



SEVERN ROAD RESOURCE RECOVERY CENTRE

CHAPTER 5- ALTERNATIVE SITES AND TECHNOLOGY

**Appendix 5.1 Table 1.0 Alternative Site Assessment Scoring (please see
Volume 3)**

Viridor

September 2009

SLR REF 402.0036.00374



solutions for today's environment

ALTERNATIVE SITES AND TECHNOLOGY 5

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INTRODUCTION

- 5.1 It is customary in undertaking an Environmental Impact Assessment (EIA), and in preparing an Environmental Statement (ES) in support of a planning application, to consider a review of the alternative sites and technologies that have been considered.
- 5.2 This section will consider the proposed Resource Recovery Centre (RRC) within the context of the development and the alternative sites and technologies that have been considered.

Alternative Sites

- 5.3 The Alternative Site Assessment demonstrates the benefits of the Severn Road site and also how a facility in this location can make a significant contribution to the effective management of residual waste in the West of England.
- 5.4 The process of an alternative site assessment is one that by its nature needs to take account of regulatory issues, including planning policy, commercial opportunities, the availability of land and amenity and environmental constraints and opportunities.

Requirement for Alternative Site Assessment

- 5.5 The requirement for an Alternative Site Assessment (ASA) is set out in the Environmental Impact Assessment Regulations 1999 (as amended) and EIA Guide to Procedures (ODPM January 2000)
- 5.6 The aim of the ASA is to provide;

'An outline of the main alternatives studied by the applicant...and an indication of the main reasons for his choice, taking into account the environmental effects'.

Background to Site Selection

- 5.7 SLR conducted Initial Site Assessment work and produced a Stage 1 Long List Site Assessment report of sites within the West of England partnership area that included;
- Brownfield land and redundant buildings;
 - Employment land allocations, existing employment land (B2/B8);
 - Existing mineral and waste sites; and
 - Sites over 0.5 hectares in size
- 5.8 Exclusionary criteria applied to these sites included; land within the Green Belt, Areas of Outstanding Natural Beauty and Conservation Areas. 119 potential sites were identified through this assessment.

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- 5.9 The West of England Partnership Preferred Options (Consultation Document January 2009) sets out the following preferred positive locational criteria for waste development;
- brownfield/previously developed land;
 - general industrial uses B2/B8;
 - existing and former waste management sites; and
 - within and adjacent to urban areas/population centres.
- 5.10 Inappropriate locations included;
- land allocated for other uses in Development Plans/Local Development Frameworks;
 - Ancient Woodlands;
 - undeveloped Coastal Zones;
 - areas of Outstanding Natural Beauty;
 - Groundwater Protection Zones and;
 - Scheduled Ancient Monuments.
- 5.11 Other locations which may be inappropriate included:
- Green Belt;
 - Floodplains;
 - Air Quality Management Areas;
 - Conservation Areas;
 - Green field sites; and
 - Sites remote from the areas of need for facility and primary road network.
- 5.12 Environmental Resource Management (ERM) Consultants then carried out an Interim Assessment of the sites which considered access, availability and any overriding constraints or benefits to the sites. Of the original 119 sites, 24 were identified by ERM for further detailed Stage 2 Assessment. All 24 sites were assessed using the same criteria to establish their suitability for strategic waste management facilities for the treatment of residual waste.
- 5.13 The application site (Sevalco North DS07 was amongst these 24 sites). The Interim Assessment Report was published in October 2008 and sent out to public consultation in January 2009. As a result of the consultations, 25 further sites were put forward for consideration and all the sites were considered in relation to the Habitat Regulations Assessment and Strategic Flood Risk Assessment for the West of England.
- 5.14 Following completion of site assessments, ERM published the Revised Detailed Site Assessment Final Report in June 2009. This report shows that 13 of the site originally considered as suitable locations for a strategic waste management facility are no longer recommended for allocation as such and 5 additional sites are recommended for allocation.
- 5.15 The sites recommended by ERM for allocation in the Joint Waste Core Strategy for strategic waste management facilities are as follows;

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- Sevalco Plant (North), Avonmouth (now under the control of Viridor Ltd);
- Broadmead, Keynsham
- South of Severnside Works
- Rhodia Chemical Works, Avonmouth;
- Gypsy and Traveller Site, Kings Weston Lane, Avonmouth;
- BZL Site, Kings Weston Business Park;
- Advanced Transport System Ltd Site, Severn Road;
- Allmead Recycling Depot, Albert Road, Bristol;
- Hartcliffe Way Refuse Destructor, Novers Hill;
- Land at Weston Airfield East Weston Super Mare;
- Weston Business Park, Locking Moor Road Weston Super Mare;
- Terra Nitrogen, Severn Beach;
- Aisecombe Way Transfer Station, Weston Super Mare;
- Cribbs Causeway, North of Lysander Road

5.16 This ASA further assess the above sites, building on the work already undertaken by the West of England Partnership and ERM. Table 1 sets out the 13 sites which are considered by ERM to be appropriate for development of a strategic waste management facility.

Alternative Site Assessment Criteria

5.17 The West of England Partnership identified a number of criteria which potential sites had to satisfy. As a minimum the site for a strategic waste management facility had to be;

- At least 4.0 hectares in size;
- Have good transport links to the primary road network;
- Have minimal environmental and amenity constraints; and
- Be available for purchase/long term lease at the time of the search exercise

5.18 In addition to these criteria, a policy review was undertaken to determine national, regional and local, locational criteria. A review of the relevant policies is set out in the following section.

Policy Review

Introduction

5.19 The consideration of a potentially suitable site for a residual waste facility and MRF must take into account the policy background as it sets out the main factors which must be taken into account when choosing a site for waste management facilities.

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National Policy

PPS 10 – Planning for Sustainable Waste Management

- 5.20 PPS 10 sets out the Government's objectives for sustainable waste management. The proposed development has been considered against these objectives in order to demonstrate its compliance with national waste planning policy.
- 5.21 In terms of locating waste management facilities, PPS 10 states that when identifying suitable sites, previously developed land and opportunities to co-locate facilities together with complementary activities should be considered.
- 5.22 Annex E of PPS 10 sets out the main factors waste planning authorities should take into account when testing the suitability of a site for waste management purposes. These are:
- protection of water resources, considerations will include the proximity of vulnerable surface and groundwater. For landfill or land raising, geological conditions and the behaviour of surface
 - water and groundwater should be assessed both for the site under consideration and the surrounding area. The suitability of locations subject to flooding will also need particular care;
 - land instability, locations, and/or the environs of locations, that are liable to be affected by land instability will not normally be suitable for waste management facilities;
 - visual intrusion, considerations will include (i) the setting of the proposed location and the potential for design-led solutions to; produce acceptable development; (ii) the need to protect landscapes of national importance (National Parks, Areas of Outstanding Natural Beauty and Heritage Coast);
 - nature conservation, considerations will include any adverse effect on a site of international importance for nature conservation (Special Protection Areas, Special Areas of Conservation and RAMSAR sites) or a site with a nationally recognised designation (Site of Special Scientific Interest, National Nature Reserves);
 - historic environment and built heritage, considerations will include any adverse effect on a site of international importance (World Heritage Sites) or a site or building within a nationally recognised designation (Scheduled Monuments, Conservation Area, Listed Buildings, Registered Historic Battlefields and Registered Parks and Gardens;
 - traffic and access, considerations will include the suitability of the road network and the extent to which access would require reliance on local roads;
 - air emissions, including dust, considerations will include the proximity of sensitive receptors and the extent to which adverse emissions can be controlled through the use of appropriate and well-maintained and

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managed equipment and vehicles; odours, considerations will include the proximity of sensitive receptors and the extent to which adverse odours can be controlled through the use of appropriate and well maintained and managed equipment;

- vermin and birds, considerations will include the proximity of sensitive receptors. Some waste management facilities, especially landfills which accept putrescible waste, can attract vermin and birds, and may be influenced by the distribution of landfill sites;
- noise and vibration, considerations will include the proximity of sensitive receptors. The operation of large waste management facilities in particular can produce noise both inside and outside buildings. Intermittent and sustained operating noise may be a problem if not kept to acceptable levels and particularly if night-time working is involved;
- litter can be a concern at some waste management facilities; and
- potential land use conflict, likely proposed development in the vicinity of the location under consideration should be taken into account in considering site suitability and the envisaged waste management facility.

Regional Policy

The Draft Regional Spatial Strategy for the South West (RSS)

5.23 Relevant RSS policies which have been considered in relation to the choosing the site are set out below:

- Policy F1: Flood Risk;
- Policy RE6: Water Resources;
- Policy RE9: Air Quality; and
- Policy W2: Waste Facilities and the Waste Hierarchy

Local policy

Bath & North East Somerset, Bristol, North Somerset and South Gloucestershire Joint Replacement Structure Plan: Adopted September 2002

5.24 Policy 29 'Sustainable Waste Management' states

'In accordance with the principles of sustainable waste management, appropriate provision of land should be made for the safe management, recycling, treatment and disposal of forecast waste arising in the area, together with an appropriate proportion of regional waste flows as necessary, in the period to 2011.

Provision will be made for the development of waste management facilities employing the best practicable environmental option (BPEO), utilising previously developed land where appropriate, in locations where :

- the facility is as close as practicable to the particular waste stream source;

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- satisfactory access to the main / principal highway network can be provided;
- making use of non-road facilities where practicable;
- the nuisance to neighbouring land uses is minimised;
- suitable provision can be made for appropriate reclamation/aftercare;
- the proposals respect the character of the locality;
- no threat is posed to watercourses and surface/groundwater resources; and
- proposals for the recovery of value from wastes being treated, including energy generation, composting and recycling can be included where practicable and environmentally acceptable'.

Bristol Local Plan 1997 (Saved Policies)

5.25 The Local Plan is broadly supportive of renewable energy technology, providing that there are no unacceptable impacts on local communities and the natural environment. The policies considered in relation to site assessment are as follows;

- ME1
- ME2
- ME4
- ME5
- ME9
- NE5
- EC7

Bristol Development Framework Core Strategy – Preferred Options Review Paper February 2009.

- 5.26 Policy BSC7 identifies Avonmouth and Bristol Port as a priority area for industrial and warehousing development including waste management and environmental technologies.
- 5.27 Policy BSC3 'Regeneration' encourages development in the Avonmouth area which would secure social, economic and physical regeneration.

Policy Summary

- 5.28 Local Planning Authorities will be required to provide the capacity to manage waste sustainably and this is likely to include technologies such as EfW. The RSS states that provision must be made for waste sites in Local Development Frameworks and identified in Waste Development Frameworks.
- 5.29 Bristol is identified in the RSS as a SSCT and it is considered that the Avonmouth site complies with the location criteria set out in policy W2 as it is an established industrial site, close to the main source of waste. The EfW facility will make a significant contribution to Bristol and the Region's target

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for managing its residual waste, diverting waste from landfill and generating a renewable source of power.

Initial Site Selection

5.30 The site selection criteria identified by the West of England Partnership and ERM are reiterated in the relevant planning policy, particularly Annex E of PPS10. It is considered that the using these criteria will enable the 13 sites identified by ERM to be judged against each other. The assessment criteria are;

- Proximity to housing;
- Proximity to road network;
- Existing land use;
- Deliverability (i.e. within control of the Local Authority or the Waste Management Industry);
- Ecological designations;
- Air quality; and
- Water environment and flood risk

Proximity to housing

5.31 Whilst strategic waste management facilities including EfW have been built close to houses, the size and operational hours of such facilities can have an impact on the amenity of residential areas in terms of light, noise and general activity.

5.32 The sites have been scored as follows;

- | | |
|---|----------|
| • Site boundary within 0 – 250 metres of housing | 0 Points |
| • Site boundary within 251 – 500 metres of housing | 1 Point |
| • Site boundary within 501-750 metres of housing | 2 Points |
| • Site boundary within 751-1000 metres of housing | 3 Points |
| • Site boundary greater than 1000 metres of housing | 4 points |

5.33 The nearest residential properties to the site are located over 1 km from the site boundary.

Proximity to Road Network

5.34 The potential for the facility to be well served by the primary road network is a key consideration in the site selection process. Strategic waste management facilities generate HGV traffic thus sites with good access to Trunk A roads and motorways score higher than those with poorly located in terms of distributor roads.

- | | |
|---|----------|
| • Site 501m or more from any of the following roads | 0 Points |
| • Site 500m or less from main distributor road | 1 Point |
| • Site 500m or less from other A road | 2 Points |
| • Site 500m or less from Trunk A road | 3 Points |

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- Site 500m or less from Motorway Junction 4 Points

Existing Land Use

- 5.35 The principle of sustainable development places strong emphasis on the use of brownfield (previously developed land) for new development and this is supported by national, regional and local level planning policies.
- 5.36 The scoring is consequently weighted in favour of brownfield sites to reflect its importance in planning policy. Land previously used for minerals or waste development is not classified as brownfield land yet could not be reasonably considered as Greenfield. For the purposes of this assessment, this land has been designated as 'beigefield land' i.e. an intermediate category.
- Greenfield Land 0 Points
 - Beigefield Land 2 Points
 - Brownfield Land 4 Points

Ecology

- 5.37 Strategic waste management facilities have the potential to impact on ecologically sensitive sites and their surroundings. The West of England is subject to a number of statutory and non statutory ecological designations, including Special Protection Areas, Special Areas of Conservation, Sites of Special Scientific Interest and Sites of Nature Conservation Interest.
- 5.38 Weighting has been given in favour of those sites further from statutory nature conservation areas.
- Sites less than 500m from statutory nature conservation site 0 Points
 - Site 501 to 1000m from statutory nature conservation site 1 Point
 - Site 1001m to 1500m from statutory nature conservation site 2 Points
 - Site 1501m to 2000m from statutory nature conservation site 3 Points
 - Site 2001m or more from statutory nature conservation site 4 Points

Air Quality

- 5.39 The potential for EfW emissions to be harmful to human health and other sensitive receptors is a key factor in determining applications for EfW facilities.
- 5.40 For the purposes of the initial site selection, the proximity of each site to a designated Air Quality Management Area (AQMA) has been considered. An AQMA is declared by a Local Authority in cases where air quality objectives set out in Regulation IV of the Environment Act 1995 are not being met. Each designated AQMA is subject to preparation of an Air Quality Action Plan.
- 5.41 AQMAs are usually associated with high density residential areas. The weighting system has been based on the shortest straight line distance between the boundary of the site to the nearest boundary of an AQMA. North Somerset does not have any AQMAs.

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- Site 0-1 km from AQMA 0 Points
- Site 1-2 km from AQMA 1 Point
- Site 2-3 km from AQMA 2 Points
- Site greater than 3km from AQMA 3 Points

Size of Site

5.42 One of the key site selection criteria identified by the West of England Partnership was size of site i.e. sites for strategic waste management facilities had to be over 4 hectares in size. Whilst other types of strategic waste management facilities could conceivably take place on sites smaller than 4 hectares, the RRC proposed in this application will need a site over 8 hectares in size to operate efficiently.

- Site less than 8 hectares in size 0 Points
- Sites greater than 8 hectares in size 1 Point

Water Environment and Flood Risk

5.43 The issue of flood risk is a high profile consideration that must be taken into account at the outset of the site selection process. The weighting system has been based on the Environment Agency's Flood Risk Map which reflect the potential for flooding at each site. Waste management is recognised as a less vulnerable use of land that may be acceptable in flood zones 2 and 3. This definition excludes hazardous waste management.

- Site within Flood Zone 3 0 Point
- Site within Flood Zone 2 1 Points
- Site within Flood Zone 1 2 Points

Deliverability

5.44 The likely waste recovery capacity gap in the West of England up to 2028/9 has identified that between 460,000 and 775,000 tpa of new capacity will be required by that date. Having regard to the existing capacity, this means that between 360,000 tpa and 675,000 tpa of new capacity is still required to meet the future waste management needs of the West of England.

5.45 A site within the ownership of the waste management industry or Local Authority (LA) is more likely to be made available within the timescales necessary to meet the waste management facility targets. Therefore, the scoring is weighted in favour of sites within the ownership of the waste management industry or LA, to reflect the importance of site deliverability.

- Site not within ownership of waste management industry or LA - 0 Points
- Site within ownership of waste management industry or LA - 2 Points

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Individual Site Appraisal

Site 1 Sevalco Plant (North), Severn Road, Avonmouth



Advantages	Disadvantages
Large site (11.07 ha)	800m from Ramsar Site, SPA and SCA.
In ownership of waste management industry	In Flood Zone 3
Over 1km from residential properties.	Potential for contaminated land.
Good proximity to waste arisings.	

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Site 2 Broadmead Lane, Keynsham



Advantages	Disadvantages
Good proximity to waste arisings.	Direct access route constrained by railway bridge.
Good links to wider road network.	Small site (4.49 ha).
10.5km from statutory ecological site	Close proximity to housing.
	Potential for contaminated land

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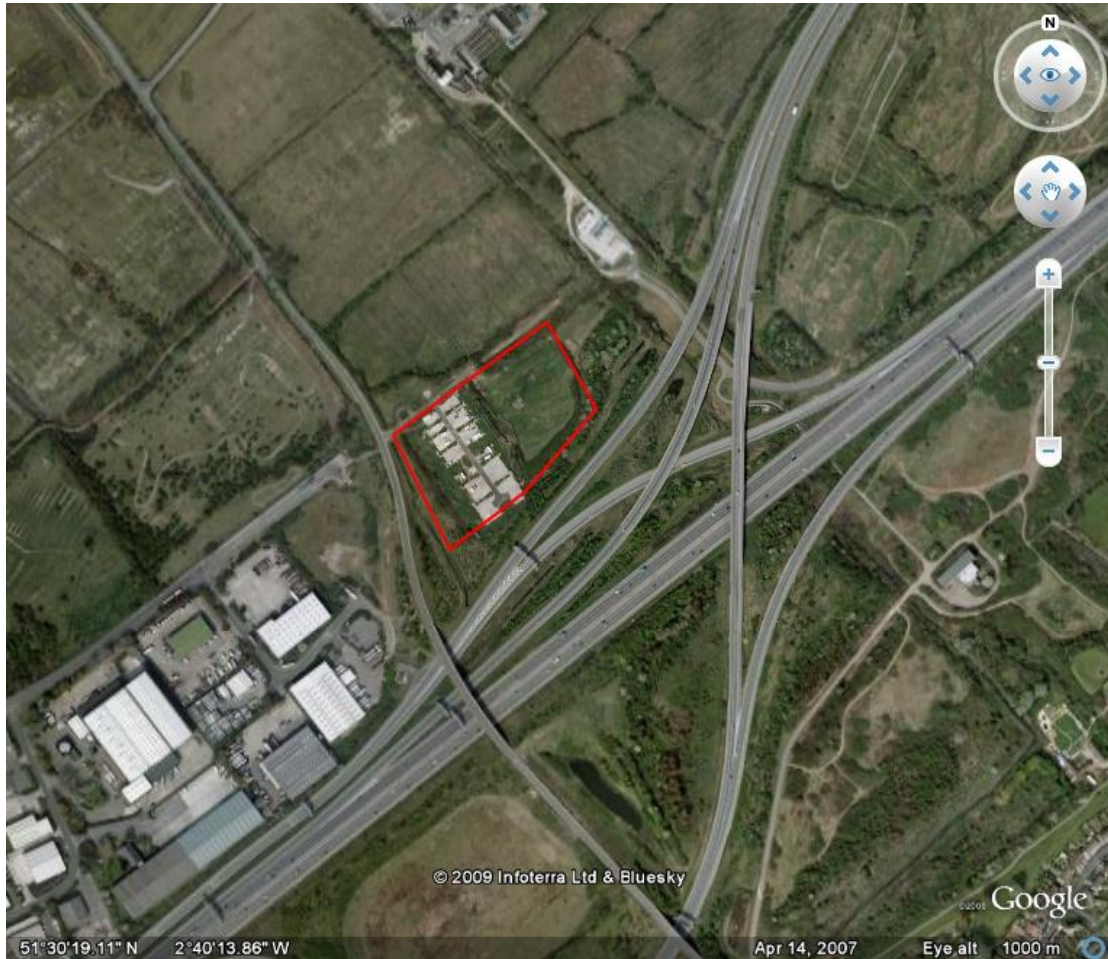
Site 3 Rhodia Chemical Works, Avonmouth



Advantages	Disadvantages
Large Site (23.24 ha).	900m from Ramsar Site, SPA and SCA.
Over 1km from residential properties	In Flood Zone 3
Good proximity to waste arisings.	Potential for contaminated land
1km from nearest motorway junction.	

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Site 4 Gypsy and Traveller Site, Kings Weston Lane, Avonmouth



Advantages	Disadvantages
Good proximity to waste arisings.	Beigefield Land.
300m from nearest motorway junction	In Flood Zone 3
	Small Site (2.53 ha)

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Site 5 Hartcliffe Way Refuse Destructor, Novers Hill



Advantages	Disadvantages
Close to waste arisings	Close to residential properties.
Close to main highway network.	Small Site (2.20 ha).
Good distance from ecological designations.	Site access over a single land bridge.

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Site 6 Advanced Transport System Ltd Site, Severn Road



Advantages	Disadvantages
Close to waste arisings	Small Site (3.32 ha)
Good links to main highway network.	300m from SSSI
Site owned by Bristol City Council.	In Flood Zone 3.
	Potential for contaminated land.

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Site 7 Allmead Recycling Depot, Albert Road, Bristol



Advantages	Disadvantages
Close to waste arisings	Close to residential properties.
Good links to main highway network.	Small Site (0.99 ha).
3.8 km from a statutory ecological designation Brownfield Site	

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Site 8 Weston Business Park, Locking Moor Road Weston Super Mare



Advantages	Disadvantages
Close to waste arisings.	Close to residential properties.
Good links to main highway network.	Small Site (5.54 ha).
2.7 km from a statutory ecological designation.	Flood Zone 3

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Site 9 Land at Weston Airfield, Weston Super Mare



Advantages	Disadvantages
Close to waste arisings.	Close to residential properties.
Good links to main highway network.	Beigefield site
Large site (30.47 ha)	Flood Zone 3
2.8 km from a statutory ecological designation	

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Site 10 Terra Nitrogen, Severn Beach



Advantages	Disadvantages
Close to waste arisings	Potential for contaminated land.
Good links to main highway network	800m from SSSI, Ramsar and SPA
Large Site (44.64)	Flood Zone 3
Brownfield Site	

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Site 11 Aisecombe Way Transfer Station, Weston Super Mare



Advantages	Disadvantages
Close to waste arisings.	800m from SSSI, Ramsar and SPA
Good links to main highway network.	Small site (1.78 ha)
	Greenfield site
	New access would be required.

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Site 12 South of Severnside Works



Advantages	Disadvantages
Close to waste arisings.	400m from Ramsar Site, SAC and SPA.
Over 1km from residential properties	New access would be required.
Good links to main highway network.	Flood Zone 3
Large Site (12.81 ha)	

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Site 13 BZL Site, Kings Weston Business Park



Advantages	Disadvantages
Close to waste arisings.	Flood Zone 3
Brownfield Site	Risk of contaminated land.
Good links to main highway network.	Residential properties within 600m
Large Site (46.20ha)	

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Site 14 Cribbs Causeway, North of Lysander Road



Advantages	Disadvantages
Close to waste arisings	Reasonably close to residential properties.
Site may not be deliverable/available in short term.	
Brownfield Site	
300m to motorway junction	
4.8km from Ramsar, SAC and SPA sites.	
Large Site (15.84ha)	

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Summary and Conclusions

- 5.46 The Alternative Site Assessment has used the above criteria to assess all the sites against each other in terms of their suitability for a strategic waste management facility for residual waste. The results are presented in **Table 1 (please see Appendix 5.1 Volume 3)**.
- 5.47 The top scoring sites were the application site (Sevalco site north) and the Terra Nitrogen site at Severn Beach which both scored 15 points out of a possible 22. In terms of environmental issues, residential amenity and planning policy, there is little to differentiate the two sites. The Terra Nitrogen site is located closer to a trunk road than the Sevalco site and is further from an AQMA. The major advantage the Sevalco site has over the Terra Nitrogen site is land deliverability, which is key to achieving this development. The Terra Nitrogen site is not owned by a Local Authority or a waste management company, therefore, it is not certain that a strategic waste management facility would be deliverable at this site within the relative short term, to allow Bristol City Council and adjoining authorities to meet their sustainable waste management targets.
- 5.48 The conclusion has therefore been reached that the most appropriate site of those considered as part of this alternative site assessment, is the Sevalco site.

ALTERNATIVE TECHNOLOGIES

Introduction

- 5.49 The Energy from Waste facility is designed to manage up to 350,000 tonnes per annum of municipal, and commercial and industrial waste that can not be recycled.

Methodology

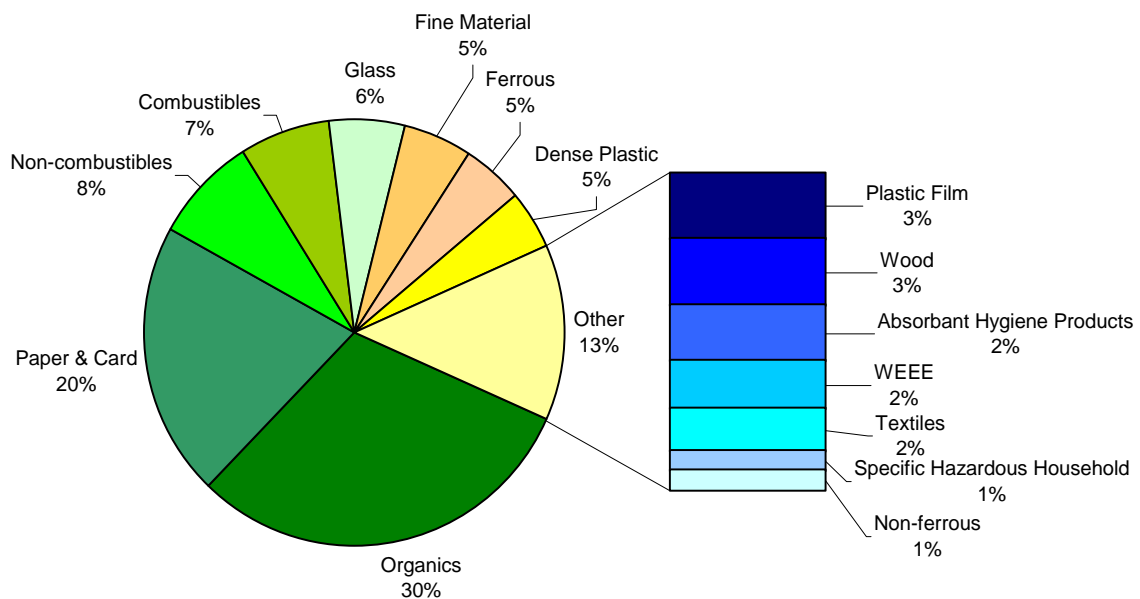
- 5.50 The Environment Agency's life cycle assessment software 'Waste and Resource Assessment Tool for the Environment' (WRATE) was utilised to model the environmental impacts of the proposed facility. The WRATE¹ software is a life cycle assessment tool specifically designed to model environmental impacts of waste and waste management processes. Its use is endorsed and encouraged by the Environment Agency (EA) and Department for Environment, Food and Rural Affairs (Defra).
- 5.51 In summary, the environmental burdens have been calculated for the processing of 350,000 tonnes of residual waste through a number of waste treatment processes, as follows:

¹ <http://www.environment-agency.gov.uk/wtd/1396237/>
Severn Road Resource Recovery Centre

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- Landfill² ;
- Energy from Waste (EfW) with power export only³ ;
- Energy from Waste (EfW) with Combined Heat and Power (CHP)⁴ ;
- Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) to EfW⁵ ;
- Mechanical Biological Treatment (MBT) with Refuse Derived Fuel (RDF) to landfill⁶ ;
- Advanced Thermal Treatment (ATT)⁷, specifically pyrolysis

5.52 The following waste composition has been assumed (the default MSW composition in the WRATE tool):



5.53 The proposed facility will process municipal and commercial and industrial (C&I) wastes⁸. The C&I wastes destined for treatment at the facility are likely to be those wastes included under the Environment Agency (EA) heading 'mixed waste' as outlined in the EA Strategic Waste Management Assessment 2002/03 survey of C&I waste . A recent study by SLR for the Environment Agency Wales⁹ demonstrates that the 'mixed' commercial and industrial waste stream is similar in composition to municipal waste. For this reason, the use of the WRATE default municipal waste composition to characterise both municipal and C&I wastes is deemed suitable for the purposes of this comparative technology assessment.

² WRATE Process – Landfill (Clay Liner, Clay Cap) (12255)

³ WRATE Process – Incinerator large, power BILLINGHAM (11264)

⁴ WRATE Process – Incinerator with district heat and power SHEFFIELD (21396)

⁵ WRATE Process – MBT composting & RDF LINDE process (11297) & Incinerator large, power BILLINGHAM (11264)

⁶ WRATE Process - MBT composting & RDF LINDE process (11297) & Landfill (Clay Liner, Clay Cap) (12255)

⁷ WRATE Process – Pyrolysis (MSW and RDF) WASTEGEN process (21252)

⁸ http://www.environment-agency.gov.uk/subjects/waste/1031954/315439/923299/1071046/?version=1&lang=_e

⁹ http://www.environment-agency.gov.uk/regions/wales/816243/1913565/?version=1&lang=_e

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- 5.54 Since a number of the waste management processes produce electricity an assumed energy mix must be defined in order to calculate the avoided burdens (from not having to produce the electricity from traditional generation methods). WRATE has default energy mixes for the UK available; the energy mix for the year 2020 has been selected as a suitable long term assessment year at which time, if planning is granted and the necessary environmental permits obtained, the planned treatment facility will be constructed and operational.
- 5.55 WRATE contains a number of default technology templates; these existing technology templates have been used as the basis of the 6 waste management scenarios. For example, the Billingham incinerator has been used to model EfW; the Billingham facility is a large power only incinerator.
- 5.56 The outputs from WRATE are life cycle impact assessment (LCIA) indicators (for example global warming potential, human toxicity etc), these can be specified by the user and measure the potential environmental impacts of the waste treatment technologies. This briefing paper presents the WRATE scores for the 6 default impact assessments. The WRATE default impact assessments are:
- Abiotic Resource Depletion;
 - Global Warming Potential (GWP100);
 - Human Toxicity (HTP inf.);
 - Freshwater Aquatic Ecotoxicity (FAETP inf.);
 - Acidification (AP); and
 - Eutrophication (EP19912).
- 5.57 Each technology has been assessed against the 6 sustainability indicators to generate overall performance scores. Performance scores for each indicator represent a quantitative evaluation that can be used to compare the scenarios within a particular impact. Units of measurement vary between different impact categories (for example antimony equivalent for abiotic resource depletion, CO2 equivalent for global warming etc).
- 5.58 To enable comparison inter-impact, and enable a preferred technology to be identified the scores have been 'normalised' using European Person Equivalents. The total European Person Equivalents for all 6 sustainability indicators is then ranked on a scale of 0 to 1, where 0 represents the worst scenario and 1 represents best scenario.
- 5.59 Sankey flow diagrams for each of the scenarios are presented in Annex A.

Results

Life Cycle Impact Assessment Results

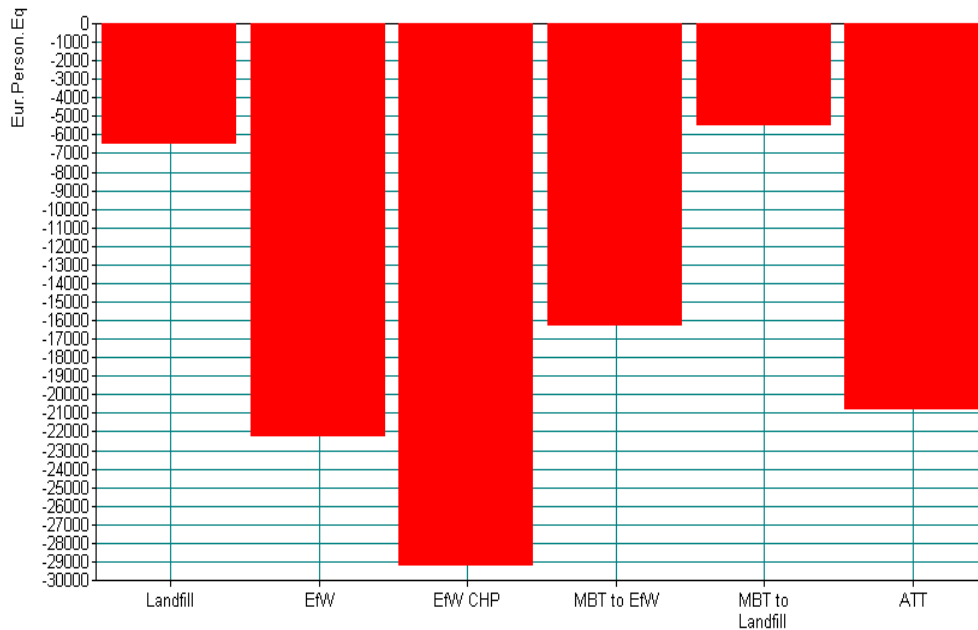
- 5.60 The purpose of appraising the performance of each scenario against the impact assessments indicators is to inform decision makers about their relative advantages and disadvantages. Summary results from modelling the

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above residual treatment scenarios in WRATE are presented in Figure 1-1 to Figure 1-6.

Abiotic Resource Depletion

Figure 1-1 Life Cycle Abiotic Resource Depletion



5.61 Key sustainable development objective is to use finite natural resources (such as fossil fuels and land) more efficiently. Producing more with less, for example by recovering resources from waste, reduces the environmental pollution and degradation caused by extraction, use and disposal of natural resources. Recovering more materials from waste will offset the requirement of non renewable virgin materials, thus reducing resource depletion.

5.62 The construction, maintenance and operation of all treatment technologies requires the use of natural resources, however the individual set up of each technology can also result in offsetting the use of natural resources. All scenarios result in an overall reduction in life cycle abiotic resource depletion which can be explained as follows:

Technology	Justification of Results
Landfill	Methane gas captured from the landfill site is combusted in gas turbines to create electrical energy. The production of electrical energy from landfill gas offsets energy production using fossil fuels and therefore reduces the depletion of resources.
EfW	Recovery of metals from the bottom ash and recycling of incinerator bottom ash offsets the extraction of raw materials. In addition the electrical energy produced offsets the requirement to extract primary fuels for energy generation.
EfW with CHP	Recovery of metals from the bottom ash and recycling of

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	incinerator bottom ash offsets the extraction of raw materials. In addition the electrical energy and heat produced significantly offsets the requirement to extract primary fuels for energy and heat generation.
MBT with EfW	Front end ferrous metal recovery offsets the extraction of raw materials. In addition the electrical energy produced through incineration of the RDF (and some energy generation from landfill gas) reduces the need for primary resources to generate energy.
MBT with Landfill	Front end ferrous metal recovery offsets the extraction of raw materials. The capture and combustion of methane from the landfill of biostabilised waste creates sufficient electrical energy to offset the energy requirement of the MBT facility but not enough to improve on the baseline scenario of direct landfill of the waste. The fact that the waste is biostabilised prior to going to landfill means that its methane generation potential is less and therefore less energy is recovered.
ATT	Recovery of metals following processing and recycling of the char/incinerator bottom ash offsets the extraction of raw materials. In addition the electrical energy produced offsets the requirement to extract primary materials to generate energy.

5.63 All scenarios, apart from MBT (Landfill), outperform the baseline scenario of waste to landfill. The highest scoring scenario is Energy from Waste (CHP) followed by Energy from Waste (electricity only).

Global Warming Potential

Figure 1-2 Life Cycle Global Warming Potential (GWP100)



5.64 Life cycle global warming potential presented in Figure 1-2 can be explained as follows:

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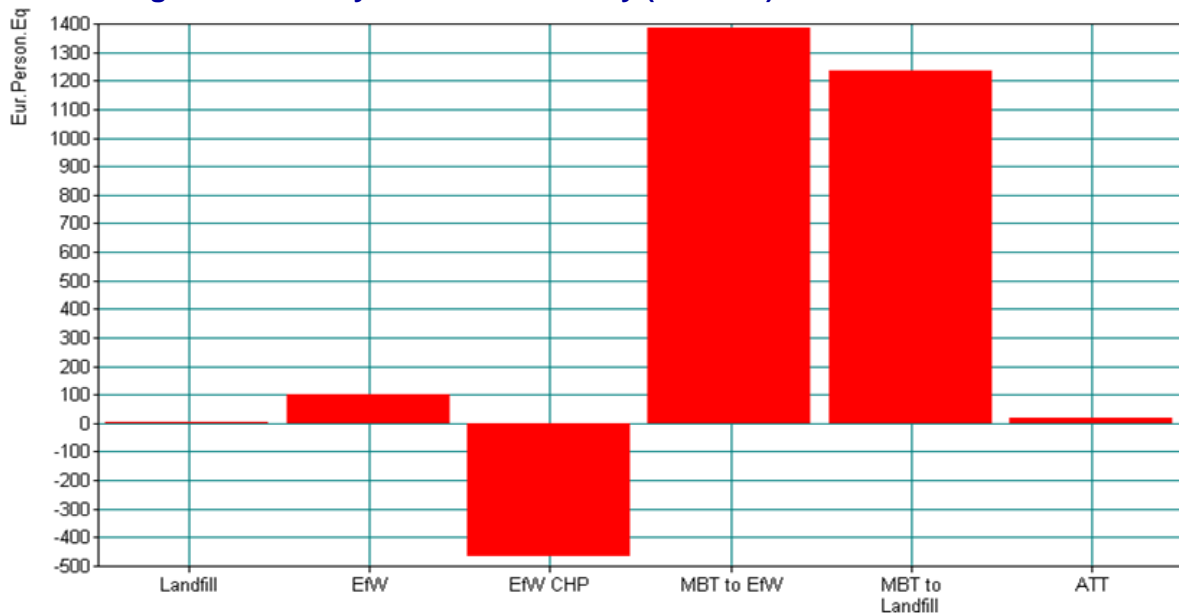
Technology	Justification of Results
Landfill	Combustion of recovered methane generates electricity, which avoids the need to produce electricity from non-renewable (fossil) sources, however this saving is negligible and there is a positive overall impact associated with fugitive emissions of methane and other GWP compounds.
EfW	EfW releases carbon dioxide from combustion of plastics and other fossil fuel derived materials. Recovered energy avoids the need to produce electricity from non-renewable (fossil) sources which in turn reduces emissions associated with the extraction and combustion of fossil fuels. Recovery of ferrous metals displaces production from virgin materials, and subsequently reduces energy requirements.
EfW with CHP	As above (for EfW). The further enhancement of heat recovery significantly increases the technology's performance for this sustainability indicator as it avoids further fossil fuel extraction and combustion.
MBT with EfW	<p>RDF combustion releases carbon dioxide from plastics and other fossil fuel derived materials. Recovered energy avoids the need to produce electricity from non-renewable (fossil) sources which in turn reduces emissions associated with the extraction and combustion of fossil fuels. Recovery of ferrous metals displaces production from virgin materials, and subsequently reduces energy requirements. The LINDE process selected recovers ferrous metals and non-ferrous metals.</p> <p>Benefits are less than those for EfW only, despite the increase in calorific value, due to the smaller quantity of material combusted, the additional burdens associated with construction of the MBT facility, higher electricity input for operation of front end equipment and due to the formation of nitrous oxide from the biological oxidation of nitrogen containing compounds.</p>
MBT with Landfill	Recovery of recyclable ferrous metals from front end processing displaces production from virgin materials, and subsequently reduces energy requirements. A positive impact is associated with fugitive emissions of GWP compounds from biostabilised material consigned to landfill and nitrous oxide from the biological oxidation of nitrogen containing compounds.
ATT	ATT releases carbon dioxide from the processing of plastics and other fossil fuel derived materials. Recovered energy avoids the need to produce electricity from non-renewable (fossil) sources which in turn reduces emissions associated with the extraction and combustion of fossil fuels. Recovery of ferrous metals displaces production from virgin materials, and subsequently reduces energy requirements. Although the benefits of energy production are similar for ATT and EfW, the burdens from operational material input is greater, and the avoided burdens from operational product output are less, leading to ATT scoring worse than EfW energy export only overall.

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- 5.65 All residual treatment technologies result in a reduction of emissions associated with global warming compared with the baseline of landfill, this is due to recovery of recyclable materials and / or energy generation. Energy from Waste (electricity only or CHP) further outperforms the other technologies and results in an overall avoided burden, i.e. a reduction in the emissions of global warming species.

Human Toxicity

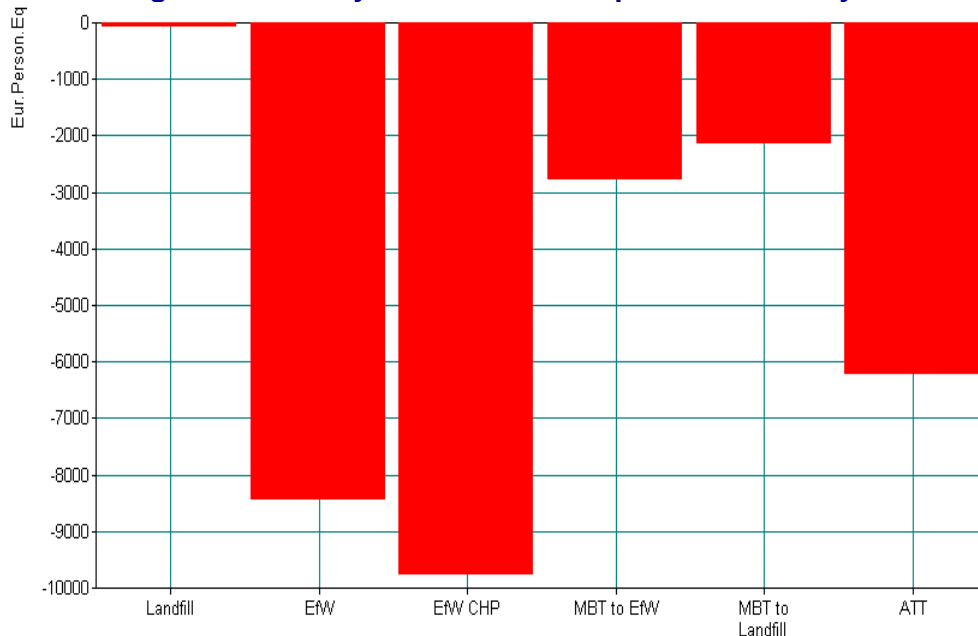
Figure 1-3 Life Cycle Human Toxicity (HTP inf.)



- 5.66 All non-landfill processes result in a positive value, i.e. a burden for human toxicity, except the EfW CHP scenario.
- 5.67 The recovery of recyclable materials results in an avoided burden to the environment as this prevents energy intensive processing of raw materials which emits substances harmful to humans. EfW CHP increases the avoided burden further by harnessing the heat produced from the process in addition to any electrical energy produced or recycles recovered.
- 5.68 Overall, with the exception of EfW CHP, the emissions associated with the treatment process itself (direct process burdens) outweigh the benefits from recycling / energy generation. The MBT processes, as modelled in WRATE, emit comparatively high quantities of Chromium resulting in the highest burden and therefore the lowest performance of all the technologies assessed. The combustion of waste emits substances that can be harmful to humans, although the energy recovered and bottom ash recycled offsets a higher proportion of the direct process burdens than for the MBT processes. The above results illustrate comparative burdens allowing comparison of different technologies, in reality any waste facility will be subject to strict emission limits which would be monitored by the Environment Agency.

Freshwater Aquatic Ecotoxicity

Figure 1-4 Life Cycle Freshwater Aquatic Ecotoxicity



5.69 All waste management scenarios will create potential impacts on water courses as they involve the following:

- the storage of waste (e.g. run off from rain and dust suppression sprays, leaching of contaminants);
- the transport of waste (e.g. run off from the delivery and tipping of materials, wheel washing); and
- the operation of plant and vehicles (e.g. potential pollution from oil and solvents, including the risk of accidental spillage).

5.70 Landfill poses the greatest risk of water contamination as it is an open air technology and problems associated with leachate are common. It is unlikely that waste management activities will significantly affect human health if facilities are well managed¹⁰.

5.71 In contrast, the recovery of recyclable materials results in an avoided impact due to the prevention of raw material extraction and processing which can emit substances which are toxic to freshwater aquatic ecosystems. The production of electrical energy and the recovery of heat also results in an avoided burden associated with freshwater aquatic ecotoxicity, due the prevention of fuel extraction and preparation. All scenarios show a negative result, i.e. an avoided burden to the environment, which demonstrates that the recyclables and energy recovery, outweighs the direct burdens of the treatment process and its construction, operation and maintenance.

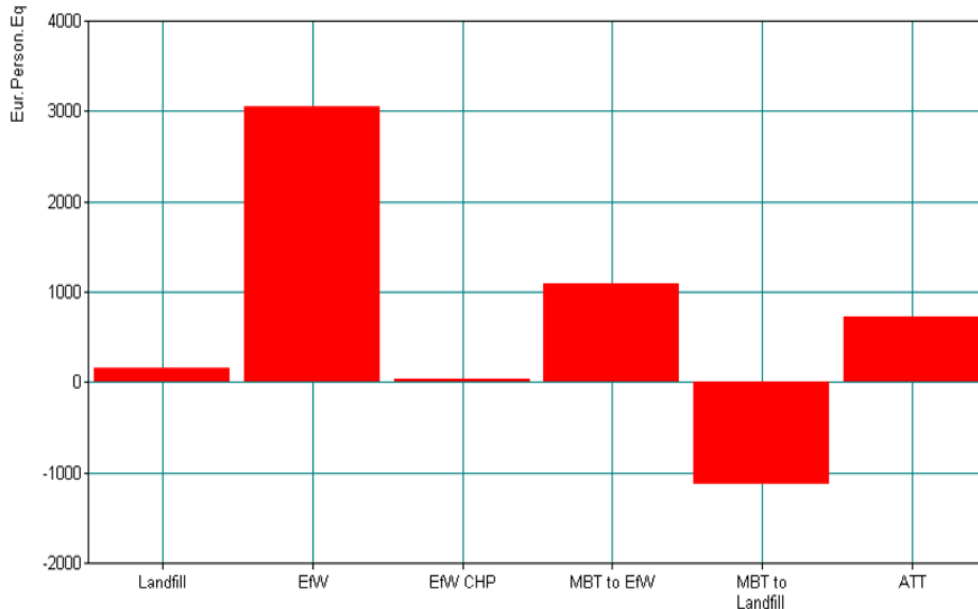
¹⁰ Review of Environmental and Health Effects of Waste Management. Municipal Solid Waste and Similar Wastes. Enviro et al on behalf of Defra (2004)
Severn Road Resource Recovery Centre

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5.72 The two Energy from Waste scenarios, followed by the ATT scenario, result in the largest avoided environmental burden.

Acidification

Figure 1-5 Life Cycle Acidification (AP)



5.73 Recovery of recyclates will reduce energy production associated with the processing of raw materials, reducing the production of compounds that contribute to acidification. Increasing the recovery of materials will have a positive impact on air acidification through the offset in requirement for processing of virgin materials. MBT processes require up front processing or sorting of waste, separating further recyclates from the residual waste, therefore recovering the greatest amount of materials.

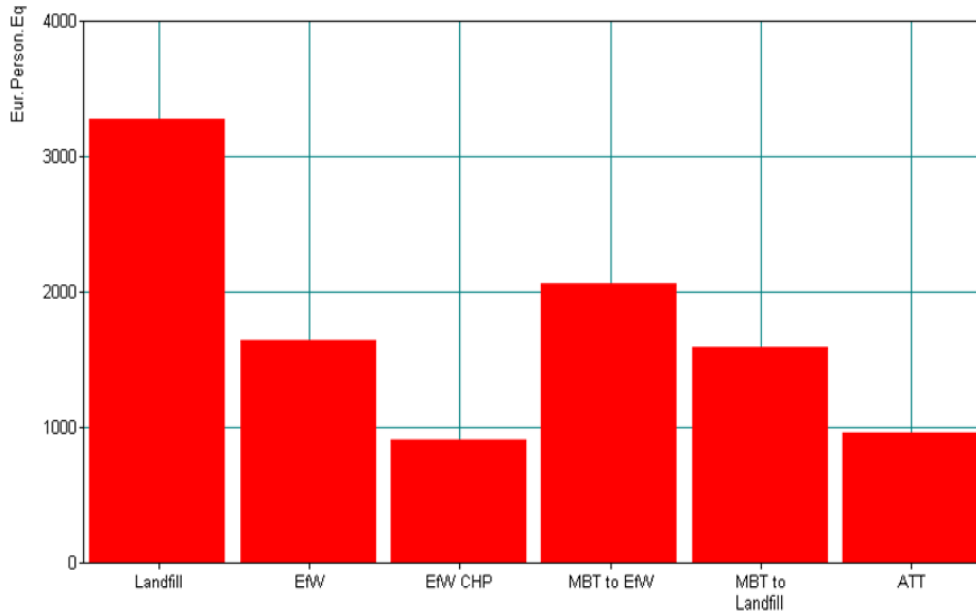
5.74 EFW gives rise to emission of NO_x and SO_x which explains the positive acidification burden.

5.75 The management of waste through non combustion processes reduces the emissions associated with acidification and therefore both landfill and MBT with landfill perform well, exhibiting an avoided burden for the acidification impact. MBT with landfill also benefits from the ferrous metal recovery.

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Eutrophication

Figure 1-6 Life Cycle Eutrophication (EP1992)



- 5.76 All scenarios show a positive result, i.e. a burden to the environment, but all scenarios perform better than the baseline to landfill.
- 5.77 Landfilling poses the greatest risk to eutrophication due to the potential for leachate. MBT processes pose a greater risk of eutrophication occurrence than EfW or ATT; as EfW and ATT does not consign any biodegradable waste to landfill. MBT technologies produce greater reject fractions requiring disposal.

Overall Performance and Normalised Scores

- 5.78 The performance of each technology process is assessed through the overall performance scores of each scenario obtained from WRATE, and through the calculation of 'normalised' performance scores.
- 5.79 The overall performance scores are collated and numerically presented in Table 1-1. Analysis of overall performance scores is difficult because of the matrix's complexity and the use of different units for each sustainability criterion. Establishing 'normalised' performance scores provides a possible solution to this problem.
- 5.80 Each result is firstly 'normalised' within WRATE by European Person
- 5.81 Equivalent and subsequently summed to provide a total European Person Equivalent for each waste management scenario. The normalised performance scores and the resulting total valued score are presented in Table 1-2.

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Table 1-1 Overall Performance Scores

Impact Assessment	Unit	Landfill	EfW	EfW with CHP	MBT EfW	MBT with Landfill	ATT
Abiotic depletion resource	kg antimony eq.	-251,058	-864,048	-1,131,833	-630,657	-214,669	-806,729
Global warming (GWP100)	kg CO2 eq.	69,319,234	-9,233,041	-50,406,802	13,312,611	44,756,947	12,346,576
Human toxicity (HTP inf.)	kg 1,4-dichlorobenzene eq.	69,279	1,952,999	-9,228,180	27,396,505	24,387,909	329,156
Freshwater aquatic ecotoxicity (FAETP inf.)	kg 1,4-dichlorobenzene eq.	-92,987	-11,126,870	-12,883,684	-3,664,035	-2,830,076	-8,190,615
Acidification (AP)	kg SO2 eq.	11,282	217,577	2,377	77,748	-80,112	51,487
Eutrophication (EP1992)	kg PO4--- eq.	106,657	53,557	29,487	67,050	51,810	31,385

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Table 1-2 Normalised Performance Scores

Impact Assessment	Unit	Landfill	EfW	EfW with CHP	MBT EfW with	MBT with Landfill	ATT
Abiotic depletion resource	European Persons Equivalent	-6,477	-22,290	-29,198	-16,269	-5,538	-20,811
Global warming (GWP100)	European Persons Equivalent	5,512	-734	-4,008	1,059	3,559	982
Human toxicity (HTP inf.)	European Persons Equivalent	4	99	-467	1387	1234	17
Freshwater aquatic ecotoxicity (FAETP inf.)	European Persons Equivalent	-71	-8,443	-9,776	-2,780	-2,147	-6,215
Acidification (AP)	European Persons Equivalent	158	3,046	33	1,089	-1,122	721
Eutrophication (EP1992)	European Persons Equivalent	3,275	1,645	906	2,059	1,591	964
Total	European Persons Equivalent	2,881	-24,150	-36,130	-12,124	-1,797	-21,998
TOTAL VALUED PERFORMANCE SCORES		0.00	0.65	1.00	0.35	0.11	0.60

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- 5.82 Table 3-2 indicates that through the summation of the European Person Equivalents for all 6 sustainability indicators EfW CHP is the highest scoring technology, closely followed by EfW and then ATT. The worst performing technology is landfill with a score of 0. All technologies result in a reduction in environmental impact compared to landfill (the baseline technology).
- 5.83 The next two highest scores after EfW CHP from Table 3-2 (EfW and ATT) are within 0.05 points on the valued score matrix, which indicates that either a weighting should be applied to the environmental indicators (based on perceived significance of each environmental issue), or that additional indicators (for example treatment cost) may be a deciding factor as the scores are relatively close.
- 5.84 It should be noted that although the 6 impact assessments that have been considered offer a good indication of the environmental impact, other social and economic factors such as cost, build time, facility size and whether the technology is proven, all play important roles in the decision making process.

CONCLUSIONS

- 5.85 This environmental burdens (including global warming potential, commonly known as carbon footprint) for the processing of 350,000 tonnes of municipal and commercial and industrial waste through a number of different residual waste treatment processes. Modelling has been carried out using the Environment Agency's Life Cycle Assessment Tool, WRATE.
- 5.86 The WRATE modelling results indicate that the best performing scenario is Energy from Waste with Combined Heat and Power. Energy from Waste with Combined Heat and Power scores highest on 5 criteria (abiotic resource depletion, global warming and human toxicity, freshwater aquatic ecotoxicity and eutrophication), the MBT (landfill) scored best on the acidification indicator. The EfW and ATT scenarios, although not scoring best on any individual criteria, score well overall.
- 5.87 Although ATT scores are comparable to those of EfW on the life cycle impact assessment (within 0.05 on the valued performance matrix) it should be considered that ATT is not currently a bankable solution for the treatment of municipal and commercial and industrial wastes, and there are no full scale operational plants in the UK. It is also unclear if ATT is a viable technology for quantities of waste as large as 350,000 tonnes per annum.
- 5.88 In conclusion, through the use of the WRATE life cycle assessment software, it can be demonstrated that most residual treatment technologies result in an environmental benefit when compared to the continued landfill of waste. Energy from Waste, preferably with Combined Heat and Power, yields an environmental impact that is better than other competing technologies. On this basis it is concluded that the proposed Severn Road Resource Recovery Centre EfW facility will result in an avoided environmental footprint, that is, an overall reduction in environmental impacts such as global CO2 emissions.

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- 5.89 In addition, the use of the MRF to separate useful recyclables will provide a source of materials which can be used in place of virgin raw materials, thus improving the environmental performance of the SRRRC even further.