litres per person per day; and
- Household water – 150 litres per person per day.

Figure 13: Map showing areas of relative water stress



Pollution

There has been good progress in tackling pollution over recent years, largely as a result of tackling point sources of pollution, such as discharges from sewage treatment works and industrial processes. However, diffuse pollution from a range of sources such as runoff from roads and farmland, and detergents and other toxic materials people put down drains is still a problem, and improvements in river quality are levelling off. One in seven urban rivers is still of poor quality, and in rural areas, water quality is affected by soil erosion carrying surplus fertiliser and manure into the water system. Emissions into the air from transport and industry can also cause water pollution. Table 24 displays the relative condition of waterbodies in England and Wales against objectives set in the Water Framework Directive (WFD).[166] The Directive sets out the ultimate objective to achieve 'good ecological and chemical status' for all EC waters by 2015.[167]

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[166] Environment Agency, The Unseen Threat to Water Quality. Available at: http://www.environment-agency.gov.uk/static/documents/Research/geho0207bzlvee_1773088.pdf

[167] EC Water protection and management. See http://europa.eu/legislation_summaries/environment/water_protection_management/l28002b_en.htm

Table 24 Percentage of Waterbodies at Risk of not Achieving WFD Objectives

Pressures	Rivers	Lakes	Estuaries	Coastal waters	Groundwater
Diffuse pollution	87	50	35	20	68
Point discharges	39	38	84	24	3
Abstraction	14	1	53	Not applicable	29
Physical changes	58	52	88	91	Not applicable
Alien species	34	20	87	61	Not applicable

Abstraction

Rivers and water bodies are also damaged when too much water is taken from them. The current system for managing abstractions was set up in the 1960's and was designed to manage competing human demands for water rather than to protect the environment.

Sewage[168]

In the past 15-20 years, legislative changes and the introduction of new ways of working have required significant investment in the treatment of sewage.

There are a number of emerging issues in this area of work. These include:

- mitigating climate change by generating renewable energy from sludge treatment;
- the potential for treating sludge together with other suitable wastes which are generated outside the regulated water and sewerage business;
- high energy prices and transportation costs;
- increased possibilities of agricultural recycling of sludge from towns where it becomes less polluted by trade effluents from heavy industry; and
- potential loss of the ability to recycle sludge to agriculture due to restrictions on sludge use.

Ground Water

Groundwater provides a third of our drinking water in England and Wales, and it also maintains the flow in many of surface water sources such as lakes, streams and rivers. In some areas of Southern England, groundwater supplies up to 80% of the drinking water. Source Protection Zones have been defined for 2,000 groundwater sources. These zones show risk of contamination from any activities that might cause pollution in the area (the closer the activity, the greater the risk). The major risk to groundwater sources from waste management practices come from potential pollutants associated with landfill site. However, most modern landfills are highly regulated and operated to high standards and therefore pose little risk of pollution of groundwater provided they are managed properly[169].

[168] Ofwat: Sustainable Sludge. Available at: http://www.ofwat.gov.uk/future/sustainable/sludge

[169] Environment Agency. See http://publications.environment-agency.gov.uk/PDF/GEHO0906BLDB-E-E.pdf

Waste Water Infrastructure[170]

The National Policy Statement (NPS), published in February 2012, sets out Government policy for the provision of major waste water infrastructure. It will be used by the decision makers as the primary basis for deciding development consent applications for waste water developments that fall within the definition of Nationally Significant Infrastructure Projects (NSIP) as defined in the Planning Act 2008.

The Government's key policy objectives are:

- Sustainable development – to seek waste water infrastructure that allows us to live within environmental limits and that helps ensure a strong, healthy and just society, having regard to environmental, social and economic considerations;
- Public health and environmental improvement – to continue to meet our obligations under the Urban Waste Water Treatment Directive (UWWTD) by providing suitable collection and treatment systems to limit pollution of the environment;
- To improve water quality in the natural environment and meet our obligations under related European Directives, such as the Habitats Directive, the Water Framework Directive and its Daughter Directives;
- To reduce water consumption by households and industry which will have the knock-on effect of reducing waste water production and therefore demand for waste water treatment infrastructure;
- To reduce demand for waste water infrastructure capacity by diverting surface water drainage away from the sewer system by using Sustainable Drainage Systems (SuDS);
- Climate change mitigation and adaptation – in line with the objectives of Defra's mitigation and adaptation plans to help deliver the UK's obligation to reduce greenhouse gas emissions by 80% by 2050 and work to carbon budgets stemming from the Climate Change Act 2008, within the context of the EU Emissions Trading System. Also to ensure that climate change adaptation is adequately included in waste water infrastructure planning; and
- Waste Hierarchy – to apply the waste hierarchy in terms of seeking to first reduce waste water production, to seek opportunities to re-use and recycle resources and to recover energy and raw materials where possible.

A.2.8 Air Quality

Many thousands of people still die prematurely due to the effects of pollution, reducing the average life expectancy of the population by six months.[171] Even though air quality in the UK

[170] See http://www.defra.gov.uk/publications/files/pb13709-waste-water-national-policy-statement.pdf

[171] Committee on the Medical Effects of Exposure to Air Pollutants (2010) "The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom. Available at: http://comeap.org.uk/documents/reports/128-the-mortality-effects-of-long-term-exposure-toparticulate-air-pollution-in-the-uk.html

is generally good, more needs to be done, especially in the cities, to reduce the harmful effects of air pollution. Air pollution has negative impacts on human health and the natural environment. Air pollution in the UK has declined significantly over recent decades through measures to reduce pollution from transport, industrial and domestic sources. However, the rate of reduction is now levelling off for some key pollutants such as oxides of nitrogen.

The main air pollutants of concern include:[172]

- **Sulphur dioxide (SO_2)** is an acidic gas, formed by the oxidation of sulphur impurities in fuels during combustion processes, particularly of solid fuel and petroleum, which account for about 90% of SO_2 emissions.
- **Oxides of Nitrogen** In the context of air quality, nitrogen oxides refer to nitric oxide (NO) and nitrogen dioxide (NO_2), collectively known as NO_x. NO_x is emitted from many combustion processes, and the main sources in the UK include power generation, industrial combustion and road transport. NO is not considered to be of concern with respect to human health. NO_2 is the more harmful compound, at least at high concentrations.
- **Particulate matter (PM)** is a complex mixture of organic and inorganic substances. Particles can be primary (emitted directly to the atmosphere) or secondary (formed by the chemical reaction of other pollutants in the air such as SO_2 or NO_2). Particles may arise from a wide variety of sources, man-made or natural. The main source of particles is combustion, e.g. vehicles and power stations. Other man-made sources include quarrying and mining activities, industrial processes, dust from construction work and particles from tyre and brake wear. Natural sources include wind-blown dust, sea salt, pollens, fungal spores and soil particles.
- **Benzene** is an organic chemical compound. Ambient benzene concentrations arise primarily from road transport and the domestic combustion of wood and non-smokeless fuel. Benzene is naturally broken down by chemical reactions in the atmosphere over a period up to several days; as a result outdoor benzene concentrations tend to correlate well with road networks and traffic density patterns, concentrations are now low due to the introduction of catalytic converters on car exhausts.
- **Carbon monoxide (CO)** is a colourless, odourless gas produced when gas and other fossil fuels (such as oil, coke and coal), wood and charcoal are burned without a sufficient supply of oxygen to fully oxidise the carbon present. Petrol engines used to emit significant amounts of CO but concentrations are now very low due to the introduction of catalytic converters on car exhausts.
- **Ozone (O3)** is a secondary pollutant gas, formed by photochemical reactions in the lower atmosphere (the troposphere). In the stratosphere (part of the upper atmosphere) O3 is formed by the action of ultraviolet light on oxygen molecules. This

[172] Defra: Air Pollution in the UK 2010. Available at: http://uk-air.defra.gov.uk/library/annualreport/viewonline?year=2010_issue_2

produces the "ozone layer" and at this level the gas has a beneficial effect by absorbing harmful ultraviolet radiation from the sun.

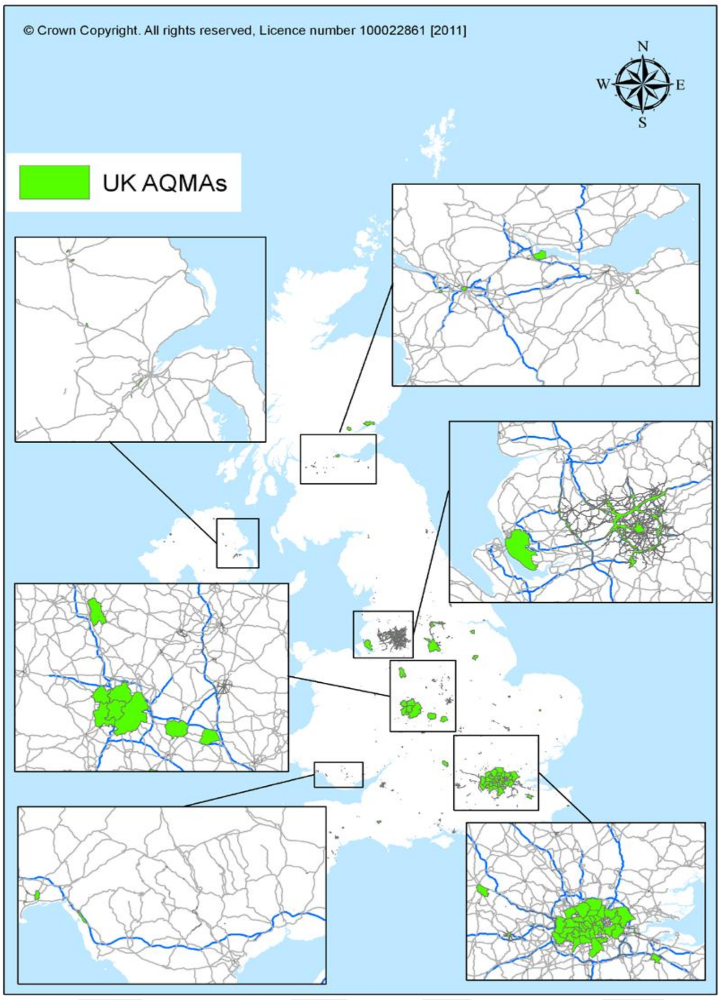
- **Lead**. The majority of lead emissions arise from industry, in particular non-ferrous metal smelters. Exposure to high levels in air may result in toxic biochemical effects which have adverse effects on the kidneys, gastrointestinal tract, the joints, reproductive systems, and acute or chronic damage to the nervous system.
- Other relevant metallic elements - Nickel, Arsenic, Cadmium, Mercury.
- **Benzo[a]pyrene (B[a]P)** The main sources of ambient B[a]P include road transport, domestic solid fuel use and activities at iron and steel plants. A major source of human exposure is also cigarette smoke. Studies of occupational exposure to PAHs have shown an increased incidence of tumours of the lung, skin and possibly bladder and other sites

Where local authorities exceed national air quality objectives they must put in place an Air Quality Management Area (AQMA) and put together an action plan to tackle the problems identified. Such a plan may include a variety of measures such as congestion charging, traffic management, planning and financial incentives. As at September 2011, there were 188 Local authorities with AQMA of which 33 were in London. Figure 14[173] shows the Air Quality Management Areas in the UK, most of which are concentrated in urban areas. It is important to note that some AQMAs are for more than one pollutant, although all of the areas are for NO2, PM10 and SO2, with no other pollutants being exceeded.

Within those local authorities with AQMAs designated there were 457 AQMAs for NO_2, 53 for PM10 and 8 for SO_2. 91% of these are as a result of traffic emissions. Figure 15 shows the proportion of AQMAs resulting from various sources.

[173] Air Pollution in the UK 2010. Defra, Welsh Government, Scottish Government, Department for Environment NI. Available at: http://uk-air.defra.gov.uk/library/annualreport/viewonline?year=2010_issue_2

Figure 14 Air Quality Management Areas in the UK, 2010

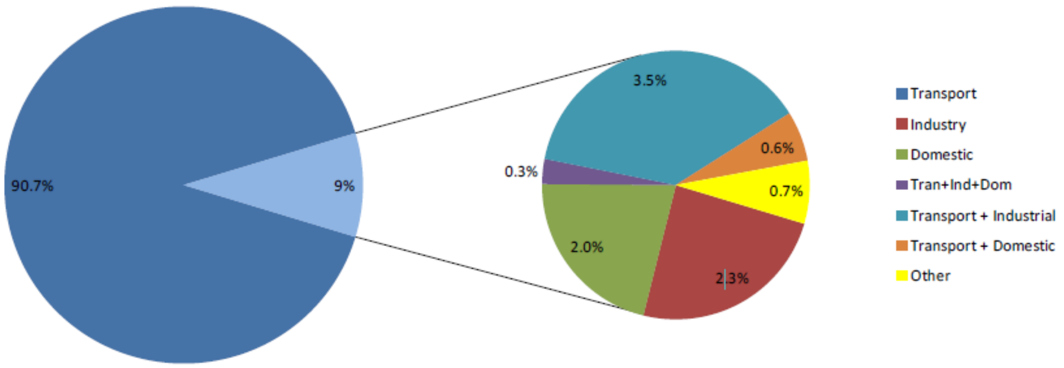


Data on exceedences of the EU standards for air quality is collated by Defra. In the 2010 report, the following exceedences were reported:

- No exceedences of the SO_2 limit values were reported in 2010 or in recent years.
- The UK exceeded the limit value for hourly mean nitrogen dioxide in three zones, and for annual mean nitrogen dioxide in 40 zones (out of a total of 43 zones). This is similar to the numbers of zones exceeding (both measured and modelled) in recent years.
- One zone (Greater London Urban Area) exceeded the daily limit value for PM10 during the year, after subtraction of the contribution from natural sources. A time extension has been granted in respect of this zone and limit value and a margin of tolerance is in force. The limit value plus margin of tolerance was not exceeded in 2010.
- Exceedences were reported for the long term ozone objective for human health in 41 zones, and exceedences were reported for the long term ozone objective for vegetation in six of the 43 zones.

- Two exceedences of the target values for nickel were reported in 2010, as was the case in 2009 and 2008.
- Eight exceedences of the target values were reported for benzo[a]pyrene in 2010 (compared with six in 2009)[174].

Figure 15: Proportion of the UK's current Air Quality Management Areas resulting from various sources[175]



All waste management facilities will result in fugitive emissions from waste arriving at the process to a greater or lesser extent. Some waste management facilities result in the generation of bio-gas from anaerobic digestion of waste. Waste management facilities which include a combustion component will result in emissions of combustion gases. These processes include pyrolysis, gasification, anaerobic digestion, landfill sites with gas collection and flaring or utilisation, and waste to energy/incineration. The substances emitted from waste combustion are primarily oxides of nitrogen, carbon monoxide, sulphur dioxide and fine particulate matter (PM10). Very low levels of metals and dioxins and furans may also be emitted[176]. Other emissions from waste management sites might include dust, VOCs and micro-organisms. Dusts may potentially include trace organic or inorganic chemicals, or micro-organisms.

A.2.9 Climate Change

It is generally reported that of the UK's total greenhouse gas (GHG) emissions, waste management activity accounts for 3% of the total, including emissions of methane from landfill, treatment of waste water, and incineration.[177] This figure stems however from the IPCC methodology of reporting which leads to an underestimation of the true impact and Greenhouse Gas (GHG) balances arising from waste management. At the global level,

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[174] Ibid

[175] Ibid

[176] DEFRA. See http://archive.defra.gov.uk/environment/waste/strategy/review/documents/appendix1.pdf

[177] Waste Review 2011

successive reports from the IPCC indicate increasing levels of certainty regarding the link between changing climate and emissions of GHGs. Past emissions effectively commit the globe to further change in climate because some GHGs reside in the atmosphere (and thus have an effect) for many years. Consequently, reductions in GHG emissions are considered necessary to prevent further climate change in future years beyond what the globe is, effectively, already committed to.

The expected impact on England is likely to be in the form of changes to growing seasons, surface temperature, sea level rise (and associated flood risk), and precipitation. The UK Climate Change Risk Register (CCRA) identifies the greatest need for action within the next five years in the following areas:

- Flood and coastal erosion risk management
- Specific aspects of natural ecosystems (e.g. managing soils, water and biodiversity)
- Management of water resources, particularly in areas with increasing water scarcity
- Overheating of buildings and other infrastructure in the urban environment
- Risks to health (e.g. from heat waves and flooding) and impacts on NHS, public health and social care services.

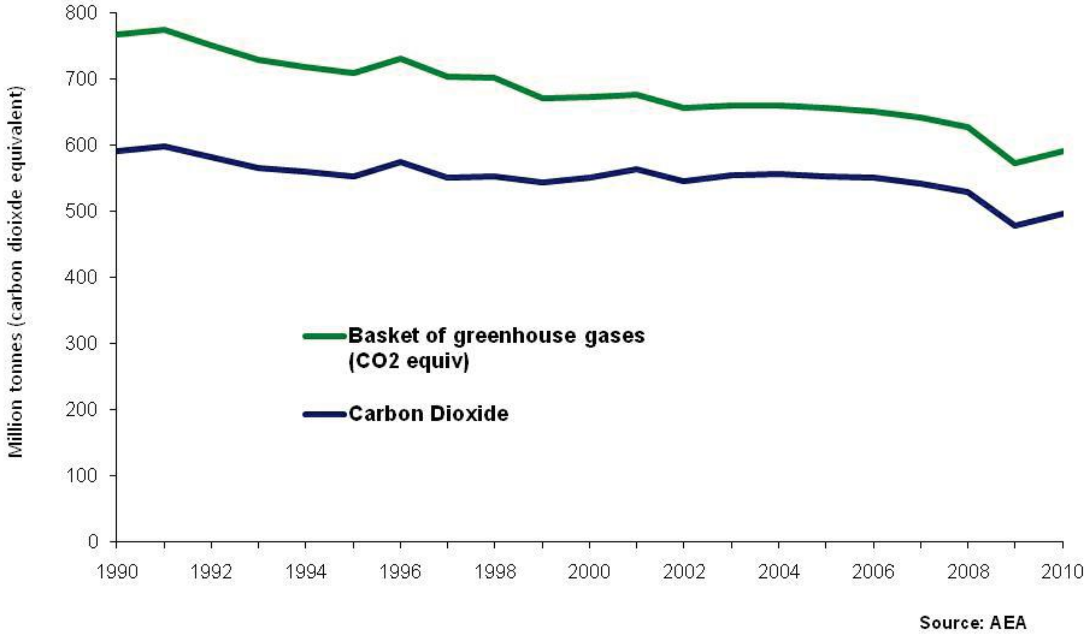
The National Adaption Programme will be published in 2013 which will focus on addressing the risks set out in the CCRA.

According to DECC's most recent data, in 2010, UK emissions of the basket of six greenhouse gases covered by the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) were estimated to be 590.4 million tonnes carbon dioxide equivalent (MtCO2e). England's share of the United Kingdom's GHGs is 77.4% as at 2008[178]

Carbon dioxide (CO_2) is the main greenhouse gas, accounting for about 84 per cent of total UK greenhouse gas emissions in 2010. In 2010, UK net emissions of carbon dioxide were estimated to be 495.8 million tonnes (Mt). The 2010 figures reflect an overall steady drop from the base year, until 2010 which saw a small rise. This was seen to be a result of the increased use of natural gas and the cold winter, and technical problems at power stations. The overall fall masks a rise in residential emissions of 10%, while energy supply and business sectors dropped by 19% and 32% respectively. Figure 16 provides a graphic representation of the emissions.

[178] Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2008 AEAT/ENV/R/3067

Figure 16 Emissions of Greenhouse Gases 1990-2010



A recent report published by DEFRA identifies the potential impacts of climate change on the waste sector[179]. This identifies the following impacts as some of the most important for the sector:

- Increased rates of waste decomposition and degradation
- Increased impacts on neighbourhood from odour and dust
- Increased risk of flooding (fluvial and flash floods) affecting facilities, access and use of mobile plant
- Increased risk of flood-related disruption to critical infrastructure and suppliers (transport, energy, ICT, etc.)
- Reduced water availability for wet processes and site management (particularly during summer)
- Increased risk of flooding / inundation at low-lying coastal sites.

The subsequent consequences on the waste industry of these impacts have been identified as follows:

- Changes to operational business costs in response to environmental factors (for example, the need for additional odour or pest control, or additional fire risk management)
- Changes to working environments (indoor and outdoor) and associated health and safety of employees

[179] Winne, S., Harrrocks, L., Kent, N., Miller, K., Hoy, C., Benzie, M. and Power, R. (2012) *Increasing the climate resilience of waste infrastructure*, Report for DEFRA, 26 March 2012

- Implications for the surrounding environment and community as a result of changes in the amounts of leachate, odour, or dust
- Changes to the availability or reliability of waste services, from disruption caused directly or indirectly by weather events
- Environmental degradation of infrastructure, leading to changes to the expected lifetime of longer-lived structures (such as landfills), through changing frequency and intensity of a range of weather events
- Changes to the processes on site to compensate for changes in precipitation, water availability, or external temperatures.

A.2.10 Material Assets

Government targets for waste are, and will be, delivered by other organisations. Local authorities are responsible for providing domestic waste collections, whilst commercial and industrial waste is processed by a combination of local authorities and the private waste sector. Other aspects of waste management are regulated by the Environment Agency.

Waste Arisings

The amount of waste arising in England in 2008 was 228 million tonnes. This represents a reduction in arisings over previous years; providing an annual growth rate of -2%.[180] The composition of England's waste is shown in Figure 17. This shows that mineral waste makes up the majority of arisings in England.

Figure 17 Waste Arisings by Material Type[180]

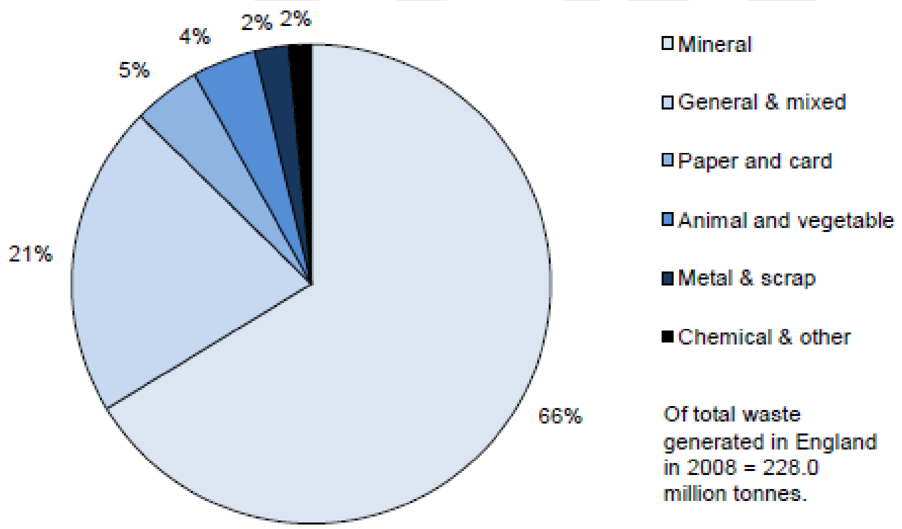
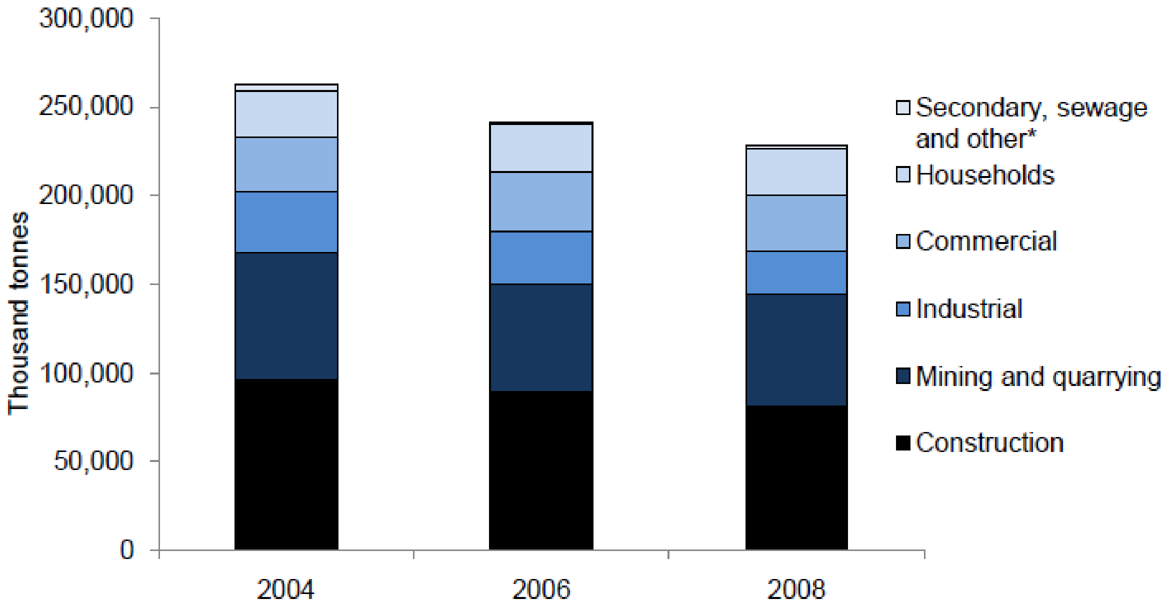


Figure 18 shows how it is broken down by sector.

[180] Defra Waste Data Overview June 2011. The information quoted here is used for submission to Eurostat. 2008 is the last available data, but 2010 data will be published later in 2012.

Figure 18 England Waste Arisings by Sector



** 'Other' includes healthcare wastes, batteries & accumulators, dredging spoils and solidified/stabilised/vitrified wastes.*

Household Waste

23.4 million tonnes of household waste was generated in the year to September 2011. Of this, 40.3 per cent was recycled, re-used or composted. This equates to 452kg of waste generation per person, per year, of which 182kg was recycled, composted or re-used.[181] The remaining waste is either sent to landfill (45%), or to energy-from-waste/incineration facilities (13%).[182]

Although household waste has fallen in recent years it is predicted to rise in the short term to close to 2005/6 levels by 2018.[182] Beyond that, predictions depend heavily on policy, behaviour change, and technology, and could rise or fall depending on these factors.

Commercial & Industrial Waste (C&I)

In 2009, 47.9 million tonnes of waste were generated by businesses – a decline from 67.9 million tonnes in 2002/3. Although this can be partly attributed to better resource management, it is thought to be significantly impacted by the economic downturn since 2008.The industrial sector accounted for 24.1 million tonnes and the commercial sector 23.8 million tonnes. Estimates show that 52 per cent of C&I waste was recycled or re-used and 24 per cent was sent to landfill. Another 16 per cent is made up of other forms of

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[181] Defra – Government Waste Policy Review 2011

[182] See http://www.defra.gov.uk/publications/files/pb13548-economic-principles-wr110613.pdf using ARIMA model.

thermal and non-thermal treatment, land recovery, and there is also a fraction of 8% where the destination has not been ascertained.[183]

Small enterprises, up to 49 employees, produced 16.6 million tonnes of C&I waste in 2009, or 35 per cent of total C&I waste.[184] As with household waste, C&I waste is predicted to rise with annual growth rates of 1.9% (commercial) and 2.3% (industrial).[185]

Mining and Quarrying Waste

Arisings of mining and quarrying (excavation) waste was estimated to be 62.9 million tonnes in 2008; the second largest contributor to arisings after construction and demolition waste.[180] This sector, however, has remained relatively stable and has not seen the fall in arisings seen in other sectors.[186]

Construction and Demolition Waste

Construction and demolition (C&D) waste forms a significant proportion of arisings that are put into landfill - 22 million tonnes in 2008. At the same time 53 million tonnes were recycled and a further 11 million tonnes were spread on exempt sites (usually for land reclamation, agricultural improvement or infrastructure projects). The recycling of C&D waste, using crushers and screeners, has increased significantly from 35 per cent in 1999 to 61 per cent in 2008. Since 2008 arisings have fallen considerably, from 94.5 million tonnes to 77.4 million tonnes in 2010, which is largely attributed to economic conditions in the industry.[187]

Infrastructure

Waste management infrastructure is categorised by the Environment Agency as:[188]

- Mechanical biological treatment;
- Anaerobic Digestion;
- Composting;
- Other biologicial treatment (including oil refinery wastes, sludges, effluents, leachate);

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[183] See http://www.defra.gov.uk/statistics/files/ci-project-report.pdf table 22

[184] See http://www.defra.gov.uk/publications/files/pb13548-economic-principles-wr110613.pdf using REEIO predictions.

[185] Defra – Government Waste Policy Review 2011

[186] See relative CDE waste arisings estimated for 2008-2010 http://www.defra.gov.uk/statistics/environment/waste/wrfg09-condem/ to show that excavated waste arisings have remained relatively stable.

[187] See http://www.defra.gov.uk/statistics/environment/waste/wrfg09-condem/

[188] Environment Agency (2011) England's Waste Infrastructure; Report on Facilities covered by Environmental Permitting, 1 October 2011. Available at: http://www.environment-agency.gov.uk/research/library/data/134327.aspx

- End of life vehicles and metal recycling sites;
- Material recovery facilities;
- Transfer stations;
- Hazardous waste treatment;
- 'Specialist' treatments (including for WEEE, batteries, clinical waste, tyres, construction and sewage);
- Incineration;
- Other energy from waste (biofuel combustion, pyrolysis, gasification); and
- Landfill.

A summary of the current facilities in England and Wales is displayed in Table 25.

Table 25 Waste Infrastructure England and Wales 2010[189]

Type of Infrastructure	Number of Sites
Operational permitted landfills	497
Transfer operations	3,609
Treatment facilities	1,625
Metal recycling sites	2,546
Waste incinerators accepting waste from off-site sources	103

Some of England's arisings are recycled back into the economy or exported for economic use elsewhere, but a significant quantity (45.9 million tonnes in England and Wales in 2010) is still being sent to landfill. The quantity of waste sent to landfill continues to fall slowly but steadily each year (by 2% between 2009 and 2010), having seen an overall drop of 46% between 2000 and 2010. There has also been a reduction in landfill available capacity, partly due to the closure of sites that no longer comply with legal requirements. The Environment Agency estimates that there are eight years of landfill life left for non-hazardous wastes in England and Wales, at 2010 input rates.[190]

Overall the capacity of treatment facilities has been rising by roughly 18% per annum in recent years, in response to the shortfall created by the decrease in landfill capacity. Anaerobic digestion, a strategic technology for the Government is currently at a capacity level of 776,000 tonnes per annum which is well below the potential available feedstock for

[189] Ibid

[190] Environment Agency. See http://www.environment-agency.gov.uk/research/library/data/132641.aspx

this type of treatment which is around 8 million tonnes per annum[191]. At present AD development is hampered by a lack of collection infrastructure and the difficulty in obtaining investment finance.

Environmental Impacts of Waste Facilities

The Scottish Zero Waste Plan[192], which cites Defra's 2004 comprehensive review of the environmental and health effects of waste management[193], and a partial Health Impact Assessment (HIA), lists the predominant impacts of waste facilities as:

- Noise produced through the operation of plant and from traffic movements;
- Odour produced by the storage and processing of waste;
- Dust, bio-aerosols and particulates released from various waste management techniques (such as open windrow composting and spreading waste to land for soil improvement);
- Local impacts on flora and fauna (as might be expected from any large industrial type facility);
- Impacts on soil through incidents of pollutant release (although these are limited) and potential local impacts from landfill;
- Impacts on water quality from point source pollution from various waste management facilities, especially landfill sites;
- Emissions to air of nitrogen dioxide and sulphur dioxide from incineration (although these emissions are very tightly regulated and impacts are minimal);
- Wide ranging impacts on climatic factors from incineration, methane production, and transport associated with waste movement;
- Visual and landscape impacts associated with large infrastructure;
- Impacts on buildings from acidification associated with incineration (although these emissions are very tightly regulated and impacts are minimal).
- Impact upon the historic environment from development pressure, climate change, airborne pollution, to which the waste management industry contributes.

Defra have produced a table mapping these impacts against the various types of waste facilities currently operational (Figure 19).[194]

[191] Eunomia Research & Consulting (2011) Anaerobic Digestion Market Outlook: Overcoming Constraints to Deliver New Infrastructure, July 2011, http://www.eunomia.co.uk/shopimages/Eunomia%20-%20Anaerobic%20Digestion%20Market%20Outlook%20Report.pdf

[192] See http://www.scotland.gov.uk/Publications/2009/08/25102241/8

[193] See http://www.defra.gov.uk/publications/files/pb9052a-health-report-040325.pdf

[194] Ibid

Figure 19 Environmental Impacts of Waste Treatment

Activity	Noise	Odour	Dust	Flora/fauna	Soils	Water quality/flow	Air quality	Climate	Building damage
Materials recycling facility	×	×	×	×	×	××	××	-	-
Composting	××	×××	××	✓	× ✓	××	×××	×	-
Mechanical biological treatment	××	×××	××	-	-	××	××	×	×
Anaerobic digestion	××	××	×	× ✓	× ✓	××	××	×	×
Gasification/ pyrolysis	××	××	××	-	-	-	××	×	×
Incineration with pre-sorting	××	××	×××	××	××	××	×××	×	×
Incineration	××	××	×××	×××	×××	×××	×××	×	×
Landfill	×××	×××	××	××× ✓	×××	×××	×××	××××	×
Waste transfer stations	××	×××	×	-	-	××	×	✓	-

Category	Meaning
✓	Direct or indirect benefit
-	No effect
×	Unlikely to be significant
××	Potentially significant impact in some cases, but can be controlled
×××	Impact can normally be controlled, but an issue at sites where design, engineering or operation falls below best practice
××××	An issue at all sites

Illegally Deposited Waste

The responsibility for enforcement of regulations is shared between local authorities, who deal with local fly-tipping, and the Environment Agency, who deal with the larger, more serious and organised waste crimes. The headline results of Defra's latest statistical release for 2010-11, are that local authorities in England dealt with 820,000 flytipping incidents, a decrease of 13.9% from 2009-10. Although this has resulted in a reduction in costs, the amount spent is £41.3 million. 2,400 prosecutions were carried out, with a 96% success rate. The Environment Agency have also seen a recent drop in major incidents, down from 1047 in 2009-10 to 636 in 2010-11. A trend in the figures is difficult to deduce as reporting changes were made during this period. In addition, it is expected that minor incidents will go unreported in the future, due to changes in enforcement policy.

A.2.11 Historic Environment

England has over 400,000 listed buildings, registered parks, gardens and battlefields, protected shipwrecks and scheduled monuments. Some of the more notable threats to the historic environment in England come from development pressure, climate change, airborne pollution, to which the waste management industry contributes. Recent and future trends in these threats are to be assessed as part of the National Heritage Protection Plan[195], published by English Heritage, which sets out how England's historic environment will be protected in the next four years. Although the above risks to heritage have and will inevitably

[195] See http://www.english-heritage.org.uk/professional/protection/national-heritage-protection-plan/

increase, progress has been made. For example, 58% of buildings at risk in 1999 in the Yorkshire area have been saved, and this level of recovery can be seen in other regions. [196]

The key priorities as identified in the National Heritage Protection Plan are:

- Marine and coastal heritage;
- 20th century heritage;
- Historic towns and suburbs;
- Rescuing heritage at risk;
- Supporting local authorities and building local capacity;
- Ensuring heritage protection continues under changes to planning system;
- Supporting the sale of public assets and encouraging their sympathetic re-use;
- Safeguarding heritage amid increasing development pressures;
- Tackling heritage crime; and
- Understanding the energy performance of historic buildings and help homeowners adapt and "green up" their properties in the most effective way.

Waste management provision in terms of the location, scale, type and design of the facility could impact both directly and indirectly on the historic environment which can include upstanding, buried subterranean or submarine heritage assets. Noise, dust, airborne pollution, hydrological impacts, vehicle movements and impacts on the setting of heritage assets and historic landscape character will usually be the main types of off-site impacts.

Options should be considered for avoiding, transferring, reducing and minimising any adverse impacts on both designated and undesignated heritage assets and the historic environment in general in proportion to their overall significance

The Environment Report will seek to identify the relative impacts upon the historic environment of the waste management options being considered. The assessment of impacts will not present impacts upon specific heritage assets, but will present a general indication of the level of impact upon the historic environment in England.

Consideration of the location aspects for waste treatment and disposal facilities is more of a matter for the National Planning framework and PPS10 which sets the high level planning framework for waste infrastructure.

A.2.12 Geology

The geology of England is mainly sedimentary with the youngest rocks starting in the South East and progressing in age towards the North West. The geology of England is recognisable in the regional landscape, building materials and its extractive industries. Poorly sited buildings can cause problems to the geology, where important rock exposures become

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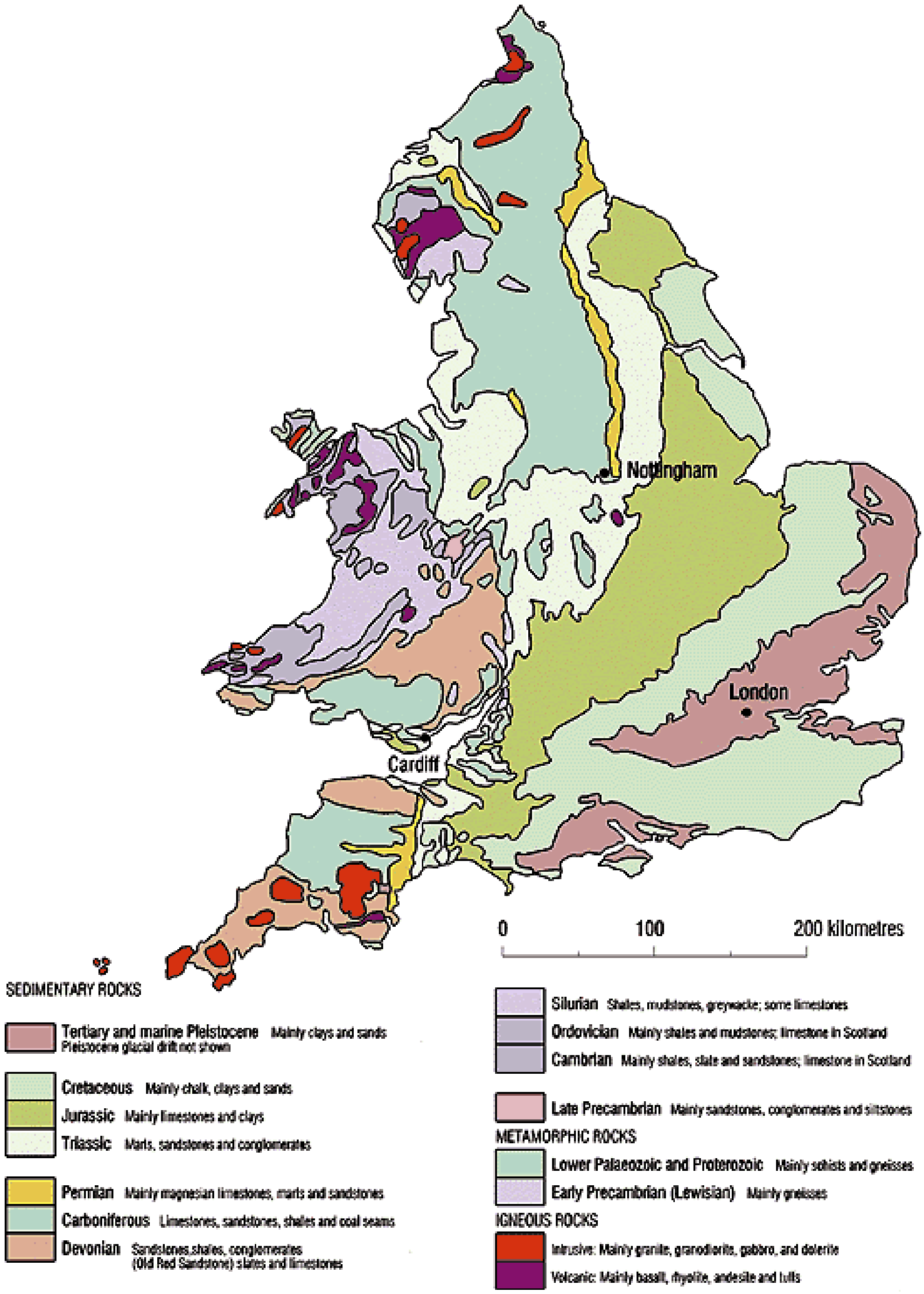
[196] See http://www.english-heritage.org.uk/publications/har-2011-local-summaries/acc-HAR-2011-yh-summary.pdf

concealed. Natural England takes an active role in the planning process to protect geological sites. A depiction of the main rock types is shown in Figure 20.

Figure 20 Geological Structure of England and Wales[197]



[197] British Geological Survey ©NERC 1995

A.2.13 Energy

Energy, primarily in the form of heat, electricity and transport, is a key component of the assessment. Energy from waste is an important priority within the Waste Review. The Government faces challenges in meeting energy demand while reducing greenhouse gas emissions. Energy production in the UK continues to drop while consumption has lowered slightly in recent years (0.4% drop in 2009 to 2010). The UK is a net importer of energy with a dependency level of 28%. Fuel poverty in England has risen from 5.9% of households in 2003 to 18.4% of households in 2009; an increase from 1.2m households in 2003 to 4m in 2009.[198]

Long Term Trends

The long term projection is for a decrease in energy consumption in the UK of 9% by 2020 from 2005 levels.[199] Within the energy mix however, there are significant peaks and troughs in the different sources of energy, as power stations and end users switch between energy sources due to market demands and production outages. In addition, extreme weather conditions affect short term trends, such recent cold winters which raised the consumption of gas-fired heating.

Renewable capacity is rising at a rate of about 11% per annum and it provided 3.2% of the UK's energy consumption in 2010. The five main contributors to this rise in capacity are solid waste treatment, sewage treatment, landfill gas, wind and hydro power. Figure 21 provides an outline of developing capacity across this sector.[198]

The EU Renewables Directive set a target of 15% of energy to be generated by renewables in the UK.[200] The ability for the UK to achieve this target is uncertain, having failed to reach its interim EU target for 10% of electricity generated by renewables by 2010[201]. However the Government's Renewable Energy Strategy stated that 30% of our electricity could come from renewable resources by 2020.

[198] DECC. See http://www.decc.gov.uk/assets/decc/11/stats/publications/energy-in-brief/2286-uk-energy-in-brief-2011.pdf

[199] European Commission, Renewable Energy: Progressing towards the 2020 target. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0031:FIN:EN:PDF

[200] See http://ec.europa.eu/energy/renewables/targets_en.htm

[201] See http://ec.europa.eu/energy/renewables/reports/doc/2011_list_renewable_energy_targets.pdf

Figure 21 Electricity generated from Renewable Sources 1990-2010