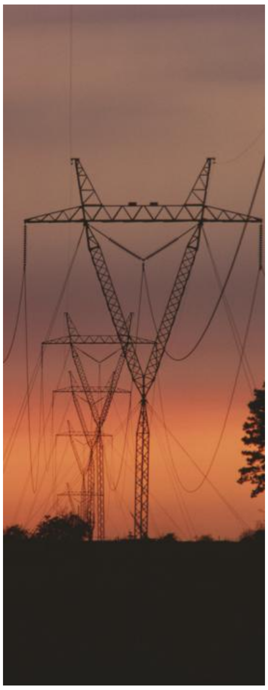
Appendix 15.1 WRATE Assessment



arc21 Residual Waste Treatment Project

WRATE Study for Environmental Statement

February 2013

E.ON Energy From Waste

Mott MacDonald

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E.ON Energy From Waste

Mott MacDonald, 40 Linen Hall Street, Belfast BT2 8BA, United Kingdom
T +44(0) 28 9089 5850 **F** +44(0) 28 9023 5145 **W** www.mottmac.com

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Executive Summary

Introduction

In order to help assess the impact on the environment of the proposed facilities a WRATE model has been prepared. This is designed to model as accurately as possible for the project, and compares it with a baseline scenario, where all of the contract waste is sent directly to landfill.

The model calculates the impact to air, land and water, and assesses them against 6 default impacts:

- Global Warming Potential 100, measured in kg CO_2-Eq (kilograms of carbon dioxide equivalents);
- Acidification potential measured in kg SO_2 –Eq (kilograms of sulphur dioxide equivalents);
- Eutrophication potential measured in kg PO_4- Eq (kilograms of phosphate equivalents)
- Freshwater aquatic ecotoxicity measured in kg 1,4 DCB-Eq; (kilograms dichlorobenzene equivalents)
- Human toxicity, kg 1,4 DCB-Eq, (kilograms dichlorobenzene equivalents) and
- Depletion of abiotic resources measured in kg antimony-Eq (kilograms of antimony equivalents).

WRATE calculates two types of environmental burdens:

- Burdens that occur as a result of the operation of the waste management system (inputs and outputs that are represented by positive values), and
- Avoided burdens (offsets) that occur when materials and energy are recovered from the waste (i.e. recycled materials replacing virgin materials, recovered energy replacing mains electricity). These are represented by negative values.

The basis for these has been 'hard-coded' into the software by The Environment Agency, and cannot be manipulated by the user.

When comparing the results with each other, the lower the score (or more negative) the lower the impact on the environment. Scores below zero indicate a calculated overall net benefit to the environment

Default and User defined process within WRATE

Within the WRATE software there are a number of default processes that are representative of existing waste management technologies – where possible these have been used. However in order to ensure the proposed technologies are accurately represented, the creation of user defined processes has been necessary. This is undertaken by using a similar default process which is available in the software database, and altering key parameters to reflect the new technology.

In modelling the Strabag process (UDP ID 22428) use has been made from the MBT – Biodrying and RDF – Herhof process (default ID process 21293) in the WRATE processes database. This has been adjusted for the anticipated mass flows for the proposed solution, using the process detailed mass flow data. This has been based on the operational data for the reference plants and reflects the anticipated performance of the proposed plant.

In general, the parameters and background allocation rules that have been altered and hence make the user defined process, for the Strabag process is as follows:

- Typical Waste Fraction Composition;
- Process and RdF Output, and
- Process emissions

Headline and process parameters, construction, decommissioning, maintenance, operation inputs and outputs have all been kept the same in order to ensure the technology is as representative as possible. For the EoN EfW plant (UDP ID 21887) the Flexible Energy from Waste Process (21849) has been used from the WRATE standard processes database, with the overall efficiency set in accordance with the proposed process efficiency, and the other user inputs changed accordingly.

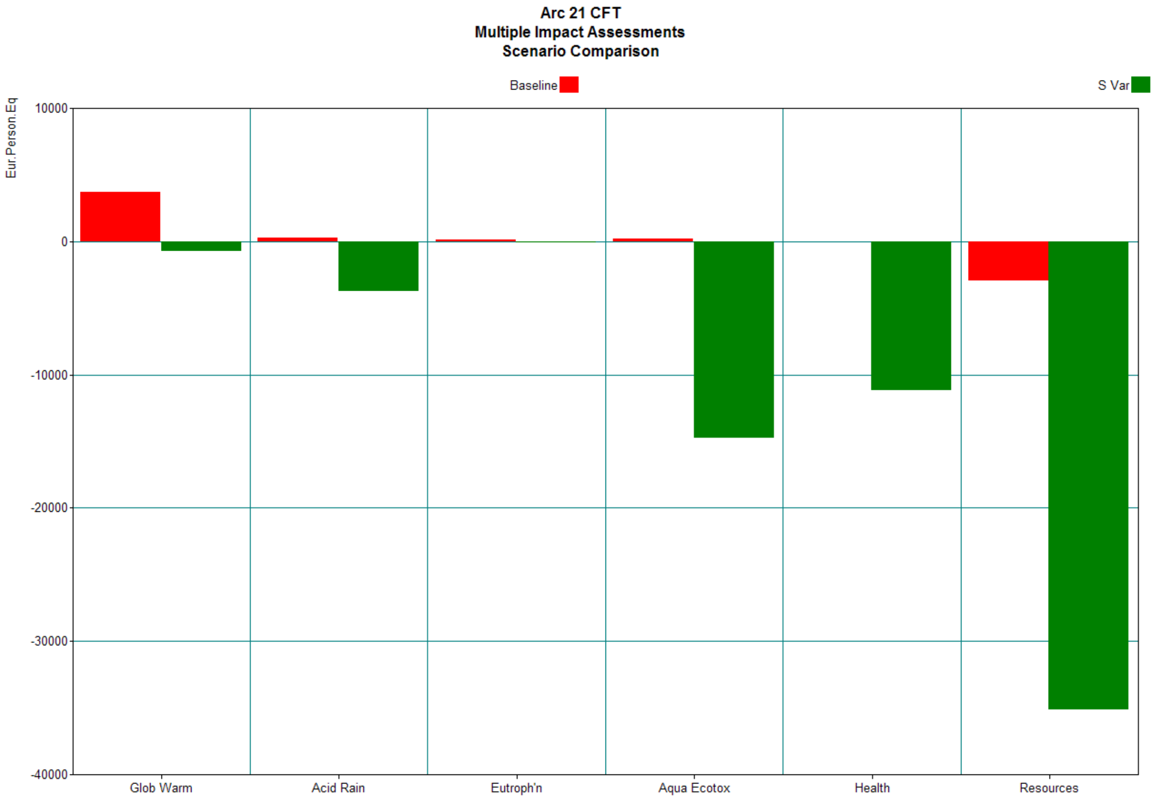
Whenever significant alterations have been made to any process, the changes have been peer reviewed and verified by an expert trained WRATE user.

Results

Overall the environmental performance of the modelled system shows a considerable benefit to the environment for all of the critical indicators, i.e. Global Warming Potential, Human Health, Acidification, Eutrophication, Resource Depletion and Aquatic Ecotoxicology. The proposed project therefore aids the mitigation of the impacts due to the management of the Authority’s waste.

This improvement can be attributed to the use of the MBT technology, which captures recyclable materials from the waste stream leading to increased recycling and use of the EfW plant. This provides electricity generation which partially off-sets the use of fossil-based fuels. In the years prior to this, the worst-case scenario has been modelled in terms of transport for the interim years and impacts within this year reflect this.

Overall Results Comparison for All 6 Indicators Against the Baseline scenario

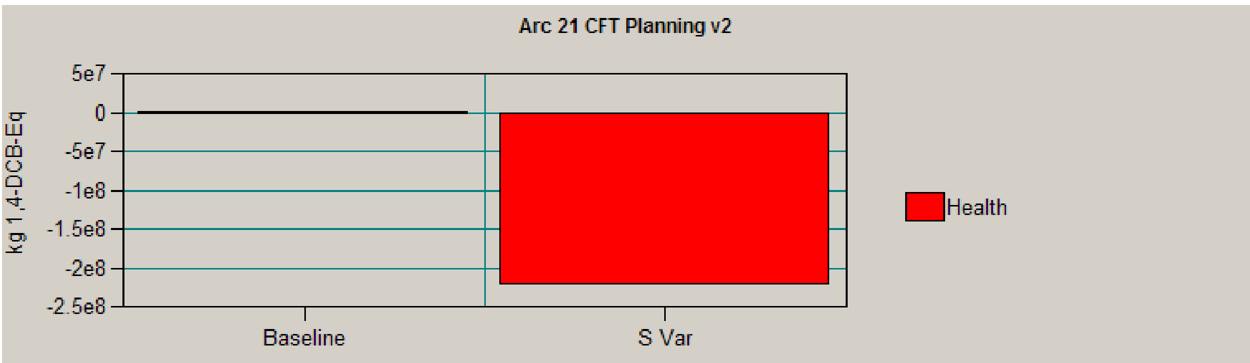


Source: EoN 'CFT' WRATE Model (Note the units for the graph are European Person Equivalents – Eur Person Eq)

Two of the most important indicators identified by the authority are Global warming potential and human health. The propose solution demonstrates that there is a considerable benefit compared with the baseline scenario for both of these indicators.

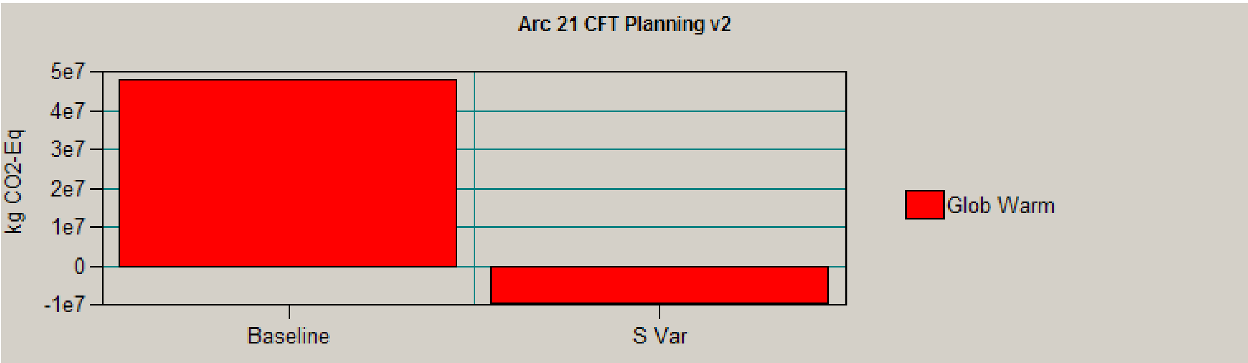
The graph below shows the overall benefit of the proposed project, which equates to a net gain of approximately 220,370 tonnes DCB (Dichlorobenzene)-Eq per annum. (note the position of the 'zero' line)

Human Health Results



The graph below shows the results for global warming potential (note the position of the 'zero' line).

GWP (100) Results



This shows an overall net benefit of approximately 57,474 tonnes CO_2-Eq per annum, and an actual net benefit to the environment of 9,764 tonnes approximately per annum.

WRATE model review

During the delivery of the contract a review will be conducted of the WRATE model every 24 months. This will be timed to coincide with the reporting of data which is required as part of the terms of the contract. The model will be assessed for its accuracy and will incorporate the operational data where appropriate. The WRATE methodology itself will also be reviewed.

The following aspects of the model will be reviewed as part of this.

- Review of the project map
- Transport data review
- Baseline assumptions review including :
  - Tonnage arisings
  - Waste composition
  - Electricity mix
  - Mass flow model review
- Process review including :
  - Default processes
  - UDP processes

This will ensure that the model accurately represents the system and produces a result that represents the impacts on the environment as accurately as possible.The model will be updated to reflect the performance of the system, any changes and /or new data that may become available. Following any changes to the WRATE model, the model will undergo a peer-review by an Expert WRATE user. The report that is produced during the review can be made available to a wide stakeholder base, and provide a high degree of transparency regarding the environmental performance of the project.

1 WRATE Analysis

1.1 Introduction

1.1.1 NI Waste Strategy

Reuse and recycling of waste helps to reduce the rate of consumption of virgin materials as well as the energy used in their mining and manufacture. The policies and actions for better resource management set out in this Strategy aim to produce important environmental, health and economic benefits.

The Northern Ireland Waste Strategy, together with the three sub-regional Waste Management Plans, provides the framework for establishing an integrated network of waste management facilities for Northern Ireland, as required by the EU Waste Framework Directive. It also incorporates Northern Ireland's measures for the management of biodegradable wastes in fulfilment of Article 5(1) of the EU Landfill Directive.

This project represents the delivery of the treatment and disposal aspects of the waste strategy for municipal solid waste in the arc 21 region; the WRATE modelling below demonstrates that this is being undertaken in a manner which is beneficial to the environment.

1.1.2 NI Carbon Strategy

The EU Landfill Directive requires Member States to reduce the amount of Biodegradable Municipal Waste (BMW) sent to landfill through setting challenging targets. The targets for the reduction of BMW landfilled are:

- To reduce by 2010 the quantity of BMW landfilled to 75% of that produced in 1995;
- To reduce by 2013 the quantity of BMW landfilled to 50% of that produced in 1995; and
- To reduce by 2020 the quantity of BMW landfilled to 35% of that produced in 1995.

The Northern Ireland Landfill Allowance Scheme (NILAS) regulations came into operation in Northern Ireland on 1 April 2005. The regulations place a statutory responsibility on District Councils, in each scheme year, to landfill no more than the quantity of BMW for which they have allowance.

This project is aimed at diverting the maximum tonnage of materials practicable from landfill, and in doing so it meets and exceeds the targets for NILAS, and will provide a benefit in terms of carbon off-sets.

1.1.3 WRATE Context

In order to assess the impact of the proposed project on the environment the Environment Agency's WRATE tool has been used to quantify the amount of Greenhouse gases emitted, as well as other key environmental indicators. WRATE is a Life Cycle Assessment (LCA) tool developed specifically for calculating the environmental impacts of waste management systems.

WRATE allows the environmental impacts of the waste management systems to be assessed over the life-cycle of all of the material, collection, treatment technology and transport elements. By using a combination of the default data in the model's databases and project specific data an overall assessment of the net benefits of the adoption of source segregation versus the 'baseline' (worst case scenario) can be established.

WRATE uses a number of databases to perform complex calculations; however the systems themselves can be built up by non LCA specialists due to the use of graphical user interface and standard processes. There is however, the flexibility to tailor the data to suit the specifics of the system or systems being studied.

1.1.4 Uses

WRATE has a number of recommended uses. These are generally in projects where a comparison needs to be made between several options, as it has been designed as a comparative tool primarily.

"WRATE is designed to inform decision-makers responsible for determining effective sustainable waste management strategies for MSW. Two types of study are predicted using the tool:

- ***Internal studies** are those that seek to investigate options using readily available data for the key parameters of the model.*
- ***External studies** are more detailed studies with the purpose of providing a public declaration on the results of the study.*

Other potential applications of WRATE include:

- *Use in developing regional and national waste strategies;*
- *Local authority waste disposal, collection and recycling contracts;*
- *Informing regional planning guidance, waste local plans and other plans,*
- *Strategic environmental assessments, technology assessments, waste services*
- *Private finance initiative (PFI) appraisal and environmental impact assessments;*
- *Waste technology evaluation;*
- *Development of other waste-related policies."*

Because it is designed specifically for wastes, particularly municipal solid wastes, WRATE can be used to compare the environmental impacts of various Local Authority waste management systems, and is especially useful in quantifying the global warming potential of a system.

1.1.5 Compliance with ISO Life-Cycle Analysis Standards

The WRATE tool has become the UK waste management industry's standard tool for LCA studies. This is largely because of its ease of use and availability, but also because of the high standard of data use in the modelling. It has been complied in accordance with the appropriate international standards for LCA studies and is therefore wholly suitable for the task of estimating the carbon impact of a proposed waste management system.

The WRATE user manual states that;

"*WRATE was developed following the International Standard ISO 14040 series. The general methodological structure of WRATE includes compliance with the following standards:*

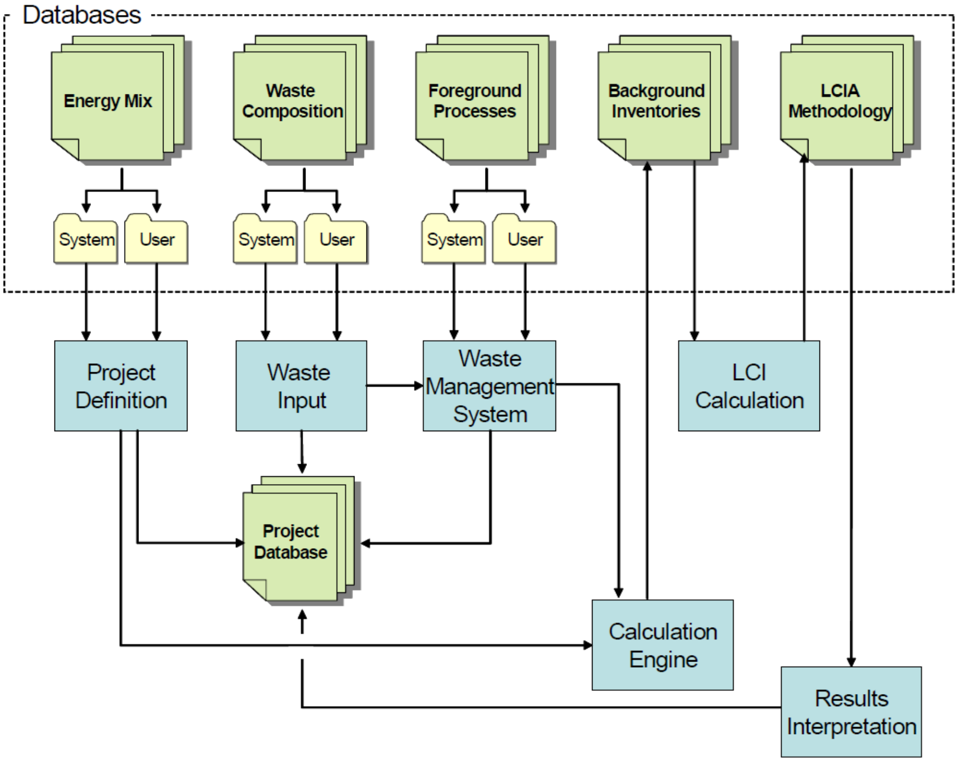
- *ISO 14040:1997 – Principles and framework*
- *ISO 14041:1998 – Goal and scope definition and inventory analysis*
- *ISO 14042: 2000 – Life cycle impact assessment*
- *ISO 14043: 2000 – Life cycle interpretation*
- *ISO 14048: 2002 – Data documentation format*
- *ISO 14049: 2000 – Examples of application of ISO 14041 to goal and scope definition and inventory analysis*

All foreground data collection was documented to the ISO 14048 standardised format. ISO 14048 and the other standards advocate transparent reporting, interpretation and review of data collection, data calculation and data quality. This was developed mainly to facilitate the exchange of LCA data in a consistent manner. ISO/TS 14048 enables fully transparent – and hence fully reviewable and verifiable – data documentation for life cycle inventories."

1.1.6 WRATE Structure

The WRATE LCA tool utilises number of databases, as shown in the diagram below. The user is able to manipulate the data in the Energy Mix, Waste Composition and Foreground data, the data in the Background inventories and the LCIA methodology cannot be accessed. These are used for the calculation of the results automatically.

Figure 1.1: WRATE Structure Diagram



Source: WRATE User Manual

1.1.7 WRATE Limitations

The limitations of the tool as described by the Environment Agency are:

"WRATE is designed for the modelling of MSW systems. It is not intended for product LCA studies. Nor is WRATE intended for the study of wastes that are not classed as municipal, unless they possess similar physicochemical properties."

The main limitations of WRATE are summarised as;

- It is not designed for product lca.
- It is limited to existing scientific knowledge.
- It is limited to the Environment Agency's waste analysis research programme data.
- It is limited number of user-entered process parameters - but complete transparency of the data and assumptions."
- WRATE does not take into account any decrease in operational performance with time or costs associated with decommissioning of the plant.

1.1.8 Model Development

After inputting a range of basic data into the model to create a WRATE project, which includes the background data on the waste arising, the population and the energy mix used to generate electricity in a given year (so that off-sets can be calculated) the WRATE model is then assembled using the graphical user interface.

This is designed to allow complex systems to be built up relatively easily using drag-and drop icons to construct a scenario map for each scenario being studied. Each icon represents a ‘process’. The processes represent each aspect of the waste system and comprise mathematical models of collection treatment and disposal processes, vehicles, receptacles and recycling options. Each of these has a range of standard processes which can be selected through the graphical interface.

Each process comprises a complex model made up of all of the mass flow, energy balance and emissions data for the process. This is then linked to the Ecoinvent database which calculates the impacts (this is the only part of the model which cannot be interrogated - WRATE therefore has several layers of complexity). The results are then displayed graphically, or tabulated

1.1.9 Results

The results produced can be relatively simple as for example in the default impacts results which show the ‘headline values for each of the main indicators for the whole system. If required, the data can be filtered to study transport or treatment only for example, and different aspects of the overall life-cycle inventory can be filtered out. This can include such factors as the lists of greenhouse gases, ozone depleting chemicals and other factors such as particulates, if this is required.

WRATE calculates two types of environmental burdens:

- Burdens that occur as a result of the operation of the waste management system (inputs and outputs that are represented by positive values);
- Avoided burdens (offsets) that occur when materials and energy are recovered from the waste (i.e. recycled materials replacing virgin materials, recovered energy replacing mains electricity). These are represented by negative values

Each process can be interrogated individually, and if required the process can be developed into a user defined process by the operator if the database of processes does not provide a standard process which is sufficiently representative.

In addition to the global warming potential a range of other indicators are calculated, which are discussed in the table below.

Table 1.1: Explanation of WRATE Calculated Impacts

Indicator	Explanation	Indicator Quality*
Global Warming Potential (GWP100/ Tonnes CO_2 eq.)	Greenhouse gases are chemicals which absorb energy in the form of light and re-emit it in the form of heat. They are believed to be responsible for the rise in atmospheric temperatures in the industrial era (mainly due to carbon dioxide) by trapping energy from the sun in the atmosphere which would otherwise escape into space. The potential for various chemicals to do this varies considerably, such as methane which is 23 times more potent than the standard comparator, carbon dioxide	Very Good The substances that produce this effect can be identified and their effect estimated in proportion to the indicator unit (carbon dioxide).
Eutrophication (kg PO4 eq.)	Eutrophication occurs due to the excessive increase of nitrogen and phosphates nutrients in the aquatic environment. These can cause an increase in the growth of micro-organisms resulting in oxygen depletion, such as by algal or bacterial growth, and other related toxic effects.	Very Good The substances that produce this effect can be identified and their effect estimated in proportion to the indicator unit
Abiotic Resource Depletion (kg antimony eq.)	Abiotic resource depletion is the depletion of natural, non-renewable, non-living resources. This factor mainly relates to the extraction of minerals and fossil fuels and other raw materials.	Good The concept of resource depletion is well established, however the use of one indicator substance will have varying relationships to actual impacts with time and in different parts of the world due to differing economics and geographies
Acidification (kg SO2 eq.)	Emissions of acidifying compounds such as sulphur dioxide and nitrous oxides, in the air can lead to acid rain, acidifying the soil and other effects such as defoliation of forests, resulting damage to ecosystems.	Very Good The chemicals that produce this effect can be readily identified and the effect they have related to one particular indicator comparatively reliably.

Indicator	Explanation	Indicator Quality*
Human Toxicity (kg 1,4 dicholorobenzene eq.)	Human Toxicity is the harm or which may be caused to humans due to exposure to a substance. This can be via a number of pathways such as inhalation, digesting or contact with the skin. The level of toxicity of a substance varies depending on a number of factors including exposure time, concentration, the subject's health, age and the physical nature of the toxin.	Fair Human toxicity is a very complex subject; the indicator does not differentiate between acute and chronic effects or other effects such as mutagenicity, teratagenicity, carcinogenicity, etc which can vary considerably with exposure and dosage.
Fresh Water Aquatic Ecotoxicity (kg 1,4 dicholorobenzene eq.)	Substances in this category cause damage to freshwater ecosystems depending on the concentration and level of exposure to the environment.	Fair Although these substances can be identified relating them to a single quantity is difficult due to the complex nature and variety of aquatic ecosystems and their responses.

*Qualitative Assessment

The set of indicators in the above table provide a means of assessing the major impacts on the environment due to the whole waste management system. A value is calculated for all of the major impacts due to emissions to air, land and water.

Although some of the indicators above are assessed as 'Fair' in terms of their suitability as an actual 'empirical' measure of the quantity that they are estimating, they can, nonetheless be used effectively in comparative studies such as the one undertaken for the proposed solution described below.

Other limitations to the software include the limited number of processes relating to transport types and vehicles, the amount of materials and energy that have been used in the construction of plants and other factors which are hard to quantify.

When working with WRATE the user must give consideration to defining the system boundary. This is one of the key decisions when undertaking a Life-Cycle Analysis study. In the study below the system boundary starts at the delivery of waste from the Constituent Councils of arc 21. This approach is appropriate for the study of a waste treatment system where the system or options being modelled will have no bearing on the way in which the waste is collected i.e. the use of different receptacles or collection vehicles.

The system boundary end point is dictated by the software itself, this is defined as the point at which the waste has been treated/ recycled or disposed. Until all of the waste being studied in a particular 'scenario' has been managed in such a way that all of the waste has reached its defined end point the software will not calculate the impacts, and an error message is given listing the issues with the management of the waste.

This includes the means by which the waste arisings are treated and managed. The software has been designed so that the management of the wastes is consistent with reality. An example of this is in the use of advanced thermal treatment processes where the waste must be appropriately pre-treated before treatment. There may also be restrictions on the physical properties of the waste, going through a process, such as the maximum or minimum moisture content.

The measurement of CO_2 emissions and other environmental impacts via LCA is an evolving science as and the impacts are constantly evaluated as the understanding of the subject evolves The WRATE tool provides a powerful method for comparing options and assessing the environmental impacts of critical strategic waste management decisions and projects.

It should be noted that one factor that can have a significant impact on the overall impact of the model is the waste composition. The composition supplied by arc 21 has been used. When the model is revised during the implementation phase of the contract, this is one area that will be specifically reviewed and updated in order to improve the accuracy of the model.

It should be noted that the assumptions used while diverging from actual practice still allow the overall impact of the system to be assessed as accurately as is possible within the limitations of the software. In many respects any differences apparent would result in a negligible effect on the overall impact of the system as most of the impacts from this type of system result from the impacts associated with materials being managed and those associated with the construction of the treatment plant, and other elements of 'hardware' in the system.

When developing the WRATE models all of the data that has been used in the financial modelling has been included regarding materials, the collection methodology and transportation. The key factors used in the development of the scenarios are;

- The scenarios include a user defined process for the MBT facility. This has been developed from the MBT Drying and RdF Herhof [21293] process within the default set of processes. The 'allocation data' for the mass flows, the energy balance and the waste composition have been altered to match the data supplied by Strabag for the proposed plant. This is also the data which is used in the submitted mass flow and financial models as a part of the overall submission. The model is therefore consistent with all of the supporting information for the proposed system.
- The Flexible Energy from Waste Process [21849] has been used to model the proposed energy from waste process, the input parameters have been adjusted to; electricity only, 21.7% efficiency, SNCR dry emissions technology and no front end recycling recovery in accordance with the proposed EoN plant.

- For the transport impacts the routes and transport types contained within the proposed transport plan and the data supplied by Arc 21 for the baseline scenario have been used to build up the transport aspects of the model. The vehicles database is somewhat limited in WRATE the vehicle 'Intermodal Transport – v2 12026' has been used for the bulk transport of materials between locations, as the closest approximation available where appropriate.
- For the transport of fly ash for the proposed solution, it has been assumed that this particular waste stream will be hauled by road to Belfast, and shipped to Liverpool for onward transport to a destination in Cheshire. This is a likely scenario for this type of material. It should be noted that in terms of the overall impact of the solution (greenhouse gas emissions), the difference between this and a local transport and disposal of fly-ash will be not significant overall. This is because the major impacts in WRATE models tend to be associated with the treatment of the wastes. Transport is not usually a significant factor unless the distances and tonnages are very high, for example if the proposed plants were both located over 100 miles away from the arc21 area, in which case the difference would be significant.
- For the transport distances and breakdowns the breakdowns of urban/rural/motorway transport as supplied by arc21 has been used where possible in the WRATE guidance issued by the authority in January 2013.

The model developed represents the years of the contract from 2019/2020. This is the first year that the input tonnage and output tonnages are predicted to be constant i.e. when the project is fully operational. The scenarios developed are described below. The results of the model are presented as a comparison between the two scenarios; the baseline model and the model of the proposed solution.

1.2 Baseline

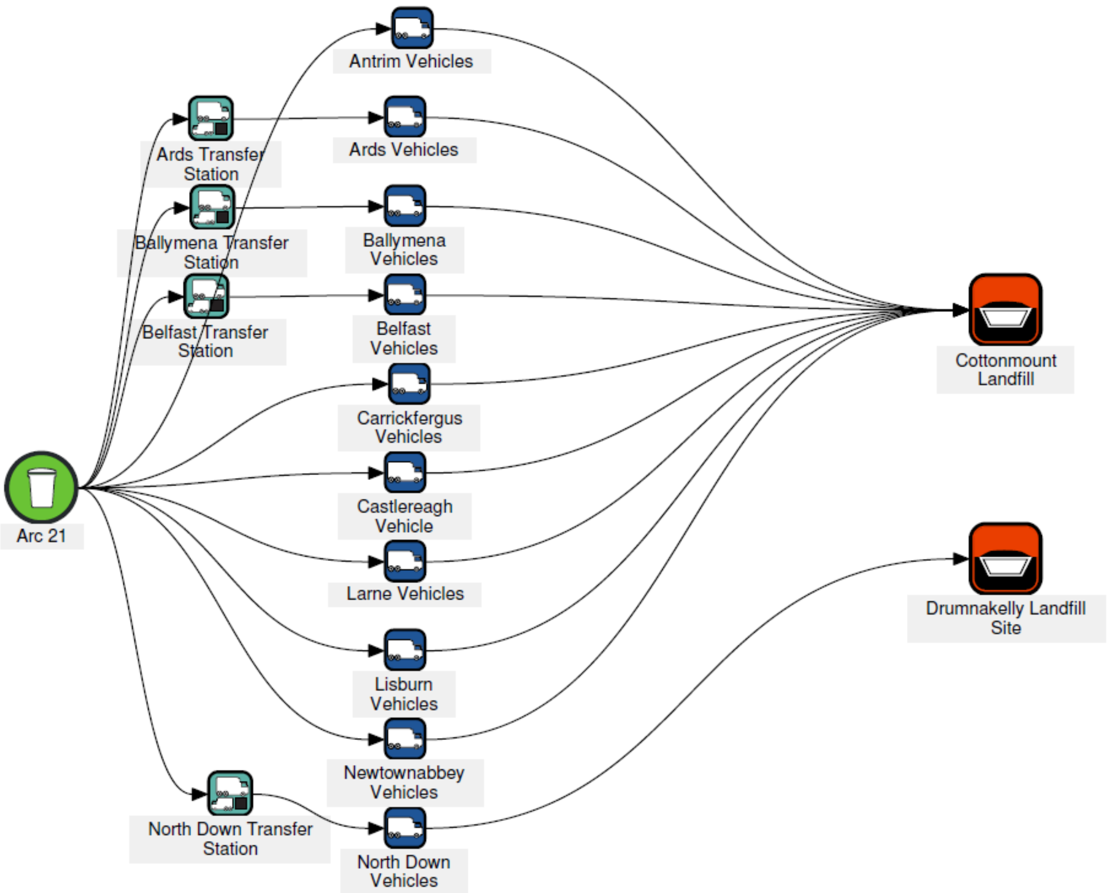
In order to demonstrate the benefits of the proposed waste management solution, it is necessary to compare the calculated performance of a baseline. Tonnages calculated in the mass flow model have been used as the basis for the development of the WRATE model.

For the WRATE model, a baseline has been created which assesses the environmental performance of a scenario where no technologies are used and all waste goes straight to landfill. This is used as a comparison against the other years where waste management technology is used in order to see how the environmental situation improves with the introduction of treatment and energy production.

The information included into the baseline is that which has been submitted by the arc21 Council's and this is used as a base for the modelled contract years. Information includes waste distribution and origin, use of transfer stations and transport logistics, such as distance and use of urban/rural roads.

The map of the baseline scenario is provided below:

Figure 1.2: Baseline Scenario Map



Source: Arc 21 CFT WRATE model

1.3 Contract year 2019-2020 onwards.

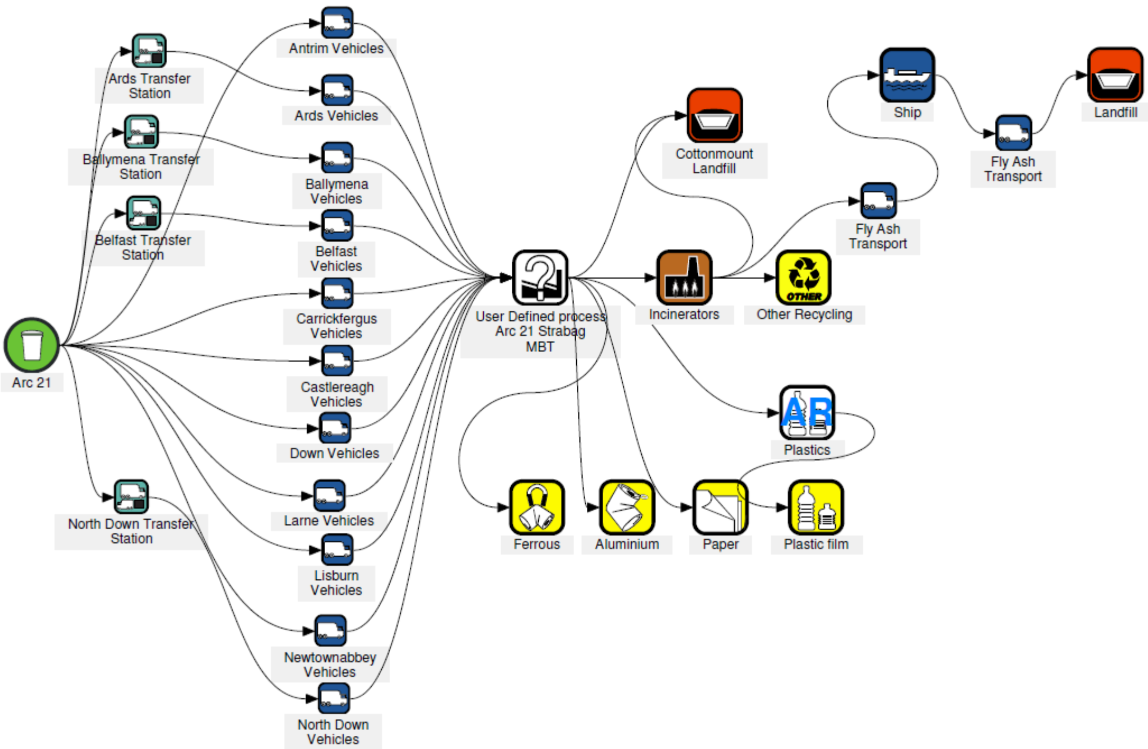
1.3.1 Description

In contract year 2019/20, both the MBT and EfW Facilities are in full operation and the tonnage of waste received is assumed to be constant for the remainder of the Service Period. Waste is transferred initially to the MBT Facility and based on the capabilities of the MBT and the mass data flow. Ferrous, aluminium, paper and plastic will also go on to further recycling facilities.

A proportion of the rejects from the MBT process are also taken to the EfW Facility, with any ferrous and non ferrous bottom ash residue then being taken to the IBA recovery facility and other process rejects being disposed of to landfill. The figure below shows the scenario map for 2019/2020. The tonnages assigned to each authority and the mass flows are in accordance with the mass flow model derived for the overall solution.

The distances travelled by the waste from the Constituent Councils of arc21 have been taken from the transport plan prepared for the overall solution, together with the council's assumptions on the split between rural/ urban and motorway transport.

Figure 1.3: Scenario Map for 2019/2020 (and subsequent years)



Source: Arc 21 CFT WRATE model

1.3.2 User defined Processes

The implementation of user defined processes (UDP) has been limited as much as possible in developing the WRATE models. However, the main processes that have necessitated a user defined process are the Strabag MBT process and the EoN Energy from Waste plant.

In modelling the Strabag process (UDP ID 22428) use has been made of the MBT – Biodrying and RDF – Herhof process (default ID process 21293) in the WRATE processes database. This has been adjusted for the anticipated mass flows for the proposed solution, using the process detailed mass flow data. This has been based on the operational data for the reference plants and reflects the anticipated performance of the proposed plant.

In general, the parameters and background allocation rules that have been altered and hence make the user defined process, for the Strabag process is as follows:

- Typical Waste Fraction Composition;
- Process and RDF Output, and
- Process emissions

These parameters are altered to reflect the waste streams and tonnages that are being processed and can be treated by the technology.

In order to calculate the RDF output from the Strabag process after biodrying the available data was used and an assumption was made that the loss of water through biodrying would be equal for each waste stream e.g. it is assumed that paper loses water at the same rate as organics. A calculation was performed to subtract the proportion of moisture coming off the waste streams during the biodrying process, the calculated CLO/RDF composition was then added to that composition of the screen overflow to calculate the combined output composition of the RDF.

The Flexible Energy from Waste Process [21849] has been used to model the proposed energy from waste process. This provides a standard approach to the production of electricity and the other outputs such as ash and fly ash. These have been treated in accordance with the project schematic and mass flow models which form a part of the final tender submission. The input parameters have been adjusted to; electricity only, 21.7% efficiency, SNCR dry emissions technology and no front end recycling recovery in accordance with the proposed plant (recyclables being recovered from the bottom ash).

Alterations to waste restrictions in the HDPE plastics recycling facility (ID 12304) have been made to accommodate the recycling of both plastic film and dense plastics. The waste restrictions for the plastics recycling process have been altered to allow it to accept mixed plastics as per the proposed solution. The lighter plastic rejects from this process are then sent to an LLDPE & LDPE agricultural film recycling plant (ID 12303). This is to represent the recycling of mixed plastics at the one site; to reflect the proposed solution. By altering the waste restrictions this allows the incoming waste into the facility to be limited. To prevent a certain waste fraction entering a process the restriction is set at zero for that particular fraction and if a certain process can only accept one type of waste then both the maximum and minimum restriction is set at zero.

Headline and process parameters, construction, decommissioning, maintenance, operation inputs and outputs have all been kept the same in order to ensure the technology is as representative as possible, reflecting the approved default process and due to lack of sufficient information about the civil engineering aspects of the proposed plant. This could be updated once there is more information on the design performance of the plant - see section below on review of the WRATE model.

Whenever significant alterations have been made to any process, the changes are peer reviewed and verified by an expert trained WRATE user.

2. Impact of the Proposed Solution

The impact of the proposed solution with respect to the WRATE default parameters is set out in Table 2.1 and Figure 2.1 below. The data has been presented as tonnages (the default setting in WRATE is kilograms). The result for each indicator is discussed compared with the baseline scenario.

2.1 Default WRATE Impacts

Table 2.1 a shows a comparison of the default impacts of the proposed solution based upon the year 2019/20, which is the first of the years where the tonnage of materials treated is at a 'steady state' and should therefore be representative of each of the contract years remaining to the end of the contract. As the service develops over the contract period the model will be modified to ensure that it represents the delivery of the project as accurately as practicable.

Table 2.1: Default Impacts of the Proposed Solution (tonnes)

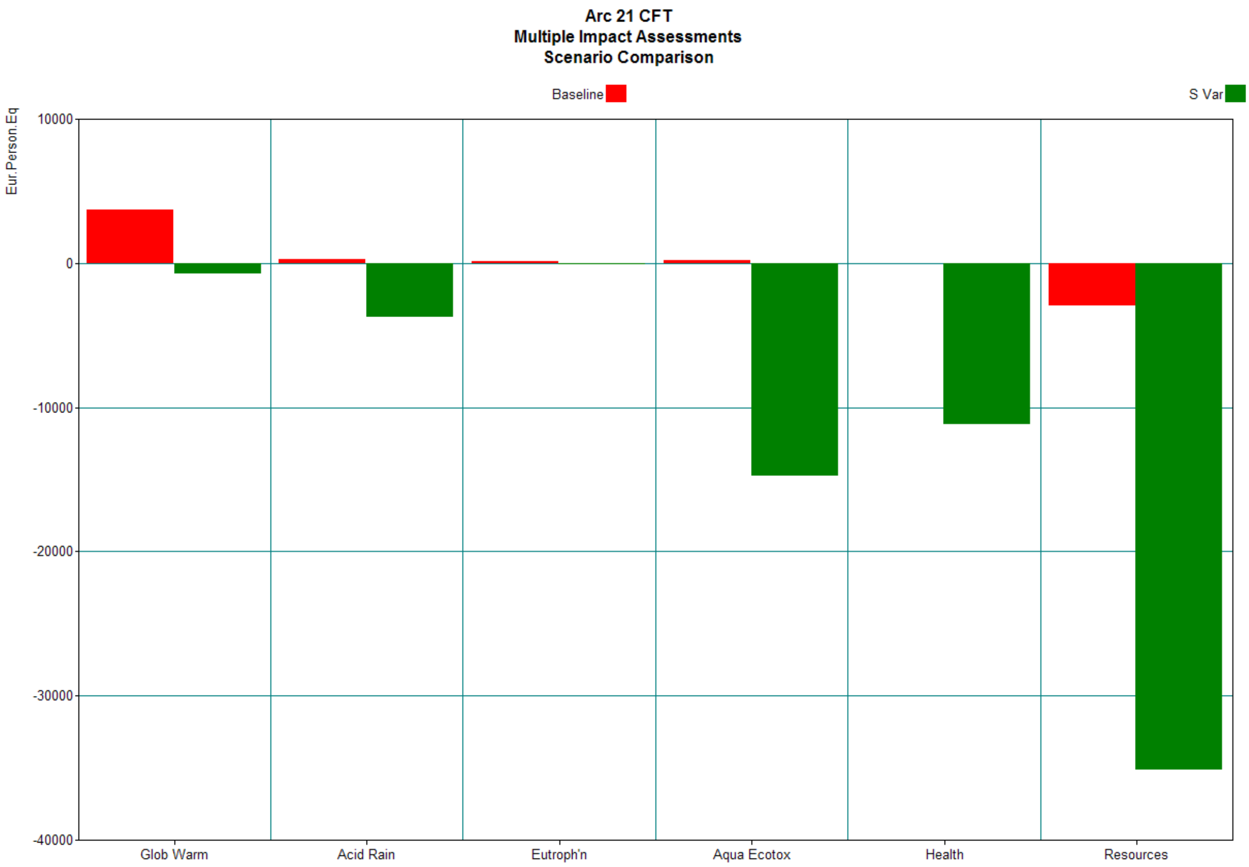
Impact Assessments	Baseline	Project (2020)
climate change: GWP 100a tonne per annum	47,711.27	-9,763.52
acidification potential: average European	-269.16	288
eutrophication potential: generic	-2.44	7.87
freshwater aquatic ecotoxicity: FAETP infinite	267.04	-19,449.27
human toxicity: HTP infinite	128.22	-220,242.07
resources: depletion of abiotic resources	-114.82	-1,358.77

2.1.1 Detailed results Display for the Proposed Solution

Figure 2.1 below shows the results in Table 8(a) compared with the results for the baseline 'do nothing' scenario where all of the waste is sent to landfill. The red blocks represent the impact of the baseline, the green blocks the performance of the proposed solution.

The proposed solution shows that the impact of all of the indicators is better than the baseline solution with the exception of eutrophication, which shows a small improvement over the baseline. For all of the other indicators there is a considerable improvement over the baseline scenario. In all of the indicators, there is an overall net benefit to the environment (represented by a negative number) i.e. below the 'zero' line across the graph on the x-axis.

Figure 2.1: The overall Results for All 6 Indicators Compared with the Baseline



Of the more reliable indicators, discussed above, particularly global warming, acidification, and resource depletion there is a considerable benefit. The health and ecotoxicity indicators also indicate a considerable benefit.

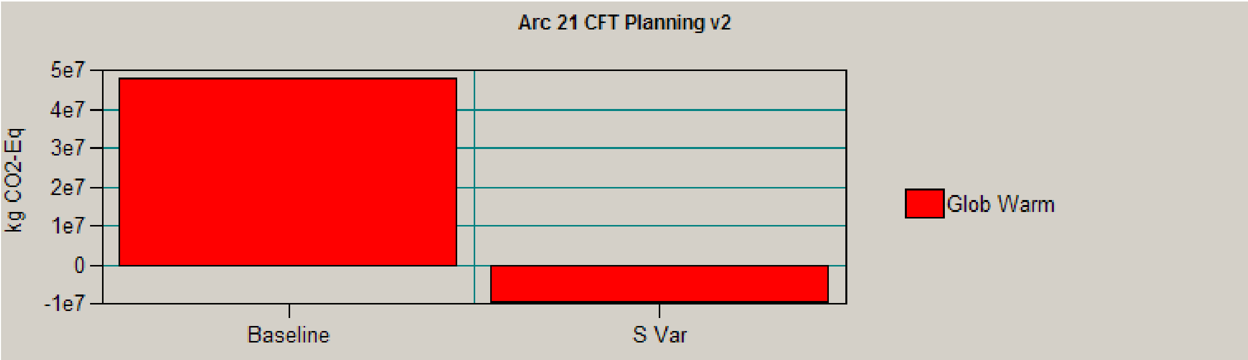
2.1.2 GHG emissions per contract year expressed in tonnes CO_2 equivalent

The data for greenhouse gas emissions shows an overall benefit of 9,764 tonnes CO_2 Eq per annum, an overall improvement of 57,474 tonnes compared with the baseline scenario.

Table 2.2: GHG emission per Contract Year Expressed in tonnes CO_2 equivalents total per Annum

Impact assessment	Unit	Total (Baseline)	Total (EfW R)	Net Benefit
climate change: GWP 100a	tonnes CO_2-Eq	47,711	-9,764	57,474

Figure 2.2: Global Warming Impact in CO_2 Equivalents



The table below lists the individual chemicals responsible for the greenhouse gas emissions from the project. Negative numbers indicate that there is an offset associated with the waste management system being modelled by WRATE i.e. there is a net benefit to the environment. The two largest figures – for CO_2 (fossil) and Methane indicate the benefits of the offset of fossil based fuels and the diversion of materials from landfill, primarily.

Table 2.3: Detailed Breakdown of the Results for the Greenhouse Gas Emissions

GHG emissions	Tonnes CO_2 Eq
Methane, (unspecified)	3,354
Carbon Monoxide (CO)	6.23
Methane, dichlorodifluoro-, CFC-12	5.10
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	2.17
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	2.27
Methane, chlorotrifluoro-, CFC-13	1.19
Ethane, 1-chloro-1,1-difluoro-, HCFC-142	0.18
Ethane, 1,1,1-trichloro-, HCFC-140	0.15
Methane, chlorodifluoro-, HCFC-22	-0.47
Carbon monoxide, fossil	-441
Methane, trichlorofluoro-, CFC-11	0.147
Methane, tetrafluoro-, FC-14	-7,168
Carbon tetrachloride [Tetrachloromethane]	-0.0008
Methane, bromotrifluoro-, Halon 1301	-0.9190
Ethane, 2-chloro-1,1,1,2-tetra-fluoro-, HCFC-124	0.0065
Sulphur hexafluoride	-15
Ethane, 2,2-dichloro-1,1,1-tri-fluoro-, HCFC-123	0.00225
Carbon monoxide, biogenic	-553
Hydrocarbons (unspecified)	2.10400
Methyl chloride [Chloromethane]	0.00041

GHG emissions	Tonnes CO_2 Eq
Dichloromethane	0.00016
Carbon dioxide (CO_2)	13.13100
Methane, trifluoro-, HFC-23	-0.000752
Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	-0.0135
Ethane, 1,1-difluoro-, HFC-152a	-2.42E-04
Chlorinated Matter (unspecified, as Cl)	-6.50E-08
Methyl bromide [Bromomethane]	5.49E-11
Methane, bromochlorodifluoro-, Halon 1211	-4.33E-01
Methane, biogenic	66.6
Nitrous oxide	1,944
Methane, fossil	-11,484
Carbon dioxide, fossil	4,502
Total	-9,764

Source: Arc 21 CFT WRATE Model

2.1.3 Greenhouse Gas Emissions (Treatment and Disposal)

The amount of greenhouse gases that are emitted in the disposal and treatment processes can be extracted from the databases in WRATE.

Table 2.4: Greenhouse gas emissions for the baseline scenario

Impact Assessment	Unit	Cottonmount	Drumnakelly	Landfill Total
climate change: GWP 100a	kg CO_2-Eq	42,465	34.917	45,957

Source: Arc 21 WRATE Model

The model calculates that 45,957 tonnes of CO_2 (Eq) is produced by the baseline scenario due to the methane from the landfill of waste together with that emitted by any landfill gas electricity generation.

Table 2.5: Greenhouse gas emissions due to landfill for the proposed project

Impact Assessment	Unit	Cottonmount	Haz. waste Landfill	Total
climate change: GWP 100a	kg CO_2-Eq	1,112	26	1,138

Source: Arc 21 WRATE Model

The carbon burden due to landfill is reduced to 1,138 tonnes during the years in which both plants are in operation.

The amount of carbon emitted during the operation of the MBT and the EfW plant is 55,478. This quantity does not include the net benefits from the off-set of fossil fuels and the recycling of materials, which gives rise to the overall calculated benefits to environment of the proposed project.

Table 2.6: Greenhouse gas emissions due to treatment only from the proposed project

Impact Assessment	Unit	MBT	EfW	Total
climate change: GWP 100a	kg CO_2-Eq	7,513	47,946	55,478

Source: Arc 21 WRATE Model

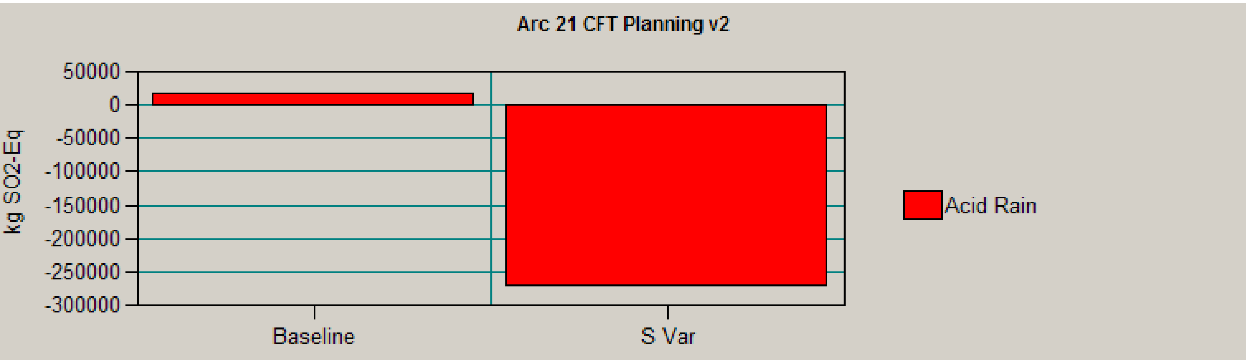
2.1.4 Acidification

The results for acidification show a considerable net benefit compare with the baseline. The overall benefit is equivalent to 288 tonnes SO2-Eq. This is due to the reduction in the use of raw materials such as metals that may produce acidic gaseous emissions during extraction and smelting. There is also a reduction in the amount of HCl that may be produced by the burning of coal, for example due to the offset of the use of fossil fuels.

Table 2.7: Table of Results and Calculated Benefits for Acidification

Impact assessment	Unit	Total (Baseline)	Total (EfW R)	Net Benefit
acidification potential: average European	tonnes SO2-Eq	18.74	-269.16	288

Figure 2.3: Figure 8.8(d) Graph of Results for Acid Rain/ Acidification



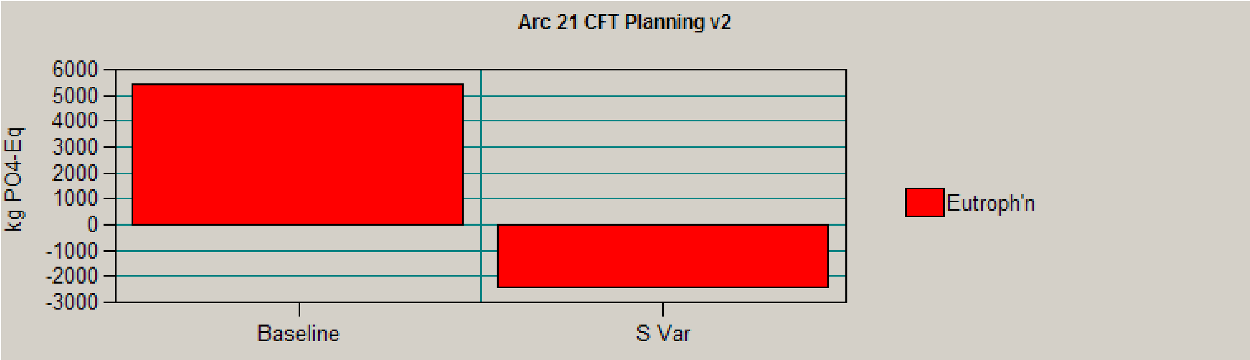
2.1.5 Eutrophication

The impact on eutrophication shows that there is a small benefit compared with the baseline 7.87 tonnes per annum PO4-Eq. This is equivalent to the amount of fertiliser that might be used on approximately 160 Ha of fields growing maize. The main sources of this are the airborne nitrogenous compounds that are associated with the combustion of wastes, and the MBT process which can be a source of ammonia, which is also a source of airborne nitrogen which can eventually find its way into water courses through rainwater

Table 2.8: Calculated Results and Calculated Benefits for Eutrophication

Impact assessment	Unit	Total (Baseline)	Total (EfW R)	Net Benefit
eutrophication potential: generic	tonnes PO4-Eq	5.43	-2.44	7.87

Figure 2.4: Graph of Results for Eutrophication



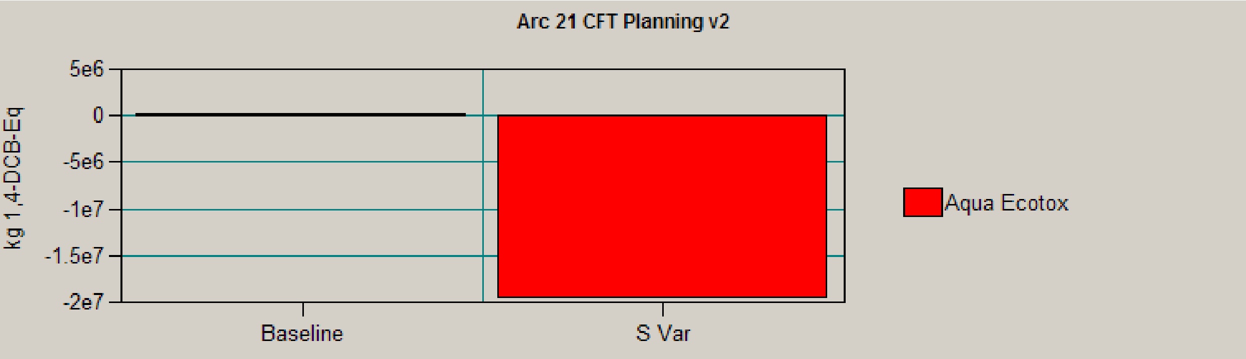
2.1.6 Freshwater Aquatic Ecotoxicology

The solution shows a net gain of 19,716 tonnes of 1,4 DCB-eq annually. This is due to the reduced run-off associated with the diversion of materials away from a reliance on landfill as a waste management option.

Table 2.9: Calculated Impact and Benefits for Human Toxicity

Impact assessment	Unit	Total (Baseline)	Total (EfW R)	Net Benefit
freshwater aquatic ecotoxicity: FAETP infinite	tonnes 1,4-DCB-Eq	267.04	-19,449.27	19,716

Figure 2.5: Graph of Results for Aquatic Ecotoxicology



2.1.7 Figure 8.8 Human Toxicity

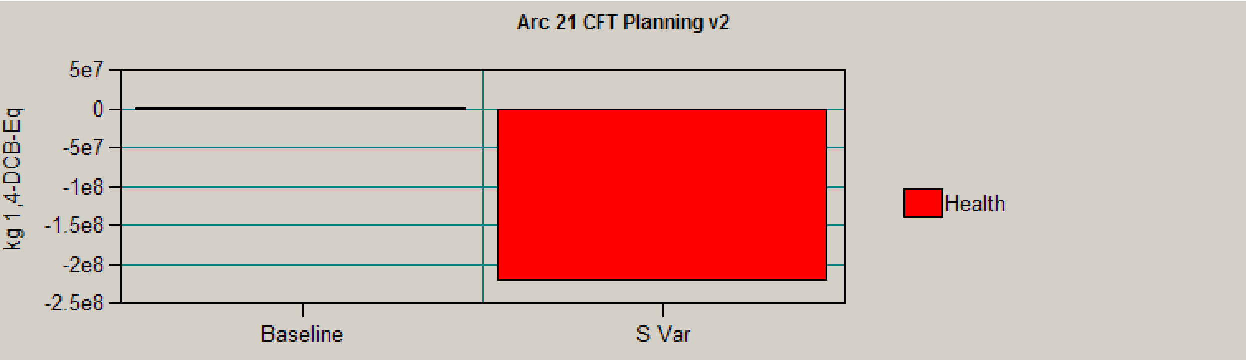
The results for human toxicity show that overall there is a net benefit of 220,370 tonnes DCB-Eq. When the full service commences the recovery of materials such as ferrous and non ferrous metals offsets the effect upon human toxicity of producing these materials, together with a further offset due to the substitution of non-fossil fuels which have health impacts during their production.

There can also be a comparatively good performance of the landfill due to the engineering of the landfill lining system. The effectiveness of retarding the progress of toxins and effective leachate management will prevent the egress of leachate into surrounding water courses.

Table 2.10: Calculated Impact and Benefits for Human Toxicity

Impact assessment	Unit	Total (Baseline)	Total (EfW R)	Net Benefit
human toxicity: HTP infinite	tonnes 1,4-DCB-Eq	128.22	-220,242.07	220,370

Figure 2.6: Graph of Results for Human Health



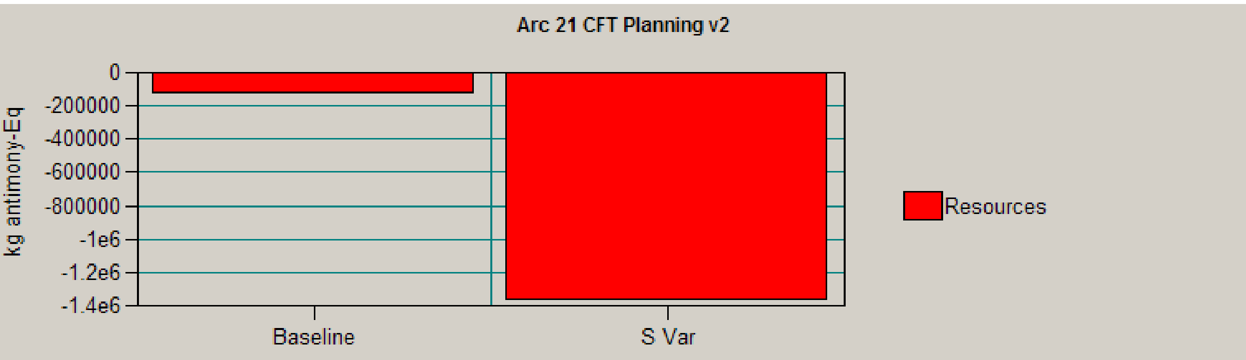
2.1.8 Resource Depletion

In comparison with the baseline scenario, the solution gain shows a considerable net benefit equating to 1,244 tonnes antimony-Eq per annum. The baseline shows an overall benefit due to the assumption within WRATE that the landfill has landfill gas electricity generation. The gains in resource depletion originate from the capture of recyclables and the off-set of the use of fossil fuels for the generation of electricity.

Table 2.11: Calculated Impact and Benefits for Resource Depletion

Impact assessment	Unit	Total (Baseline)	Total (EfW R)	Net Benefit
resources: depletion of abiotic resources	tonnes antimony-Eq	-114.82	-1,358.77	1,244

Figure 2.7: Graph of Result for Resource Depletion



2.2 Calibration of the Model

To ensure that the model most accurately reflects its performance, several key datasets will be maintained in order to update and calibrate the model. These relate to the principle processes in the system and are the ones which will enable the major emissions to be much more accurately modelled.

However, it should be noted that monitoring the proposed facilities in isolation will not ensure that the model is accurate unless the data regarding the waste composition is maintained. Also, no particular factor on its own can provide a 'litmus test' for the system as a whole. Instead a number of key data need to be utilised together with the development of accurate user defined processes where appropriate for the proposed solution.

For the EfW facility the following data will be utilised in the calibration of the model;

- The overall quantity of electricity produced
- Data related to the consumption of electricity/fuel and other factors in the 'parasitic load' of the facility
- The overall calculated efficiency of the plant using the available heat balance data updated as appropriate,
- The tonnage of materials produced (residues and recyclables), together with the overall mass flow data for the plant.
- Any other relevant data such as the plant availability, etc

The use of the variable standard process can therefore be assessed and a 'user defined process' substituted if this is necessary.

Any additional information regarding transport impacts can also be included. In terms of ensuring the accuracy of the modelling of this part of the solution, net energy generation and the tonnage-flow of materials are the most important factors.

For the MBT process the following data will provide a method of ensuring the accuracy of the model by ensuring accurate data for;

- The electricity/ fuel consumption overall for the plant and the mobile plant operation.
- Mass of the recyclables separated and their types as appropriate
- The destination of the recyclables
- The transport data and assumptions for the off-take of the materials
- Any other relevant data such as the plant availability, etc

Using this data together with the waste composition data the overall mass and energy flows can be assessed and the model refined.

2.3 Bi Annual Modelling

2.3.1 Purpose

The model will be revised and updated every two years. The purpose of the bi-annual modelling is to enable the project to be assessed and improved on the basis of the operational data, which will then be incorporated into the model, resulting in iterative improvements in the environmental performance over time.

Modelling of the system will be achieved through a combination of data gathering and review followed by an update of the model using the proposed methodology as outlined below. This is intended to provide the basis for the development of the model over the course of the contract period, and will ensure that it reflects as accurately as is practicable the environmental impacts of the system as estimated by WRATE.

This will allow the WRATE model to form a basis for reporting the environmental performance of the system to a wider stakeholder base. In addition it can be used as a tool to help assess the performance of the overall solution and identify areas that may need to be improved.

It should be noted that the process of developing a model such as the WRATE model for the project is an iterative one built on the fundamental principles of life-cycle methodologies. That is to say the model is assessed periodically, data gathered and the model updated according to a set protocol to ensure that the process is robust, and is representative of the data available.

The process of reviewing the model will be done once every two years as outlined within the following section, in addition to a further expert peer review of any changes made.

2.3.2 Review of the model

The 24 month review of the model will be a detailed exercise and will be timed to coincide with the reporting of data that is required by arc21, in order to integrate the process with arc21's normal activities. The reporting of data from both plants will be integrated into this process as a part of the production of the monthly and other reports relating to the operation of the plant. In addition, data will be gathered relating to the parameters that make up the 'allocation data' for the User Defined Processes.

This will include the data relating to the energy consumption of both plants, the electricity generation of the energy from waste facility, and any changes to underlying data such as the distances travelled of the transport of recyclable materials.

Other data relating to the mass flow of the plant is particularly critical and will include consumables, chemicals and any data that becomes available relating to the maintenance of the plants. Transport data will be analysed for any divergences from the proposed transport plan.

Also, particularly in the first review of the model, the data relating to the construction of both plants will be reviewed. This will be undertaken in order to validate the data used in the development of the UDP which is based on the data within the original WRATE efault processes that the model was developed from. This may involve liaising with the EPC contractors to obtain bills of quantities and calculation of the actual tonnage of materials excavated, etc.

The emissions data will also be checked to see that it conforms to the current BAT estimates for both technologies employed.

2.3.3 Operational assumptions review

An assessment of the baseline assumptions will be carried out on the data and assumptions used on the first sheet when developing the WRATE model, i.e. on the project information tab, including:-

- Tonnage arisings
  A comparison of the tonnages in the output specification tonnages compared with the most up-to-date data available, and the tonnages revised if necessary.

- Waste Composition
  The waste composition will be revised to allow for the most accurate representation of arc21 waste. Any discrepancies between the waste composition split, the supplied composition and the breakdown in WRATE will be addressed and any new data incorporated.

- Electricity Mix
  The chosen electricity mix will be updated on the basis of the latest data and updated if necessary. This will become more important in the latter years of the contract, as the electricity mix plays a large part in determining the off-sets and therefore the benefits of the system overall. The electricity mix has been based upon long-term projections which are likely to differ from the actual data in the latter years of the contract.

2.3.4 Review of the project map

The overall schematic that represents the system will be reviewed to ensure that the flow of materials and the linking of processes are appropriate. The mass distribution for each process will be checked to ensure that the mass flow is accurate for the process.

2.3.5 Transport data review

The data relating to the transport aspects of the model will be assessed and updated where necessary. This will include the mode of transportation, mileages of transport movements, the types of vehicles used in the model, the type of fuel and the road mileage profile (the split between rural urban and motorway mileage) assessed and updated if necessary.

The need for any further development of this aspect of the model can be discussed with arc21 in order to balance the need for accuracy.

2.3.6 Process Review

The individual processes used for each step in the system will be reviewed and assessed to ensure they are appropriate for the model on the basis of the latest available data. This can be broken down into two main parts.

- Default Processes
  Whether the use of a particular default process is appropriate will be assessed and revised if necessary. The use of an alternative default process or by the development of a user defined process will be assessed. As the WRATE tool is developed and updated by the Environment Agency the default process database will be assessed for new processes which may be appropriate for the model. An example of which may be in the transport processes, such as the vehicle types. This database is quite limited in the current version of the software.

- User Defined Processes
  The continued adoption of any user defined process will be assessed. The database of default processes is updated with each revision of WRATE, and as such it may be appropriate that the user defined process be replaced with a default process.

Where this is not appropriate the user defined process will be peer reviewed and evaluated by an expert WRATE user, referring to the available data for the processes during the delivery of the service. For the MBT process, these can be updated using the latest operational data, in order to give an up-to-date assessment of the performance of the system.

2.3.7 WRATE Updates

The WRATE software itself is periodically updated by the Environment Agency. The current version is Version 2. The main differences between the two versions lay in the updating of many of the default processes, in addition to improved functionality.

If WRATE is updated it will be ensured that any improvements in the process databases will be incorporated into the new model and that the impact of the changes will be assessed as a part of the biennial review of the model.

2.3.8 Software Revisions

WRATE was initially released in 2006 and updated to version 2 in 2009. Prior to this the standard LCA tool used in the UK waste management industry was WISARD 3.0 developed by Ecobilan for use by British local authorities. If the standard tool used during the contract period changes the transition from one tool to another will be discussed with arc21.

2.3.9 Report and Updated Model

A report will be submitted to arc21 outlining any changes that have been made to the model making reference to the workshop session if necessary, and giving the reasoning behind the changes together with the data sources used, etc. This will be accompanied by a copy of the updated model .lca files and copies of the LCA reports produced by WRATE. The underlying data and assumptions will also be included as appropriate.