NORTH LONDON WASTE AUTHORITY

NORTH LONDON HEAT AND POWER PROJECT

COMBINED HEAT AND POWER (CHP) DEVELOPMENT STRATEGY

The Planning Act 2008 The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Regulation 5 (2) (q)

AD05.06

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Executive summary

i.i.i This report describes the Combined Heat and Power (CHP) development strategy for the proposed Energy Recovery Facility (ERF), which forms part of the North London Heat and Power Project. This document has been prepared to support the North London Waste Authority's (the Applicant's) application (the Application) for a Development Consent Order (DCO) made pursuant to the Planning Act 2008 (as amended). The purpose of this document is to demonstrate the CHP opportunity and how it is planned to be implemented. This report responds to Overarching National Policy Statement for Energy EN-1 [1](NPS EN-1) which requires applications for thermal generating stations, such as the proposed ERF, to consider CHP as a minimum.

i.i.ii CHP operation is a term given to a thermal generating plant which can provide useful energy in the form of electrical power and heat for use in space heating and hot water applications in buildings, industrial processes, and other uses. The benefits of CHP are twofold: the first is that the overall ERF efficiency improves, such that more energy is recovered from the fuel processed; the second is that fossil fuels which would otherwise be used are displaced. In this way, CHP operation provides carbon emissions savings.

i.i.iii An important aspect to this strategy is to review existing published work that documents the opportunity for the development of large scale heat networks in the Upper Lee Valley area. In 2011, recognising the importance of the opportunity, the North London Strategic Alliance (NLSA) commissioned a pre-feasibility study for a decentralised energy network (NLSA Study [2]); it demonstrated the opportunity for a large scale commercially sustainable heat network centred around a low carbon heat supply from the Edmonton EcoPark. Then in 2012, London Borough of Enfield (LB Enfield) led the formation of LVHN Ltd with the purpose of developing and operating the Lee Valley Heat Network (LVHN), which would serve as the catalyst to the wider strategic heat network. As part of the pre-feasibility study and work carried out to realise the LVHN, extensive stakeholder engagement was carried out with public authorities, housing associations, private developers and large heat customers.

i.i.iv In order to frame the CHP potential of the ERF and Edmonton EcoPark, LVHN Ltd undertook an assessment of the heat supply available from the existing Energy from Waste (EfW) facility and of the heat demand available in the area.

i.i.v The Applicant's technical adviser, Ramboll, provided provisional technical design parameters. This showed that the ERF could be designed to support up to $160MW_{th}$ heat supply. However, heat supply impacts power generation and with $160MW_{th}$ of heat supply, gross electrical output diminishes to $15MW_e$. This is from a power only gross electricity generation

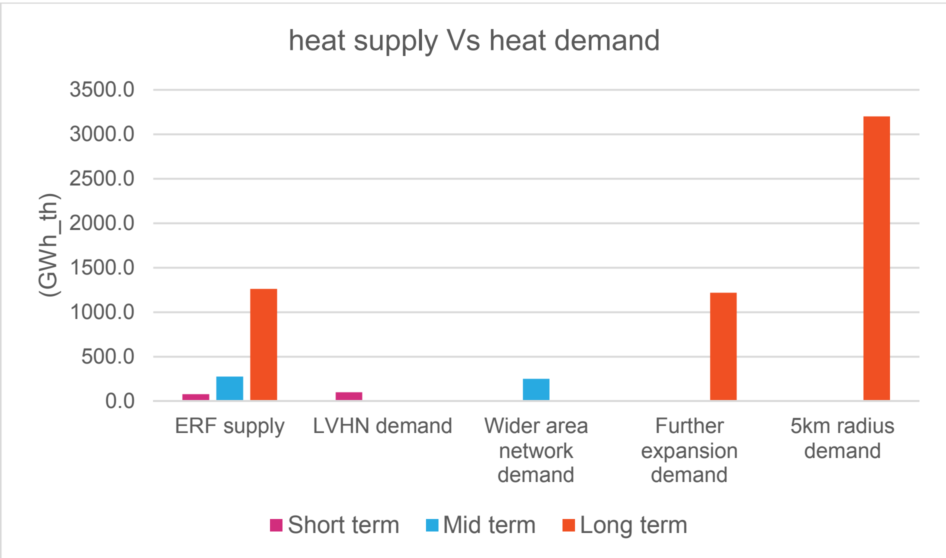
[1] Department of Energy and Climate Change, Overarching National Policy Statement for Energy (EN-1), July 2011.
[2] North London Strategic Alliance, Parsons Brinckerhoff, Upper Lee Valley Decentralised Energy Network Pre-feasibility Study, 2011.

capacity of over 70MWe. The ERF steam turbine would be designed to suit the expected heat supply requirements. The likely heat demand is expected to be 35MW_{th} peak output. Gross electrical output would then be 63MW_e. Additional heat export may be provided subject to commercial viability and a heat demand materialising.

i.i.vi The resulting annual heat supply available would be around 275GWh_{th}. In addition, the minimum heat supply required to meet the Mayor's Carbon Intensity Floor was identified through an assessment compliant with the Mayor's Emission Performance Standard[3,4], which showed the minimum annual heat supply to be around 96GWh_{th} (12MW_{th} output over 8,000hrs).

i.i.vii The heat demand assessment (which forms part of this report) confirms that the LVHN project plans to supply around 100GWh_{th} annually in the short term leading up to 2025 with the beginning of the ERF operation. In the medium term, the heat demand from the strategic heat network opportunity (NLSA Study) was estimated at around 250GWh_{th} annually. In the longer term, far more potential heat demand connections have been identified in the Greater London Authority's (GLA) report on Secondary Heat[5] which identifies that 670GWh_{th} and 550GWh_{th} could be supplied to LB Enfield and LB Waltham Forest respectively. Finally, examination of the National Heat Map[6] shows the annual heat demand in a 5km radius from the Edmonton EcoPark at 3,200GWh_{th}, which would be ten times the proposed heat supply.

i.i.viii The following figure compares heat supply with heat demand projections, and illustrates the short, medium and long term projections.



[3] Mayor of London's Greenhouse Gas (GHG) Calculator for Municipal Solid Waste (v2.1), Available on the Greater London Authority website at: http://www.london.gov.uk/priorities/environment/putting-waste-good-use/making-the-most-of-waste (accessed 21st March 2014).
[4] GLA, Eunomia The Greenhouse Gas Emissions Performance Standard for London's Municipal Waste – 2011/,2 Update, August 2013.
[5] GLA, Buro Happold, London's Zero Carbon Energy Resource: Secondary Heat, Report Phase 2, 2013.
[6] Department of Energy and Climate Change, National Heat Map http://tools.decc.gov.uk/nationalheatmap/ (accessed July 2015).

i.i.ix This report also describes how the approach to developing the CHP opportunity has been assessed. It reviews the ERF design, existing heat infrastructure on-site, and potential connections to heat networks in the short- and long-term.

i.i.x The proposed ERF would supply a heat range of between 10-160MW$_{th}$ (peak) corresponding to 80 to 1,260GWh$_{th}$ annually. Space allowances are included in the design for the required heat off-take equipment and to route the heat pipework out of the building.

i.i.xi A routing feasibility study was commissioned by the Applicant to assess and safeguard a route for district heating pipework between the ERF and the north and south boundaries of the Edmonton EcoPark. The southward safeguarded route would supply heat to the LVHN Ltd's proposed District Heating Energy Centre (DHEC) in the south of the Edmonton EcoPark, and the northward route could supply heat out of the north of the Edmonton EcoPark, should the southern route fail for any reason, or if the heat export capacity were to be expanded through a heat network created to the north of the Edmonton EcoPark.

i.i.xii The principles required to realise the CHP potential at the Edmonton EcoPark have been established between LVHN Ltd. and the Applicant and are subject to detailed design and agreement on commercial terms. The plans would facilitate the supply of heat from the existing EfW facility to the LVHN DHEC until the proposed ERF is commissioned and takes over the heat supply around 2025. The heat offtake from the existing EfW facility has been deemed as feasible by a Decentralised Energy Project Delivery Unit report for the GLA and the Applicant.

i.i.xiii In conclusion, the opportunity for CHP development from the Edmonton EcoPark, using the proposed ERF as the source of low carbon heat, is backed by the following:

a. the heat demand in the area is greater than the potential heat supply from existing and planned future centralised heat sources;
b. a large portion of the heat demand has been shown to be feasible for connection via heat networks in the short and long-term, initially materialising through LVHN's plans; and
c. the proposed ERF has been designed to allow for heat off-take and routes to the edge of the Edmonton EcoPark for future heat network connections have been safeguarded.

1 Introduction

1.1.1 This Combined Heat and Power (CHP) Development Strategy has been prepared to support North London Waste Authority's (the Applicant's) application (the Application) to the Secretary of State for Energy and Climate Change for a Development Consent Order (DCO) made pursuant to the Planning Act 2008 (as amended).

1.1.2 The Application is for the North London Heat and Power Project (the Project) comprising the construction, operation and maintenance of an Energy Recovery Facility (ERF) capable of an electrical output of around 70 megawatts (MW_e) at the Edmonton EcoPark in north London with associated development, including a Resource Recovery Facility (RRF). The proposed ERF would replace the existing Energy from Waste (EfW) facility at the Edmonton EcoPark.

1.1.3 The Project is a Nationally Significant Infrastructure Project for the purposes of Section 14(1)(a) and section 15 in Part 3 of the Planning Act 2008 (as amended) because it involves the construction of a generating station that would have a capacity of more than $50MW_e$.

1.2 Purpose of this document

1.2.1 The purpose of this document is to demonstrate the CHP opportunity associated with the Project and how it is planned to be implemented. This report responds to Overarching National Policy Statement for Energy (NPS EN-1)7 which requires applications for thermal generating stations, such as the proposed ERF, to consider CHP as a minimum. It has been prepared to support the Applicant's application for a DCO made pursuant to the Planning Act 2008 (as amended).

1.2.2 This Strategy forms part of a suite of documents accompanying the Application submitted in accordance with the requirements set out in section 55 of the Planning Act and Regulations 5, 6 and 7 of the Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009 (APFP Regulations 2009), and should be read alongside those documents (see Project Navigation Document AD01.02).

1.3 Document structure

1.3.1 The structure of this report presents the assessment of the CHP development strategy, as follows:

a. Section 2 covers the background to the Application including a summary of previous work to document the opportunity and to develop local heat networks in the area;

b. Section 3 sets out policy and guidance relevant to the assessment as well as key requirements;

c. Section 4 evaluates the CHP potential of the Application Site; and

[7] Department of Energy and Climate Change, Overarching National Policy Statement for Energy (EN-1), July 2011.

d. Section 5 sets out the approach to CHP development from a technical perspective. This section, along with Section 6, compiles the range of work done to prove the heat supply potential, the heat demand of the surrounding area, and the practical measures which are planned to enable technical extraction of heat and connection to heat networks.

1.4 The Applicant

1.4.1 Established in 1986, the Applicant is a statutory authority whose principal responsibility is the disposal of waste collected by the seven north London boroughs of Barnet, Camden, Enfield, Hackney, Haringey, Islington and Waltham Forest (the Constituent Boroughs).

1.4.2 The Applicant is the UK's second largest waste disposal authority, handling approximately 3 per cent of the total national Local Authority Collected Waste (LACW) stream. Since 1994 the Applicant has managed its waste arisings predominantly through its waste management contract with LondonWaste Limited (LWL) and the use of the EfW facility at the existing Edmonton EcoPark and landfill outside of London.

1.5 The Application Site

1.5.1 The Application Site, as shown on the Site Location Plans (A_0001 and A_0002 in the Book of Plans (AD02.01)), extends to approximately 22 hectares and is located wholly within the London Borough of Enfield (LB Enfield). The Application Site comprises the existing waste management site known as the Edmonton EcoPark where the permanent facilities would be located, part of Ardra Road, land around the existing water pumping station at Ardra Road, Deephams Farm Road, part of Lee Park Way and land to the west of the River Lee Navigation, and land to the north of Advent Way and east of the River Lee Navigation (part of which would form the Temporary Laydown Area and new Lee Park Way access road). The post code for the Edmonton EcoPark is N18 3AG and the grid reference is TQ 35750 92860.

1.5.2 The Application Site includes all land required to deliver the Project. This includes land that would be required temporarily to facilitate the development.

1.5.3 Both the Application Site and the Edmonton EcoPark (existing and proposed) are shown on Plan A_0003 and A_0004 contained within the Book of Plans (AD02.01). Throughout this report references to the Application Site refer to the proposed extent of the Project works, and Edmonton EcoPark refers to the operational site. Upon completion of the Project the operational site would consist of the Edmonton EcoPark and additional land required to provide new access arrangements and for a water pumping station adjacent to the Deephams Sewage Treatment Works outflow channel.

Edmonton EcoPark

1.5.4 The Edmonton EcoPark is an existing waste management complex of around 16 hectares, with an EfW facility which treats circa 540,000 tonnes per annum (tpa) of residual waste and generates around 40MW_e (gross) of electricity; an In-Vessel Composting (IVC) facility; a Bulky Waste Recycling Facility (BWRF) and Fuel Preparation Plant (FPP); an Incinerator Bottom Ash (IBA) Recycling Facility; a fleet management and maintenance facility; associated offices, car parking and plant required to operate the facility; and a former wharf and single storey building utilised by the Edmonton Sea Cadets under a lease.

1.5.5 In order to construct the proposed ERF, the existing BWRF and FPP activities would be relocated within the Application Site; the IVC facility would be decommissioned and the IBA recycling would take place off-site.

Temporary Laydown Area and eastern access

1.5.6 The proposed Temporary Laydown Area is an area of open scrubland located to the east of the River Lee Navigation and north of Advent Way. There is no public access to this area. The Temporary Laydown Area would be reinstated after construction and would not form part of the ongoing operational site.

1.5.7 In addition to the Temporary Laydown Area the Application Site includes land to the east of the existing Edmonton EcoPark which would be used for the new Lee Park Way entrance and landscaping along the eastern boundary.

Northern access

1.5.8 The Application Site also includes Deephams Farm Road and part of Ardra Road with land currently occupied by the EfW facility water pumping station between the junction of A1005 Meridian Way and Deephams Farm Road.

1.6 Surrounding area

1.6.1 The Application Site is located to the north of the A406 North Circular Road in an area that is predominantly industrial. The Lee Valley Regional Park (LVRP) is located to the east of the Edmonton EcoPark.

1.6.2 Land to the north and west of the Application Site is predominantly industrial in nature. Immediately to the north of the Edmonton EcoPark is an existing Materials Recovery Facility (MRF), which is operated by a commercial waste management company, alongside other industrial buildings. Further north is Deephams Sewage Treatment Works. Beyond the industrial area to the north-west is a residential area with Badma Close being the nearest residential street to the Application Site (approximately 60m from the nearest part of the boundary) and Zambezie Drive the nearest to the Edmonton EcoPark at approximately 125m west.

1.6.3 Eley Industrial Estate, located to the west of the Application Site, comprises a mixture of retail, industrial and warehouse units.

1.6.4 Advent Way is located to the south of the Application Site adjacent to the A406 North Circular Road. Beyond the A406 North Circular Road are retail and trading estates; this area is identified for future redevelopment to provide a housing-led mixed use development known as Meridian Water.

1.6.5 The LVRP and River Lee Navigation are immediately adjacent to the eastern boundary of the Edmonton EcoPark, and Lee Park Way, a private road which also forms part of National Cycle Network (NCN) Route 1, runs alongside the River Lee Navigation. To the east of the River Lee Navigation is the William Girling Reservoir along with an area currently occupied by Camden Plant Ltd. which is used for the crushing, screening and stockpiling of waste concrete, soil and other recyclable materials from construction and demolition. The nearest residential areas to the east of the Application Site and LVRP are located at Lower Hall Lane, approximately 550m from the Edmonton EcoPark and 150m from the eastern edge of the Application Site.

1.7 The Project

1.7.1 The Project would replace the existing EfW facility at Edmonton EcoPark, which is expected to cease operations in around 2025, with a new and more efficient ERF which would produce energy from residual waste, and associated development, including temporary works required to facilitate construction, demolition and commissioning. The proposed ERF would surpass the requirement under the Waste Framework Directive (Directive 2008/98/EC) to achieve an efficiency rating in excess of the prescribed level, and would therefore be classified as a waste recovery operation rather than disposal.

1.7.2 The main features of the Project once the proposed ERF and permanent associated works are constructed and the existing EfW facility is demolished are set out in the Book of Plans (AD02.01) and comprise:

a. a northern area of the Edmonton EcoPark accommodating the proposed ERF;

b. a southern area of the Edmonton EcoPark accommodating the RRF and a visitor, community and education centre with offices and a base for the Edmonton Sea Cadets (‘EcoPark House’);

c. a central space, where the existing EfW facility is currently located, which would be available for future waste-related development;

d. a new landscape area along the edge with the River Lee Navigation; and

e. new northern and eastern Edmonton EcoPark access points.

1.7.3 During construction there is a need to accommodate a Temporary Laydown Area outside of the future operational site because of space constraints. This would be used to provide parking and accommodation for temporary staff (offices, staff welfare facilities), storage and fabrication areas, and associated access and utilities.

1.7.4 Schedule 1 of the draft DCO (AD03.01) sets out the authorised development and the works are shown in the Book of Plans (AD02.01), supplemented by Illustrative Plans (included in the Design Code Principles, AD02.02) that set out the indicative form and location of buildings, structures, plant and equipment, in line with the limits of deviation established by the draft DCO (AD03.01).

1.8 Stages of development

1.8.1 The proposed ERF is intended to be operational before the end of 2025, but with the precise timing of the replacement to be determined. In order to do this, the following key steps are required:

a. obtain a DCO for the new facility and associated developments;
b. obtain relevant environmental permit(s) and other licences, consents and permits needed;
c. identify a suitable technology supplier;
d. agree and arrange source(s) of funding;
e. enter into contract(s) for design, build and operation of new facility and associated development;
f. move to operation of new facility; and
g. decommission and demolish the existing EfW facility.

1.8.2 Site preparation and construction would be undertaken over a number of years and it is expected that the earliest construction would commence is 2019/20, although this may be later. Construction would be implemented in stages to ensure that essential waste management operations remain functioning throughout. This is especially relevant for the existing EfW facility and associated support facilities.

1.8.3 The stages of the Project are as follows:

a. Stage 1a: site preparation and enabling works;
b. Stage 1b: construction of RRF, EcoPark House and commencement of use of Temporary Laydown Area;
c. Stage 1c: operation of RRF, EcoPark House and demolition/clearance of northern area;
d. Stage 1d: construction of ERF;
e. Stage 2: commissioning of ERF alongside operation of EfW facility, i.e. transition period;
f. Stage 3: operation of ERF, RRF and EcoPark House, demolition of EfW facility; and
g. Stage 4: operation of ERF, RRF and EcoPark House, i.e. final operational situation.

2 Background and current status

2.1 What is Combined Heat and Power?

2.1.1 CHP refers to a system which delivers useful energy in two forms; electric power and heat. It enables higher system efficiencies than conventional electrical generation through the capture and use of lower temperature heat that is less useful for power generation.

2.1.2 The proposed ERF could achieve, in power-only mode, an overall efficiency of around 29 per cent (gross); however, with the ERF in CHP mode, the overall efficiency could improve to around 40 per cent[8] with a $35MW_{th}$ heat supply.

2.1.3 For the ERF to run in CHP mode, the heat must be transmitted to heat users. Heat users could typically include industrial facilities requiring heat for processes, or developments requiring heat for hot water or space heating. Heat is transmitted in the form of hot water (or steam) pumped through a network of insulated pipes that form part of a heat network, otherwise known as district heating.

2.1.4 Operation of the ERF in CHP mode saves carbon through two mechanisms:

a. the first occurs at the ERF and is introduced through the increased energy recovery; and

b. the second comes from the displacement of other forms of fossil fuel consumption for heating. For example, a new heat network customer would be supplied by low carbon heat from the ERF, therefore gas or other higher carbon heating fuels would not be used to supply the heat demand.

2.2 Development of heat networks in the local area

2.2.1 The area around the Application Site currently does not have any district heating networks installed and operational, nor does the existing EfW facility operate in CHP mode. Nevertheless, considerable effort has been made by a number of local organisations to design and implement a large scale heat network to serve the Upper Lee Valley (ULV) including the immediate environs of the Edmonton EcoPark. This section reviews the history and current status of these efforts.

2.2.2 The ULV Opportunity Area Planning Framework[9] describes the planning mechanism put in place and the key value drivers:

"Following the recommendation from the Draft Energy Strategy 2010, an Upper Lee Valley masterplanning steering group has been established to maximise the opportunities for developing a decentralised energy network within the opportunity area. This group comprises the North London Strategic Alliance, the London boroughs of Enfield, Haringey and Waltham

[8] Total system efficiency is quoted here and is the result of the ratio of total energy out (heat and electricity) over total energy in (that contained in the waste entering the ERF). 40 per cent efficiency includes for a $35MW_{th}$ heat offtake. System parameters as supplied by designer Ramboll.
[9] Greater London Authority, Upper Lee Valley Opportunity Area Planning Framework, July 2013.

Forest and the Greater London Authority, with a wider stakeholder group comprising the Lee Valley Regional Park and the North London Waste Authority. Together the stakeholders have identified the following drivers for a decentralised energy network:

- *Ability to generate inward investment;*
- *Reduction in fuel poverty;*
- *Reduction in carbon emissions across the Upper Lee Valley; and*
- *Return on investment: social, economic and environmental".*

2.2.3 In 2011, the North London Strategic Alliance (NLSA) commissioned a Pre-feasibility Study for a Decentralised Energy Network (NLSA Study[10]). This study demonstrated that there is a feasible and viable opportunity to deliver a commercially sustainable heat network in the area.

2.2.4 The London Borough of Enfield's (LB Enfield) Edmonton EcoPark Planning Brief Supplementary Planning Document[11] (Edmonton EcoPark SPD) states the main benefits perceived from the strategic heat network:

2.2.5 *"Enfield Council in partnership with Haringey and Waltham Forest Councils, the North London Strategic Alliance (NLSA) and Greater London Authority (GLA) are working together to facilitate the delivery of the strategic heat network, which would provide low carbon, low cost energy to 10,000 homes and more than 150 businesses. The scheme would cut carbon dioxide emissions by 41,000 tonnes per annum, the equivalent of 9,750 homes' annual carbon dioxide production but could have wider economic and social benefits, including job creation".*Figure 2.1 illustrates the potential district heating scheme identified by the NLSA Study. The Figure illustrates the key energy supply assets, the main heat customers and the main interconnecting pipelines. The figure also illustrates a connection to the Olympic Park network, to realise the larger benefits of interconnection, such as the ability to share low carbon heat from the Edmonton EcoPark.

2.2.6 The NLSA Study identified two potential sources of heat to serve the planned heat network:

a. the existing EfW facility at the Edmonton EcoPark. The study assumed that the existing EfW facility would supply heat until 2025, by which point the EfW facility would be decommissioned, with the expectation of a new EfW facility taking over the heat supply; and,

b. the React Energy (formerly Kedco) biomass gasification project at Gibbs Road (Edmonton), which is under construction.

[10] North London Strategic Alliance, Parsons Brinckerhoff, Upper Lee Valley Decentralised Energy Network Pre-feasibility Study, 2011.

[11] LB Enfield, Edmonton EcoPark Planning Brief, Supplementary Planning Document to the Local Plan, 2013.

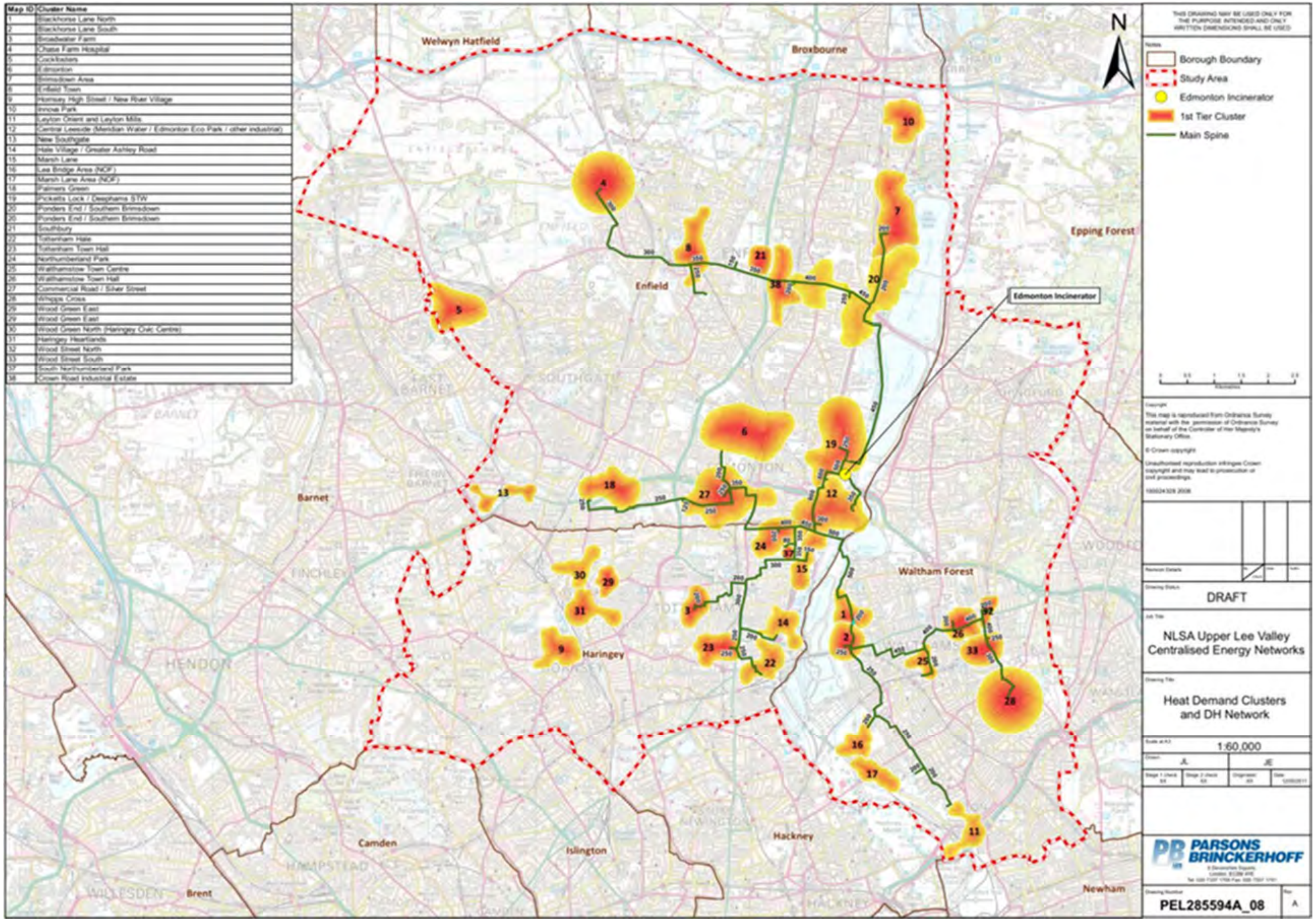


Figure 2.1: North London Strategic Alliance Upper Lea Valley Centralised Energy Networks

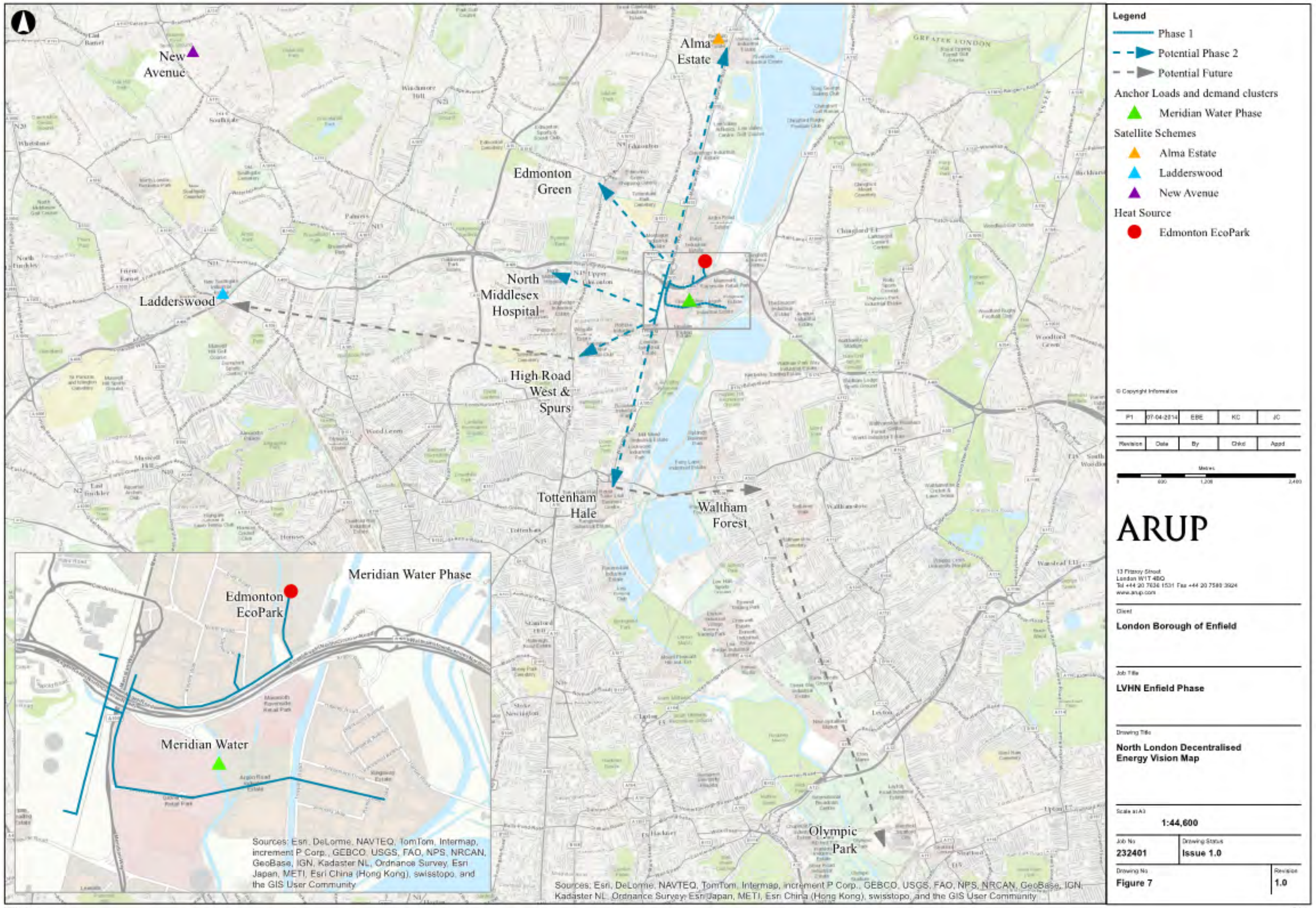


Figure 2.2: Lee Valley Heat Network vision map[12]

[12] LB Enfield website http://www.enfield.gov.uk/lvhn/ (accessed April 2015).

2.2.7 The Lee Valley Heat Network (LVHN) project is the initial phase of delivering the strategic scheme outlined in the NLSA Study. LVHN aims to deliver a network to supply heat from the Edmonton EcoPark to around 5,000 homes and 200,000m^2 of commercial space initially.

2.2.8 In 2012, LB Enfield led the formation of a special purpose vehicle, called LVHN Ltd, with the express purpose of developing and operating a heat network. It is now consolidated and in final negotiations with heat suppliers prior to appointing various contracts that would secure the design, build, operation, maintenance, and customer services required to realise the LVHN. The Design, Build, Operate contract tender provides an estimated contract start date of 1 September 2015[13].

2.2.9 The strategic scheme is catalysed through the development of satellite heat networks around the London Borough of Waltham Forest (LB Waltham Forest), and the CHP schemes at Ladderswood, Alma Estate and New Avenue, which are planned to connect into the wider scheme as part of a future phase[14,15].

2.2.10 Figure 2.2 illustrates the LVHN vision map.

2.2.11 The GLA's London's Zero Carbon Energy Resource[16] report also identifies both the existing EfW facility and the proposed ERF as key low carbon heat sources which could supply an area wide heat network.

2.3 Current status of heat connections to the Edmonton EcoPark

2.3.1 The Applicant is working with LB Enfield on the planning of an initial heat connection to be implemented from the existing EfW facility to supply the LVHN District Heating Energy Centre (DHEC). The Decentralised Energy Project Delivery Unit (DEPDU)[17] study undertaken for the NLWA identifies that connection to the existing EfW facility could supply around 20MW_{th} of low carbon heat to the network.

2.3.2 The LVHN DHEC is planned to be located on the southern part of the Edmonton EcoPark, and a heat connection route is being safeguarded between the existing EfW facility and the DHEC, as well as from the DHEC to the main pipeline of the LVHN network as illustrated on Figure 2.3.

2.3.3 The figure shows the pipe routing as two stages; Stage A covers the route from the existing EfW facility to the DHEC and the southern edge of the Edmonton EcoPark, while Stage B covers the extension of the route to the ERF and the northern edge of the Edmonton EcoPark.

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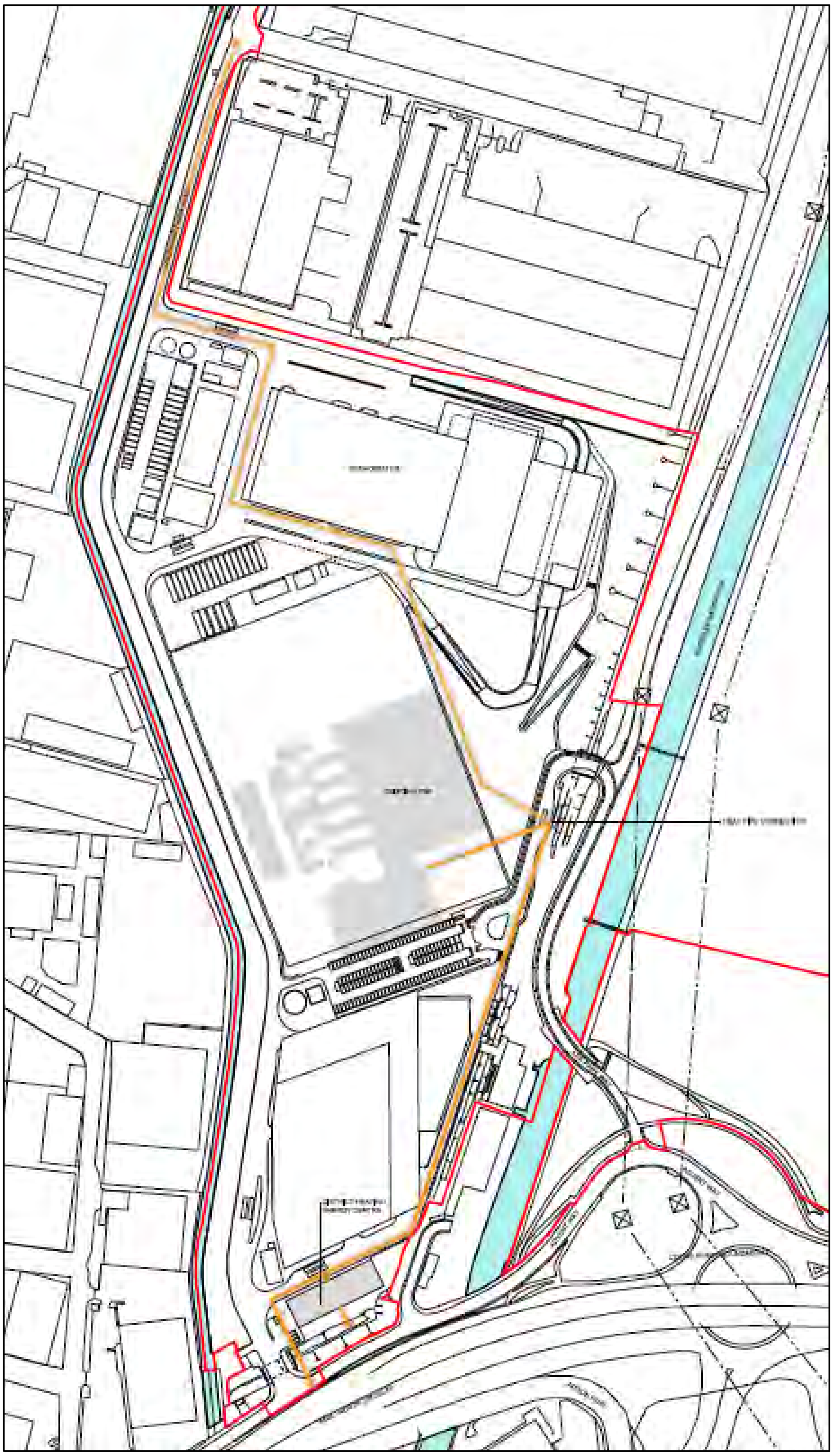
[13] Energy For London Website, as accessed on 9th April 2015, http://www.energyforlondon.org/north-london-heat-and-power-project/

[14] Enfield LVHN website, as accessed 9th April 2015, http://www.enfield.gov.uk/lvhn/info/2/section_one

[15] North London Strategic Alliance, Parsons Brinckerhoff, ULV Decentralised Energy Network, Waltham Forest Satellite Schemes, 2012.

[16] GLA, Buro Happold, London's Zero Carbon Energy Resource: Secondary Heat, Report Phase 2, 2013.

[17] NLWA, funded by the European Investment Bank through the GLA Decentralised Energy Project Delivery Unit (DEPDU) EfW heat offtake study, 2014.



HEAT PIPE STAGE A

HEAT PIPE STAGE B

Figure 2.3: Lee Valley Heat Network District Heating Energy Centre and safeguarded heat export routes

3 Policy and guidance

3.1.1 This section provides a summary of key policies related to the provision of CHP.

3.2 National policy and guidance

3.2.1 Overarching National Policy Statement for Energy EN-1 (NPS EN-1)[18] states that:

a. as outlined in Department of Energy and Climate Change (DECC) 2006 guidelines, a development application for a thermal generating station is required to include CHP, or at least the consideration of CHP;

b. applicants should consult with a number of stakeholders, including: potential heat customers, the Homes and Communities Agency, Local Enterprise Partnerships and Local Authorities to obtain advice on the opportunity for CHP; and

c. the applicant should demonstrate that the equipment required to produce a CHP enabled generating station should not impinge on the ability to be Carbon Capture Ready.

3.2.2 National Policy Statement for Renewable Energy Infrastructure EN-3 (NPS EN-3)[19] states that new development should consider CHP as part of its application, or show that CHP has been considered. NPS EN-3 states that the Planning Inspectorate will seek further information should this not be provided, and development consent will not be given until the Planning Inspectorate is satisfied that sufficient evidence about CHP is provided.

3.2.3 The National Waste Strategy[20] states that:

a. the National Planning Policy for Waste sets out the government's key planning objectives for sustainable waste management, requirements for waste plan-making authorities and the approach for the determination of planning applications. The policies set out in this document may be material to decisions for individual planning applications;

b. the National Planning Policy for Waste supersedes National Planning Policy Statement 10 (2011); and

c. the key relevant objective is the delivery of sustainable development and resource efficiency, including provision of modern infrastructure, local employment opportunities and wider climate change benefits.

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[18] Department of Energy and Climate Change, Overarching National Policy Statement for Energy (EN-1), July 2011.
[19] Department of Energy and Climate Change, National Policy Statement for Renewable Energy Infrastructure (EN-3), July 2011,
[20] Department for Communities and Local Government, National Planning Policy for Waste, October 2014.

3.2.4 The National Planning Policy Framework (NPPF)[21] states that:

a. the NPPF does not contain specific waste policies, since national waste planning policy will be published as part of the National Waste Management Plan for England. However, local authorities preparing waste plans and taking decisions on waste applications should have regard to policies in the NPPF so far as relevant;

b. to help increase the use and supply of renewable and low carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources;

c. when determining planning applications, local planning authorities should not require applicants for energy development to demonstrate the overall need for renewable or low carbon and approve the application if its impacts are (or can be made) acceptable; and

d. local plans should take account of climate change over the longer term, including factors such as flood risk, coastal change, water supply and changes to biodiversity and landscape. New development should be planned to avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure.

3.2.5 DECC's Future of Heating Strategy reports:[22, 23]

a. introduced DECC's strategy for decarbonising heating in the UK; the 2012 report outlined the options, with the 2013 report proposing implementation pathways;

b. proposes increasing rollout of district heating networks, which from 2020 should be expanded to wider strategic networks serving larger areas, as well as being adapted to use sources of lower carbon heat such as energy from waste; and

c. in terms of current policies encouraging CHP enabled energy from waste generation, under the Renewables Obligation some types of renewable (including EfW) CHP are eligible for a higher level of support per MWh_e electrical output than power-only plant. In general, renewable CHP schemes accredited up until 31 March 2015 are eligible to apply for this support.

3.3 Regional and local policy and guidance

3.3.1 The London Plan[24] includes a number of policies of relevance to the Application as set out below.

[21] Department for Communities and Local Government, National Planning Policy Framework, March 2012
[22] DECC, The Future of Heating: A strategic framework for low carbon heat in the UK, 2012.
[23] DECC, The Future of Heating: Meeting the Challenge, 2013.
[24] Mayor of London, The London Plan, March 2015.

3.3.2 Policy 5.2 Minimising Carbon Dioxide Emissions:

a. requires that development proposals contribute to reducing carbon dioxide emissions by adhering to the energy hierarchy: Be lean (use less energy); Be clean (supply energy efficiently); and Be green (use renewable energy); and

b. an energy assessment must be submitted with all new major developments to provide a detailed energy assessment which shows their commitments to reducing greenhouse gas emissions. This energy assessment should include calculation of the proposed demand for energy, and resultant carbon dioxide emissions; any proposals to decrease or mitigate these emissions on-site; any off-site mitigation strategies; and any proposals to supply decentralised energy through district heating, and cooling and CHP.

3.3.3 Policy 5.5 Decentralised Energy Networks:

a. sets out a target of 25 per cent of London's heat and power to be generated by localised decentralised energy systems by 2025; and

b. commits to promoting the provision of decentralised heating and cooling networks, at the area-level and site-specific scale.

3.3.4 Policy 5.6 Decentralised Energy In Development Proposals:

a. requires the evaluation of the possibility of providing CHP systems for all developments. Where a new CHP system is appropriate, development applications must assess opportunities to extend the system beyond the boundary of the Edmonton EcoPark;

b. sets out the following hierarchy of energy systems which should be followed for all major development proposals:

c. connection to existing heating or cooling networks;

d. site wide CHP network;

e. communal heating and cooling.

f. where future network opportunities have been previously identified, proposals should be designed to connect to these networks.

3.3.5 Policy 5.17 Waste Capacity:

a. wherever possible, proposals for waste management developments should take the opportunity to provide CHP and Combined Cooling, Heating and Power (CCHP).

3.3.6 The adopted Enfield Core Strategy[25] states that:

a. the outputs of waste facilities (for example materials or heat and electricity) can be used in other industrial processes (e.g. manufacturing) or in district CHP schemes. Locating facilities in close proximity to each other reduces the need to transport materials and is essential for the efficiency of district CHP, all of which aids the creation of more sustainable communities; and

[25] The Enfield Plan, Core Strategy 2010-2025, November 2010.

b. in order to drive waste management up the waste hierarchy, it is necessary to ensure that there is sufficient infrastructure in place to support more sustainable waste management options. Ensuring ease, efficiency and convenience of the storage and collection of waste must form part of this Strategy. In larger developments, on-site treatment of waste may be the most sustainable option, for example, through a CHP facility.

3.3.7 The Enfield Development Management Document (DMD)[26] includes Policy DMD 52 Decentralised Energy Networks which:

a. requires proposals for major developments which produce heat and/or energy to contribute to the supply of decentralised energy (DE) networks, unless it can be demonstrated that this is not economically viable or technically feasible; and

b. states that all major developments should connect to or contribute towards existing or planned decentralised energy networks supplied by low or zero carbon energy. Where no connection is available to a decentralised energy network and no DE network is planned within range, on-site CHP or CCHP will be expected where demand makes it feasible. Where on-site CHP or CCHP is not financially viable or technically feasible, developments will be required to be designed to connect to a DEN or contribute to a DEN or other carbon reduction measures in the borough in the future.

3.3.8 The Lee Valley Heat Network within Enfield's Central Leeside Proposed Submission Area Action Plan (CLAAP)[27] includes Policy CL30. This states that the Council supports the development of the LVHN and that all major developments should connect to or contribute towards the LVHN in accordance with DMD Policy 52. Where the development is expected to be completed before the LVHN is able to supply heat and there are no firm plans for extension of the LVHN within a feasible and viable range of the development, provision of on-site CHP will be expected where demand for heating makes this feasible.

3.3.9 The Edmonton EcoPark SPD does not detail specific policy, but does give detailed, site specific guidance on how to achieve the objectives set out in the Enfield Local Plan, particularly the adopted Core Strategy and CLAAP. Chapter 1 of Edmonton EcoPark SPD references London Plan Policy 5.17 which states that wherever possible, opportunities should be taken to provide CHP and CCHP. The Edmonton EcoPark SPD also recognises the significant opportunity for development at the Edmonton EcoPark to generate additional community benefits through the provision of heat. One of the objectives for the Edmonton EcoPark is to play a key role in providing affordable, secure, low carbon energy to Central Leeside as part of a wider decentralised energy network in the Lee Valley area. The SPD states that *"to facilitate the delivery of the LVHN, proposals for the EcoPark site must incorporate space for an energy centre, a connection from sources of*

[26] LB Enfield, Draft Development Management Document, 'Planning a better Enfield with you', May 2012.
[27] LB Enfield, Enfield's Local Plan, Central Leeside Area Action Plan, Sustainability Appraisal Scoping Report, July 2014.

energy/heat into the energy centre, and both steam and LTHW [Low Temperature Hot Water] pipe network leaving the site, having regard to meeting the technical specification for the LVHN including the minimum allowances for energy/heat output, and the requirement for operational and ancillary plant equipment".

3.4 Summary of key policy requirements

3.4.1 The NPS EN-1 and NPS EN-3 set out the requirement for this document to be prepared and submitted in support of the Application. The NPSs require the contents of this report to provide clear evidence that the scheme would be CHP enabled and that heat demands required and the heat networks envisioned to supply the heat are either existing, under development or consideration. The NPSs also require an audit trail with the relevant stakeholders including prospective heat customers.

3.4.2 Regional and local policy, as contained in the London Plan, Enfield Core Strategy, Enfield DMD and CLAAP all support the treatment of waste at the Edmonton EcoPark and that facilities should accommodate CHP. The Enfield DMD and CLAAP state that developments should, where possible, connect or contribute to a District Energy Network (DEN). Where this is not possible on-site CHP or CCHP is expected where this is feasible. The Edmonton EcoPark SPD sets an expectation that development at the Edmonton EcoPark would supply the LVHN.

4 Evaluation of CHP potential

4.1.1 This section presents evidence of the CHP potential of the Edmonton EcoPark including the potential for heat supply and how it matches with the potential heat demand.

4.2 Stakeholder consultation

4.2.1 NPS EN-1 states that applications must either include CHP or contain evidence that it has been considered, noting that the evidence "*should be through an audit trail of dialogue between the applicant and prospective customers*" (para. 4.6.6). Applicants should also obtain advice on opportunities for CHP from bodies such as:

a. Homes and Communities Agency (HCA);

b. Local Enterprise Partnerships (LEPs); and

c. Local Authorities.

4.2.2 The Applicant has consulted with the following public bodies as recommended by NPS EN-1:

a. GLA (as the equivalent body to the HCA for London);

b. London Enterprise Panel;

c. LB Enfield;

d. LB Haringey; and

e. LB Waltham Forest.

4.2.3 The Applicant has also consulted with the following prospective heat customers:

a. LVHN Ltd;

b. Meridian Water major development site (through LB Enfield);

c. Blackhorse Lane development site (through LB Waltham Forest);

d. Thames Water Utilities Ltd (TWUL) – Deephams Farm Sewage Treatment Works;

e. Coca-Cola Enterprises;

f. SEGRO Navigation Park;

g. Ravenside Retail Park; and

h. North Middlesex University Hospital.

4.2.4 Details of the consultation which have informed the CHP strategy within the scheme are set out at Appendix A.

4.3 Method of analysis

4.3.1 The analysis is based on the following:

a. a heat supply assessment, to determine the potential for heat supply from the ERF;

b. a description of operational modes, to determine the different heat to power ranges available and the interaction with the associated carbon emissions;

c. a heat demand assessment, to review the heat demands in the area as identified by various sources, and reinforced by relevant stakeholder engagement;

d. a review of the longer term heat demand potential; and

e. a summary of the above to determine the match between the available heat and the potential for heat supply in order to consolidate the evidence supporting the ability of the Edmonton EcoPark to operate in CHP mode.

4.4 Heat supply assessment

4.4.1 The ERF is intended to employ an extraction condensing steam turbine to facilitate heat supply.

4.4.2 The ERF would have a gross power generation capacity of circa 70MWe in power only mode, processing 44 t/hr of waste per process line with a net calorific value of 10 MJ/kg. Other key modelling assumptions for this estimate are as follows. These factors would be decided upon at the detailed design stage of the ERF:

a. Air Cooled Condenser (ACC) cooling with 0.1bara back pressure;

b. 50bara, 425°C steam parameters at boiler outlet;

c. single steam turbine generator unit;

d. flue gas temperature at boiler exit - 170°C;

e. excess air ratio of 1.5; and

f. Selective Catalytic Reduction (SCR) nitrogen dioxide (NO_{x}) abatement.

4.4.3 The ERF can be designed to supply up to 160MWth of heat. Heat supply would impact power generation. Gross power generation would reduce to circa 15MWe with 160MWth of heat of heat supply.

4.4.4 The total efficiency of the ERF improves with increasing heat supply as indicated by the chart shown in Figure 4.1. As a consequence, the carbon emissions associated with the supply of heat reduce with increasing heat supply.

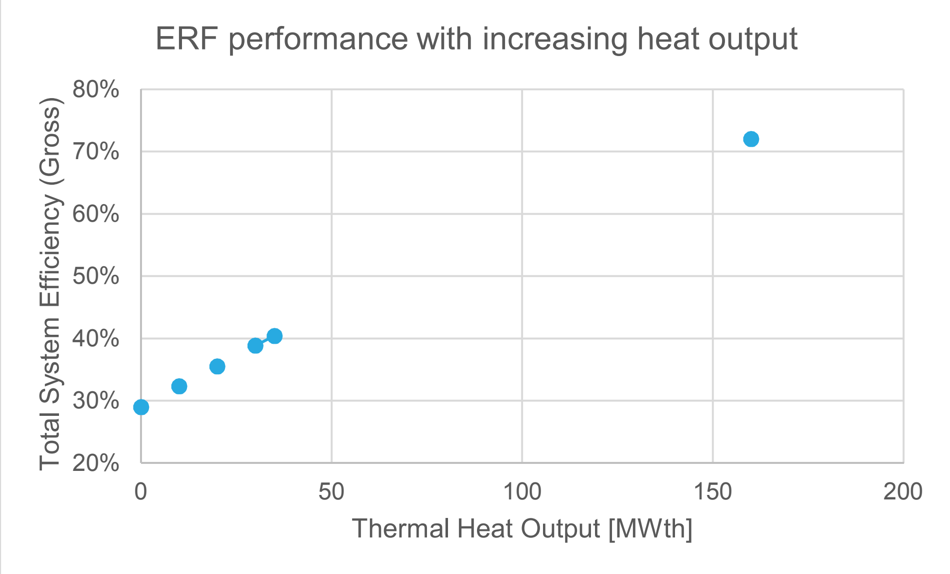


Figure 4.1: ERF performance with increasing heat output

4.4.5 The diversion of steam from the turbines would result in a drop in electricity production; given the importance of electricity exports to the Project, the steam turbine plant is planned to be designed for thermal output range of 10-35MW_{th}. At this range of heat supply, the gross electrical output would be between 68.5-63.2MW_e respectively. Table 4.1 shows the relationship between heat and power outputs. However, the Applicant is not averse to heat sales beyond 35MW_{th} subject to commercial viability and the heat demand materialising. As such, the ability to efficiently supply greater levels of heat would be realised through the specification of appropriate steam extraction / bleeds points on the turbine, which will occur at the detailed design stage. The table also shows the auxiliary power allowance to drive the generating equipment and associated processes, as well as the net power output which would be the resulting grid electrical export.

Table 4.1: Heat output vs electrical output

heat output (MW_{th})	0.0	10.0	20.0	30.0	35.0	160.0
gross electricity output (MW_e)	70.6	68.5	66.4	64.3	63.2	15.0
auxiliary power allowance (MW_e)	9.0	9.0	9.0	9.0	9.0	9.0
net power (MW_e)	61.5	59.4	57.3	55.2	54.2	6.0

4.5 Description of different operational modes

4.5.1 A key ambition of CHP operation is the ability of the ERF to achieve the minimum Carbon Intensity Floor (CIF) of 400gCO_2/kWh as set by the Mayor's Emissions Performance Standard[28] (EPS).

4.5.2 Calculations compliant with the Mayor's EPS have been performed to determine the heat to power ratio bands within which the ERF could meet

[28] Eunomia, The Greenhouse Gas Emissions Performance Standard for London's Municipal Waste – 2011/12 Update, August 2013

the minimum CIF. The report detailing the analysis is included in – WRATE and Carbon Intensity Floor Modelling: Technical Report.

4.5.3 The minimum heat to power ratio required to meet the CIF is around $12MW_{th}/68MW_e$[29]. However, the planned design point is $35MW_{th}/63.2MW_e$ which could represent an improvement on the ERF CIF bringing it to circa $300gCO_2/kWh$[30].

4.5.4 The actual annual heat supply range available for export could be between 80-1,260GWh_{th} depending on heat demand. The ERF would be able to modulate the heat and power balance on a continuous basis to provide heat on demand to the heat network up to the maximum peak of $160MW_{th}$.

4.5.5 All annual heat supply estimates take into account ERF availability of 90 per cent, which means that the ERF would be operational for 90 per cent of the year (i.e. 8,000 hours per year). This assumption takes account of expected down time and other issues which would reduce the ERF heat and power outputs from the rated design capacity. The annual heat supply figures quoted above are correspondingly lower than the theoretical energy output from operating the ERF continuously.

4.6 Heat demand assessment

Existing and planned development

4.6.1 Currently, the key opportunity to establish a heat off-take from the ERF would be through a heat supply connection to LVHN. LVHN Ltd. expects to serve a heat demand, which if supplied by the ERF, would secure the minimum threshold required for the ERF to meet the Mayor's CIF. The kick-start network would supply $32GWh_{th}$, sufficient to serve 2,500 homes and 98,000m^2 of commercial floor space. A planned network expansion could then serve an additional 2,700 homes and 140,000m^2 of commercial floor space. This could more than double annual heat demand to circa $100GWh_{th}$.

4.7 Potential for additional heat demand

4.7.1 By 2050, the wider strategic heat network scheme, as set out in the NLSA Study, identified a total level of heat demand in the order of $250GWh_{th}$, with main loads including three hospitals (Chase Green, Whipps Cross and North Middlesex); new developments at Meridian Water, Blackhorse Lane and Ponders End/Southbury; and other key public sector loads such as communally heated housing estates and council properties.

4.7.2 The NLSA Study's projection for the strategic scheme identified heat demand clusters of $200MWh_{th}$ and above, which was treated as a threshold below which the value of connection to the heat network would be economic. Therefore, the result produces a conservative estimate for what could be the potential heat demand met by the heat network if all loads in the study area were included.

[29] According to Scenario C.4 – Tipping Point in the analysis included in Appendix C.
[30] According to the Main Scenario C in the analysis included in Appendix C.

4.7.3 The future projection for secondary heat supplies to the area has been identified by the GLA Report on secondary heat (GLA Report[31]). It shows the proportion of the heat demand which could be met by secondary heat sources, by borough, in the long term as follows; the Edmonton EcoPark being mentioned as a main source of low carbon heat for this projection:

a. LB Enfield: 675GWh_{th}, equivalent to 30 per cent; and

b. LB Waltham Forest: 550GWh_{th}, equivalent to 35 per cent.

4.7.4 Examination of the National Heat Map [32]shows that a three kilometre radius around the Application Site would theoretically exhaust 1,050GWh_{th} of heat available from the ERF per annum. However, with a practical approach, not all heat customers would be feasible for connection due to a wide range of socio-economic, technical and commercial reasons. However in a five kilometre radius, there is projected to exist three times the heat demand at 3,200GWh_{th}.

4.7.5 With the proposed ERF providing its design point of a 35MW_{th} peak heat supply, the annual heat supply would reach around 275GWh_{th}, which would provide around 10 per cent of the heat demand in a 5km radius surrounding the Edmonton EcoPark. Figure 4.2 compares heat supply with heat demand projections, and shows the short (2025), medium (2035) and long term (2050) projections.

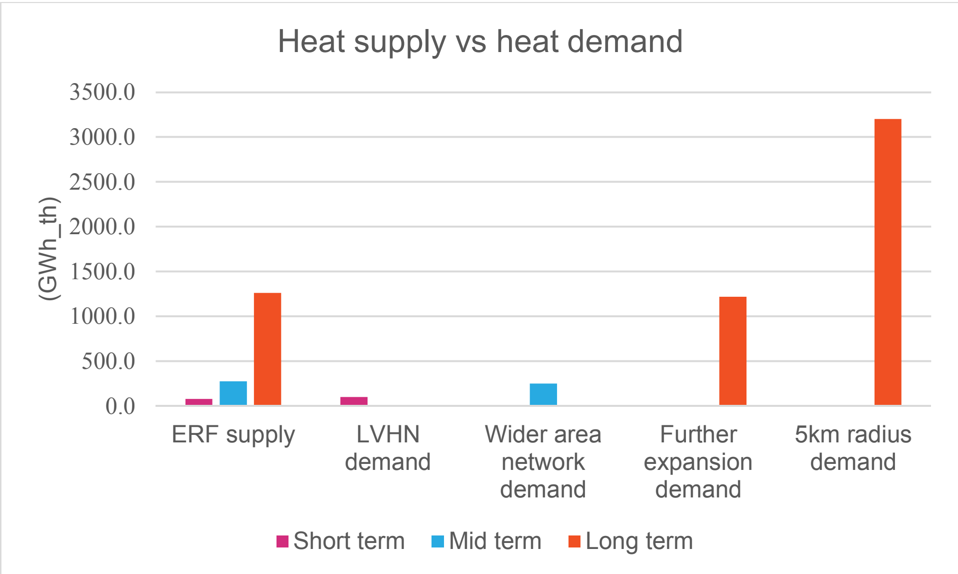


Figure 4.2: Heat supply vs heat demand

31 GLA report by Buro Happold, London's Zero Carbon Energy Resource: Secondary Heat, Report Phase 1, 2013.

32 Department of Energy and Climate Change, National Heat Map http://tools.decc.gov.uk/nationalheatmap/ (accessed July 2015).

4.8 Summary of CHP potential

4.8.1 The heat supply and demand requirements for the Project to realise its CHP potential are documented in numerous feasibility studies and are planned for realisation in the short-term coinciding with the ERF beginning operations in 2025.

4.8.2 In the short-term (2025), the LVHN could provide a heat demand in excess of the 96GWh_{th} threshold to ensure the Mayor's EPS Carbon Intensity Floor of 400gCO_2/kWh is met.

4.8.3 Further improvement on the carbon intensity of the heat and power produced by the ERF could be achieved as the wider strategic heat network is expanded to a heat demand of around 250GWh_{th} of heat demand, providing the opportunity for additional heat supply by the ERF.

5 Approach to CHP development

5.1.1 Based on the key policy requirements and consideration of the current status of heat network development in the local area, this section identifies the approach to the development of the Project to deliver heat as well as power.

5.2 Facility design

5.2.1 The Project includes a CHP enabled ERF that could supply up 160MW_{th} of heat. For this, the ERF would employ an extraction condensing steam turbine with a controlled extraction point. The Project includes provision for the supply of heat in the form of hot water or steam to the boundary of the Edmonton EcoPark for connection to a DHEC for heat distribution to heat customers by LVHN.

5.2.2 The ERF combustion process is used to heat water in a boiler. This turns to steam, which then drives a turbine to produce electricity. The steam can be bled from the turbine to heat water which can be piped as part of a district heating scheme, but there is an associated reduction in electricity output.

5.2.3 Based upon the projected heat demand, maintaining electricity production between 60 and 70MWe (gross) is the planned design point that supports the wider context of the Project. Electrical generation would reduce to 63.2MW_{e} (gross) with 35MW_{th} of heat supply, representing a 10 per cent drop in electrical output compared with the maximum electrical output in power-only mode.

5.2.4 The ERF preliminary design incorporates space allowances for the heat offtake equipment and pipework which would enable the ERF for CHP operation. The relevant sketches are included in Appendix B for information, noting that the internal space design is subject to refinement as the design progresses.

5.3 Existing heat infrastructure on the Application Site

5.3.1 For the ERF to be CHP enabled, there is a need for infrastructure on the Edmonton EcoPark to transport heat from the ERF and deliver it to a heat network. This is allowed for in the draft DCO.

5.3.2 There is currently no heat infrastructure on the Edmonton EcoPark; however, the existing EfW facility is planned for upgrade to become CHP enabled to become a low carbon heat source to proposed local heat networks development.

5.3.3 The Applicant is engaged in negotiations with LVHN Ltd. to undertake enabling works which would allow the existing EfW facility to supply heat to the proposed DHEC. The current timetable is for the connection and network works to go ahead by end of 2017. The EfW facility would supply heat until the new ERF is commissioned, subject to any final agreements between parties.

5.4 Connection to heat networks

5.4.1 The Application safeguards district heating pipework routes leading from the ERF to the edge of the Edmonton EcoPark. One export route is planned via the south of the Edmonton EcoPark, with a second route safeguarded for future export to the north of the Edmonton EcoPark.

5.4.2 The Authority commissioned Arup to produce a District Heating Routing Feasibility Study (the Routing Study) to understand the main constraints surrounding the proposed routes for district heating pipework routing within the Edmonton EcoPark. The Routing Study, provided in Appendix D, covers likely phasing, two options for export (via the north and south), and main engineering constraints involved with other existing and proposed utilities within the Edmonton EcoPark.

5.4.3 Figure 5.1, developed on the basis of the Routing Study, shows the safeguarded routes to the north and south of the Edmonton EcoPark, which could hold future pipework in coordination with other proposed utilities.

5.4.4 The current plans for LVHN include a DHEC building which 'in principle' would be located on the south of the Edmonton EcoPark as indicated by Figure 5.1. It would incorporate all equipment required for the successful supply of heat to the heat network, including:

a. thermal storage vessels;
b. backup and top-up gas boilers;
c. distribution pumping equipment;
d. pressurisation and expansion equipment;
e. water treatment and filtration equipment; and
f. controls and electrical equipment and other ancillaries.

5.4.5 The DHEC proposal does not form part of the Application. The proposals for the DHEC would be brought forward by the promoters of that scheme as a standalone planning application.

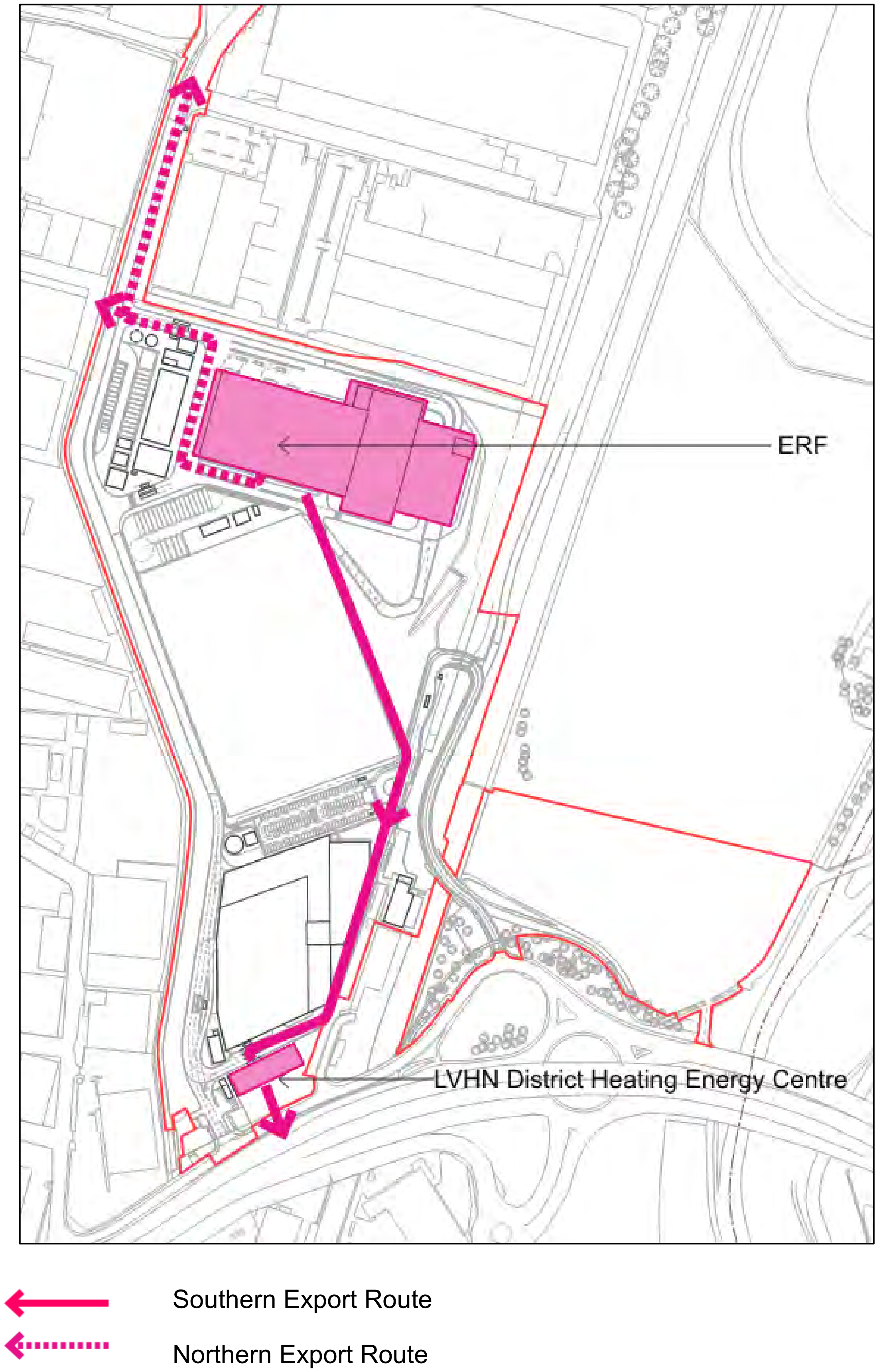


Figure 5.1: Safeguarded heat export routes from ERF via the north and south of the Edmonton EcoPark

5.5 Connection to future heat loads

5.5.1 As set out in the Routing Study (Appendix D), a second heat export route has been safeguarded to the northern boundary of the Edmonton EcoPark to enable an alternative or additional route for heat export towards the Eley Estate, Deephams Sewage Treatment Works and any other customers arising in this direction.

5.5.2 LVHN is considered a catalyst project which would initiate the development of the strategic heat network identified by the NLSA Study. The development plans for LVHN are set out in two stages. As LVHN expands, the peak heat requirement could increase to $80MW_{th}$ on completion of the second phase. The capacity for exporting heat via the south of the Edmonton EcoPark would initially be limited to this; therefore, the second export route to the north of the Edmonton EcoPark would accommodate a further $80MW_{th}$ which could eventually maximise the heat output potential of the ERF.

5.6 Summary of CHP Development Strategy

5.6.1 The Project includes a CHP enabled ERF that could supply between 10-160MWth of heat if the demand materialises.

5.6.2 The proposed ERF design is based on $35MW_{th}$ peak heat export for the steam turbine design point but does not preclude the efficient supply of greater levels of heat. This would produce a drop of around 10 per cent in electrical production (to around $63MW_{e}$) but would provide up to $275GWh_{th}$ of low carbon heat supply. This heat to power ratio is considered a favourable combination in terms of maintaining a high electrical power generation capacity whilst serving a heat demand which is likely to materialise in the medium and long term leading up to 2050.

5.6.3 Heat off-take equipment space allowances have been made in the ERF preliminary building design, and district heating pipework routes have been safeguarded to link the ERF to the northern and southern edges of the Edmonton EcoPark, enabling heat export. The routing has been detailed by means of a Routing Study.

5.6.4 The planned heat network opportunity which would enable immediate heat export for the ERF is the LVHN scheme. LVHN Ltd. intends initially to use heat supplied by the existing EfW facility until the ERF is operational. If greater levels of heat demand come forward, these could be catered for through the specification of steam extraction/bleed points on the turbine which would occur at the detailed design stage.

Appendix A – Stakeholder Consultation

A1 Public Body Consultation

A1.1.1 The Applicant has consulted with the public bodies as summarised in Table A.1.

Table A.1: Summary of consultation with public bodies

Entity	Relevant body	Summary of outcome	Document reference
Homes and Communities Agency (HCA)	HCA	The HCA has not been contacted in this case given that the GLA undertake HCA responsibilities with Greater London.	n/a
Local Enterprise Partnerships (LEPs)	London Enterprise Panel	Please refer to engagement with the GLA.	n/a
Local Authorities	LB Enfield	Heat demand for LVHN confirmed.	A.3.1
	LB Haringey	No response and on-going discussions with relevant parties	n/a
	LB Waltham Forest	No response and on-going discussions with relevant parties	n/a
	Greater London Authority	Response provided that supports the maximum provision of heat to local heat customer opportunities.	A.3.2

A2 Private Body Consultation

A2.1.1 The Applicant has also consulted with prospective heat customers as summarised in Table A.2.

Table A.2: Heat customer consultation summary

Name of potential customer	Nature of organisation	Summary of outcome	Document reference
LVHN Ltd.	Municipal ESCo established by LB Enfield, which is actively developing district heating network opportunities in the borough.	Extensive discussions have been held between the applicant and LVHN. No formal commercial agreement is in place, but discussions are positive and ongoing in respect of a future heat off-take from the ERF.	Through LB Enfield A.3.1
Meridian Water major development site.	A masterplan being promoted by LB Enfield.	Discussions have been held with LB Enfield on the potential for the ERF to supply heat to Meridian Water. LB Enfield's	Through LB Enfield A.3.1

		preferred route is through LVHN.	
Blackhorse Lane Development	Current masterplan being promoted by LB Waltham Forest – details in the Local Area Action Plan.	No response	n/a
Thames Water Utilities Ltd, Deephams Sewage Treatment Works	Sewage Treatment Works undergoing upgrade beginning 2015. Currently includes CHP on a self-sufficient basis.	Confirmed self-sufficiency and ability to export own heat.	A.3.3
Coca-Cola Enterprises	Coca-Cola Edmonton factory in Eley Estate. Address: Unit 10-10A, Nobel Rd, London N18 3DJ.	No response.	n/a
SEGRO Navigation Park	Navigation Park is also prospective and is further north.	No response.	n/a
Ravenside Retail Park	retail park including, Mothercare, Next, Wickes, Curries and Argos	No response.	n/a
North Middlesex University Hospital	Potentially large heat customer approximately 2.5km from EcoPark west along the A406.	No response.	n/a

A3 Potential customer consultation response

A3.1 LB Enfield

ENFIELD Council

[redacted]
NLWA
Unit 1B, Berol House
25 Ashley Road
Tottenham Hale
London N15

Please reply to : [redacted]
E-mail : [redacted]@enfield.gov.uk
Phone : [redacted]
Textphone :
Fax :
My Ref :
Your Ref :
Date : 11 May 2015

Dear [redacted]

Lee Valley Heat Network Ltd has been set up by LB Enfield with the express intention to utilise heat from the Energy from Waste facility at Edmonton Eco Park as the principal source of heat for a strategic heat network to serve Meridian Water, other developments and also existing homes and businesses in Enfield and the surrounding area. Discussion of the terms on which heat will be made available are on-going between LVHN and NLWA, and have made good progress. Accordingly, I confirm that LVHN expects shortly to reach a long term agreement with NLWA for the supply of hot water for the purposes of the heat network from both the existing facility and the new ERF. Once that agreement is reached, the Council expects to be in a position to authorise investment in the construction of the strategic heat network.

LVHN's business plan indicates that, by 2025, which I understand to be the scheduled date of completion of the new ERF, the annual quantity of heat required will be about 25 GWh. The development at Meridian Water will continue to be implemented beyond that date, and is expected to result in the construction of around 8,000 residential properties. However, demand from businesses, schools and other non-residential premises is expected to account for more than half total heat demand. Eventually, as the strategic heat network is extended, its requirement for heat may well exceed the proposed capacity of the ERF.

Yours sincerely

[redacted]

cc: [redacted]

A3.2 Greater London Authority

MAYOR OF LONDON

Development, Enterprise and Environment

[redacted]
North London Waste Authority
[redacted]
Unit 1B,
Berol House,
25 Ashley Road,
Tottenham Hale,
London, N17 9LJ

Our ref: D&P/2367c SK
Date: 21 August 2015

Dear [redacted]

Planning Act 2008, Overarching National Policy Statement for Energy, July 2011, and National Policy Statement for Renewable Energy Infrastructure, July 2011.

Site: Edmonton Eco-Park (North London Heat and Power Project), Advent Way, N18 3AG (pre-application meeting 2)
LB: Enfield
Our reference: 2367c

Further to the second pre-planning application meeting held on 24 March and 25 June 2015, I enclose a copy of the GLA's assessment which sets out our advice and matters which will need to be fully addressed before the application is submitted to the local planning authority.

Please note that the advice given by officers does not constitute a formal response or decision by the Mayor with regard to future planning applications. Any views or opinions expressed are without prejudice to the Mayor's formal consideration of the application.

Yours sincerely,

[redacted]

cc [redacted]

pre-application report 2 D&P/2367c/SK

22 July 2015

Edmonton Eco-park

in the Borough of Enfield

The proposal

The North London Heat and Power Project would comprise of an energy recovery facility (ERF) using waste as a fuel and capable of an electrical output of approximately 70 megawatts (MW). The proposal has a heat link potential via the Lee Valley Heat Network (LVHN).

As the North London Heat and Power Project would generate energy over 50MW it is classified as a Nationally Significant Infrastructure Project (NSIP) under section 14 (1) (a) and section 15 (2) of the Planning Act 2008. National Policy Statements (NPS) EN-1 (overarching National Policy Statement for Energy and EN-3 (National Policy Statement for Renewable Energy Infrastructure) both apply to the North London Heat and Power Project.

The applicant

The applicant is **North London Waste Authority (NLWA)**

Context

1 On 25 June 2015 a follow up pre-planning application meeting was held at City Hall with the following attendees:

GLA group

- [redacted] [redacted]
- [redacted] [redacted]

Applicant team-NLWA

- [redacted] [redacted]
- [redacted]

2 The advice given by officers does not constitute a formal response or decision by the Mayor with regard to future planning applications. Any views or opinions expressed are without prejudice to the Mayor's formal consideration of the application. Please note that the advice you receive is dependent upon the quality of the information and documentation that you provide.

Summary of meeting discussion

3 The meeting discussion covered strategic issues with respect to energy principles and technical requirements (combined heat and power (CHP), technical specification and Lee Valley Heat Network (LVHN). GLA officer advice in respect of these issues is set out within the sections that follow.

4 This second pre-application (follow up meeting) was requested by NLWA, following the Planning Inspectorate Round Table meeting held at EcoPark on 10th June 2015. The applicant discussed its interim CHP development strategy, which is available through the project website www.northlondonheatandpower.london, and which will be finalised for submission of the application in the autumn.

5 In summary, the proposed Energy Recovery Facility will be capable of producing 70MWe, and could produce up to a maximum of 160WMth of heat, displacing electricity production such that a minimum of 15MWe would be produced and exported to the grid.

6 The applicant stated that NLWA has confirmation from Enfield of their proposals for a heat network with an annual requirement of 25GWh in 2025, the date when the new ERF is projected to become operational. The applicant stated that it understands that the proposed ERF facility could form a strategic hub for heat supply and requested this meeting to obtain direction/a steer from GLA officers on this topic, and confirmation that the proposed replacement ERF could contribute to these strategic plans. In addition, the applicant proposed to have a specific technical discussion about the "Z factor".

Energy

7 As stated above, a meeting was requested to specifically discuss the energy matters in more detail.

8 The applicant was advised to future-proof the steam turbine (as we would future proof buildings) in regard to the turbine's heat supply capacity for district heating, and to do this in such a way so as to optimise the cost of heat for future district heating businesses.

9 NLWA indicated that it is supportive of the LVHN and is working to make available an economically optimised heat supply capacity to interested heat recipients/suppliers from both the existing and future ERF facilities. NLWA stated that LVHN are putting their own boilers in at the site but have not defined what their technical requirements are at this point. It is understood that the eastern part of the site will house the pipework and connections for the LVHN system.

10 NLWA was advised not to limit the steam turbine heat supply capacity on the known LVHN heat demand scenarios but to build-in the maximum economic supply capacity for district heating to the proposal. They were advised to opt for a steam turbine capable of supplying a variable district heating load, allowing for more heat to be supplied during the winter months and higher electrical generation in the summer. This is a typical energy from waste CHP application.

11 NLWA was advised to provide a technical description of the steam turbine, the heat supply capacity, the pressures and temperatures at which steam is taken off and a process flow diagram to demonstrate how this will be achieved. NLWA was advised to submit a 'Z' factor calculation. NLWA mentioned that consultant's Ramboll are currently undertaking the ERF technical specification work for the procurement of the plant and equipment. The GLA energy officer offered to participate during the steam turbine market assessment (soft market testing) to ensure a common understanding of the best options available to NLWA. This would establish confidence that the heat supply arrangements avoid expensive heat production that could compromise the business case for district heating.

12 NLWA stated that the DCO process allows it to undertake this specification exercise as the scheme develops and the Environment Agency will review the options it presents.

13 Although the available steam turbine configurations are dependent on the market and demand, NLWA are committed to optimising the electrical output and heat supply capacity to be available for other heat off-takers and not just the LVHN who are the current interested party.

Statement of Common Ground

14 It was agreed at the meeting that subject to the strategic objectives being delivered (as set out above); the GLA, in its capacity as a statutory consultee, would consider entering into a Statement of Common Ground (SoCG) if appropriate once the application has been submitted. It is proposed that a SoCG will set out the matters which NLWA and the GLA agree on and any areas where agreement has not yet been reached. The pre-application meetings had (and remaining) are an attempt to address key issues and achieve the required strategic outcomes from the proposal. It was agreed that the pre-application process would help to provide justification or reasoning to the guidance and 'specification of kit' being provided; and help to provide evidence of project progression at the forthcoming examination.

Conclusion

15 NLWA is required to provide information of the proposed heat off-take arrangements, specify the temperature and pressure levels of the off-take, a provide process flow diagram and to submit the 'Z' factor calculation to demonstrate 'best practice' ERF CHP. More information on 'Z' factor can be found at http://www.chpqa.com/guidance_notes/GUIDANCE_NOTE_28.pdf.

16 It was agreed that a third pre-application meeting would be had in advance of preparing a SoCG, which is also dependent on actions being undertaken by NLWA.

for further information contact GLA Planning Unit, Development & Projects Team:

[redacted]

GREATER**LONDON**AUTHORITY

pre-application report 1 D&P/2367c

16 July 2015

Edmonton Eco-Park (North London Heat and Power Project), Advent Way, N18 3AG

in the London Borough of Enfield

The proposal

The proposed development (known as the North London Heat and Power Project) would comprise of an energy recovery facility (ERF) using waste as a fuel and capable of an electrical output of approximately 70 megawatts (MW). The proposal has a heat link potential via the Lee Valley Heat Network (LVHN), an objective, outlined in the Upper Lee Valley Opportunity Area Planning Framework (ULV OAPF), adopted by the Mayor in July 2013.

As the North London Heat and Power Project would generate energy over 50MW it is classified as a Nationally Significant Infrastructure Project (NSIP) under section 14 (1) (a) and section 15 (2) of the Planning Act 2008. National Policy Statements (NPS) EN-1 (overarching National Policy Statement for Energy and EN-3 (National Policy Statement for Renewable Energy Infrastructure) both apply to the North London Heat and Power Project.

The applicant

The applicant is **North London Waste Authority (NLWA).**

Context

1 On 25 February 2015 a request was received for a pre-planning application meeting with the Greater London Authority on a proposal to develop the above site for the above uses. On 24 March 2015 a pre-planning application meeting was held at City Hall with the following attendees:

<u>GLA group</u>

- [redacted]

<u>Applicant team</u>

- [redacted]

2 The advice given by officers does not constitute a formal response or decision by the Mayor with regard to future planning applications. Any views or opinions expressed are without prejudice to the Mayor's formal consideration of the application. Please note that the advice you receive will be dependent upon the quality of the information and documentation that you provide.

Site description

3 The Edmonton Eco Park is within the Upper Lee Valley Opportunity Area. This site is bounded by:

- industrial uses and Deephams farm to the north;
- the Lea Navigation and the Lee Valley Regional Park (including the King George V and William Girling reservoirs, both of which are Sites of Special Scientific Interest) to the east;
- Advent Way, a Sea Cadets building on site and the Lee Valley district energy centre to the south; and
- Salmons Brook, Ely Industrial Estate and a residential corridor to the west.

4 The site is accessed from Advent Way, which leads to the A406 North Circular Road, part of the Transport for London Road Network (TLRN). The site lies some 1.5km from the nearest section of the Strategic Road Network (SRN) at the A1010 Fore Street.

5 Whilst Angel Road National Rail station lies approximately 500m to the south west, the walking environment between this station and the site is very poor. Currently frequency of service throughout the day is also poor (2 trains per hour - tph).

6 Infrastructure upgrades to deliver 4 trains per hour service are, however, funded and will be delivered by 2019. Local bus routes include the 34, 341 and 444 run within 450m of the site, although the quality of the pedestrian routes between the site and bus stops served by these routes is again very poor. The site has a public transport accessibility level of 1b within the range of 6 (highest) and 1 (lowest).

7 The site currently operates as a waste processing facility and contains a central 'Energy from Waste' (EfW) incinerator, a composting facility, bulky waste and recycling facilities and Enfield Council's refuse vehicle depot. It is understood that Deephams Farm, to the north of the site is used for cooling purposes by NLWA.

Details of the proposal

8 The proposal comprises an electricity generating facility or energy recovery facility (ERF) using non-recycled waste as a fuel and capable of an electrical output of around 50 Megawatts. The energy generating facility will have a capacity to process up to 700,000 tonnes per annum (at its peak around Easter and Christmas periods), which with current recycling rates means that the new facility would be capable of handling all local authority waste generated in the seven constituent North London Boroughs of Barnet, Haringey, Camden, Islington, Enfield, Hackney, and Waltham Forest.

9 While a recycling rate of 33% is currently being achieved across the constituent North London boroughs, the Authority's target is to increase this to around 50% by 2020/21. Achieving 50% recycling will offset any increase in non-recycled waste arising and requiring management as a result of expected population growth in North London. The facility is expected to be linked to the Lee Valley Heat Network (LVHN), providing heat to homes in Enfield and Haringey.

10 Based on the documentation provided, the main plant would comprise:

- two process lines, with each line having a moving grate, furnace, boiler and a flue gas treatment plant and stack;
- a steam turbine and generator set;
- "heat off-take" equipment within the ERF with an initial heat supply through a connection to a separate heat network centre located on the site. The system will be designed to be capable of providing heat in the region of 40 MW which will provide benefit to north and east London;
- a waste bunker with sufficient capacity to hold a minimum equivalent of 5-7 days of processing capacity;
- two overhead cranes in the bunker hall;
- air or water cooled condenser(s);
- a plant control and monitoring system;
- an emergency diesel generator;
- a tipping hall and one way access ramp;
- fuel preparation plant (FPP);
- bulky waste recycling facility (BWRF); and
- household waste recycling centre (HWRC).

11 Ancillary elements would include a weigh bridge; and hard and soft landscaping directly related to the main building works. The project is expected to include the following associated development:

- upgrade of the electricity connection to the National Grid;
- new site access from the Lee Park Way;
- new internal roads and parking areas;
- administrative buildings and visitor centre;
- the decommissioning of the existing Edmonton EfW facility and making the site good (timed to take place following commissioning of the new ERF and with a transition period of up to a year).
- re-location of the LondonWaste Limited (LWL) vehicle depot and servicing.
- A heat supply connection to a proposed separate heat network centre (the Lee Valley Heat Network) located on the site. The connection system will be designed to be capable of providing heat in the region of 40 MW which will provide benefit to north and east London.

12 The buildings would be located either side of the existing plant. There will be a facilities overlap period of 6-12 months from the decommissioning of the existing energy from waste (EFW) facility and the 2027 new operations.

Strategic planning issues and relevant policies and guidance

13 The relevant strategic issues and corresponding policies are as follows:

- Principle of development — London Plan;
- Waste — London Plan; the Municipal and Business Waste Management Strategies;

• Sustainable development	London Plan; NPPF and NPPG; Mayor's Climate Change Mitigation and Energy Strategy;
• Biodiversity	London Plan;
• Ambient noise	*London Plan; the Mayor's Ambient Noise Strategy;*
• Air quality	*London Plan; the Mayor's Air Quality Strategy; Control of dust and emissions during construction and demolition SPG*
• Urban design	*London Plan; Housing SPG; Shaping Neighbourhoods: Play and Informal Recreation SPG*
• Transport	*London Plan;*
• Parking	*London Plan; the Mayor's Transport Strategy*
• Air quality	London Plan; the Mayor's Air Quality Strategy;
• Ambient noise	London Plan; the Mayor's Ambient Noise Strategy;
• Transport	London Plan; the Mayor's Transport Strategy; Land for Industry and Transport SPG
• Crossrail	London Plan; Mayoral Community Infrastructure Levy;

14 For the purposes of Section 38(6) of the Planning and Compulsory Purchase Act 2004, the development plan in force for the area is the Enfield Core Strategy, November 2010, the Enfield Development Management Document, November 2014 and the March 2015 London Plan.

15 The following are also relevant material considerations:

- The National Planning Policy for Waste (October 2014)
- The Upper Lee Valley Opportunity Area Planning Framework, July 2013
- The Edmonton Eco Park Planning Brief, Supplementary Planning Document, May 2013
- Central Leeside Area Action Plan (submission version- consultation period, 5 January - 16 February 2015)

Summary of meeting discussion

16 Following a presentation of the proposed regeneration scheme by the applicant team, meeting discussions covered strategic issues with respect to the **principle of development, energy, design environmental impacts** and **transport**. GLA officer advice in respect of these issues is set out within the sections that follow.

Principle of development

Energy

17 GLA officers have been working with the NLWA and Enfield Council (and to a lesser degree with Haringey and Waltham Forest Boroughs) to develop a strategic heat network throughout the Lee Valley Heat Network area, taking heat from the existing EfW plant and supply affordable low carbon heat for heating buildings and industry.

18 Heat networks require substantial levels of investment and having a 40 year plus life, the new ERF will give the heat network investors confidence that heat will continue to be available following the closure of the existing plant. The replacement of the existing facility will therefore

assure the continuity in providing energy to the proposed 5,000 new homes in the Meridian Water area and provide for further heat supply capacity for any heat network expansion. This proposal is therefore strongly supported, being a key aspiration of the Upper Lee Valley Opportunity Area Planning Framework and in meeting the policies of the London Plan.

19 The new plant should be designed and built as a combined heat and power (CHP) plant enabling heat to be supplied to the network in the most economic way. The NLWA should always quote the electricity capacity (MWe) and the heat supply capacity (MWth) when describing the plant energy output.

20 The heat off-take capacity of the plant should be optimised in terms of the economic production of heat, and be in line with good steam turbine/district heating practice. The off-take capacity should not be designed to meet just the demands currently being negotiated with the Lee Valley Heat Network (LVHN). The LVHN capacity will be far less than the plant potential. The provision made in the steam turbine for heat off-take tappings that would supply the district heating heat exchangers (provided by others) would allow for the plant's capacity to be optimised and not just at a procured/ contracted capacity arrangement. This provision costs very little and its retro-fit at a later date is not practical. GLA officers therefore ask that the plant is specified and procured to optimise the economic heat off-take capacity irrespective of whether there is a customer for that heat or not. GLA officers require further design information on how NLWA will specify and procure its steam turbine and its heat off-take provision. This should be shown in diagrammatic format, demonstrating the temperature and pressure levels as well as capacity.

21 The facility should meet the carbon intensity floor of 400 grams of $CO2$ eq per kWh of electricity generated [as outlined in the Further Alterations to the London Plan Policy 5.17]. The applicant states that the thermal stores are to optimise power versus heat arrangements to meet the carbon intensity floor. To mitigate the NOX, a flu gas cleaning system is proposed (the injection of a lime slurry (200ml per cubic metre) to reduce the acid gasses)-through the installation of a catalytic reduction system. The applicant states that this technology is not used in the UK, however it is used in Continental facilities which are exceeding EU emissions targets (going beyond the minimum requirement).

22 Those elements of the development that are covered by Part L of the Building Regulations (e.g. administrative buildings, offices, and visitor centre) should demonstrate how they are minimising carbon dioxide emissions to meet the targets in Policy 5.2 of the London Plan and be designed to meet Part L 2013 through energy efficiency measures alone (guidance available https://www.london.gov.uk/priorities/planning/strategic-planning-applications/preplanning-application-meeting-service/energy-planning-gla-guidance-on-preparing-energy-assessments)

23 Overall, the proposed facility will be an asset to London in achieving net self- sufficiency and will allow for energy gains to be achieved, as proposed by the Council's Lee Valley Heat network proposals. Strategically, the proposal will facilitate the objectives set out in the Upper Lee Valley OAPF and the London Plan and is therefore strongly supported.

Waste

24 The applicant was informed at the meeting that the proposal is broadly supported meeting London Plan waste policies 5.16 and 5.17–namely for the benefit of North London Boroughs meeting waste apportionment and helping London become 100% net waste self-sufficient. The facility will support additional bulky waste recycling capacity, make use of an

existing brown field and waste site, manage waste close to source, and divert over 500,000 tonnages of waste from landfill.

25 The applicant stated that the proposed ERF technology – "moving grate incineration" is the best commonly available system and that it is considered to be a robust technology available which has been tried and tested. It mentioned a Ramboll Report on technology type selection. The applicant is asked to take a flexible approach to allow for the adoption of other technologies that may become available that deliver greater efficiencies and be cost effective. The applicant is not proposing any pre-treatment capacity on site to recover material suitable for recycling, noting this would add additional cost with little benefit. The applicant is asked to provide more information on what measures are/will be in place to ensure waste going to the ERF is 'truly residual waste', as to not negatively impact the achievement of recycling targets sets by the North London boroughs and the Mayor's recycling targets for London.

26 The applicant also emphasised that the technical operations of the facility have a lot of mitigation built into the process/plant to overcome environmental concerns such as air quality, noise and flood risk. These are discussed later in the report.

27 Officers considers that the proposal complies with the London Plan waste policy providing the applicant can demonstrate how the proposal will not crowd out opportunities for the North London boroughs to reach 50% recycling performance.

28 Overall, the NLWA proposal for a heat and power facility is strongly supported in strategic terms because of the wider sustainability gains that it will achieve, not only for the north London, Upper Lee Valley area but also since it will contribute towards net self-sufficiency in London. The proposal will provide additional recycling capacity, whilst making use of the existing brown field land, and manage waste as close to its source as possible. The proposal has the potential to achieve the carbon intensity floor target (addressed in the energy section of this report) and deliver low carbon heat through connection with the planned Upper Lee Valley Heat Network.

Urban design

29 As presented at the meeting, the proposals are generally well thought out and the intention to open up existing points of access into the site is welcomed as this enables the opportunity to form a public facing frontage along the river edge via Advent Way. As discussed, the applicant should provide further detail on how the existing footbridge can be upgraded, incorporated into the proposals and positively contribute to enhancing the pedestrian environment along the river edge.

30 The form and massing strategy is broadly supported and it is understood that the scale and extent of building envelopes have been designed to meet the minimum sizing and processing requirements of internal plant and machinery. This results in a simple and refined appearance which is further enhanced by the use of high quality facing materials, which is welcomed. It is understood that the height of the flue chimney is determined by Building Regulations requirements; however the applicant should provide a views analysis to understand the degree that this structure will impact on the setting of the neighbouring conservation area.

31 The key design issue in relation to the proposals is the impact on the openness of the adjacent Metropolitan Open Land (MOL). While it is acknowledged that the site sits outside of the MOL, it lies within the setting of it and therefore contributes to the level of openness and the experience of the MOL. The applicant is required to undertake a views analysis to demonstrate whether the proposals will result in any negative impact on the openness of the

MOL. This should include a series of specific views from within the site and within the MOL and these will need to be agreed for testing in discussion with GLA officers and the Council.

32 As discussed, the use of level changes may help to reduce the impact of the proposals in both long distant and local views, by embedding the eastern section of the recovery plant into the topography of the landscape. This will also provide the opportunity to maximise greening and biodiversity along the river edge of the site, in line with the objectives of London Plan 7.28.

Air Quality

33 The ERF plant will be 50 megawatts (MW) in size, and will have a thermal capacity which falls outside the scope of the CHP/Biomass guidance written by AMEC, the GLA's independent consultants. The proposal is very large, however it will have fairly low emissions for the size as a selective catalytic reduction (SCR) system is proposed. Due to the size, the facility will be regulated by the Environment Agency whom will ensure the plant meets the limits set.

34 The Environmental Impact Assessment Scoping Reports provide details of the air quality assessment that will be undertaken. It appears to be comprehensive and includes best practice. Emissions from the stack, and emissions as a result of traffic serving the facility will be considered. GLA officers will be able to comment in more detail when the Environmental Statement has been prepared.

<u>Air quality, noise and other potential environmental impacts</u>

35 The applicant will be required to undertake noise and air quality assessment work to demonstrate the proposal is acceptable in strategic policy terms. The applicant should ensure that the requirements of London Plan policy 5.17 and in particular 5.17e/f and D are fully addressed to ensure that environmental impacts are mitigated. The proposal to replace the waste function at the Eco-Park, alongside the other ancillary land uses proposed, and future development in the area (adjacent sites); should ensure that the waste management site is *'designed to minimise the potential for disturbance and conflict of use.'*

36 The applicant will be required to refer to guidance relating to non-road mobile machinery (NRMM) contained within the Control of Dust and Emissions During Construction and Demolition SPG (see link)-
https://www.london.gov.uk/priorities/planning/publications/the-control-of-dust-and-emissions-during-construction-and

37 The SPG seeks to reduce emissions of dust, PM10 and PM2.5 from construction and demolition activities in London. It also aims to manage emissions of nitrogen oxides (NOx) from construction and demolition machinery by means of new non-road mobile machinery Ultra Low Emissions Zone (ULEZ). This SPG provides more detailed guidance on the implementation of all relevant policies in the London Plan and the Mayor's Air Quality Strategy to neighbourhoods, boroughs, developers, architects, consultants and any other parties involved in any aspect of the demolition and construction process; sets out the methodology for assessing the air quality impacts of construction and demolition in London; and identifies good practice for mitigating and managing air quality impacts that is relevant and achievable, with the over-arching aim of protecting public health and the environment.

38 The SPG, provides guidance on the implementation of London Plan policy 7.14 - Improving Air Quality, as well as a range of policies that deal with environmental sustainability, health and quality of life. Compliance with this document is required to ensure conformity with the London Plan and the Mayor's Air Quality Strategy.

Flood risk and surface water management

39 The proposals are at an early stage and the applicant stated that flood risk will be considered in detail within an Environmental Impact Assessment (EIA). This will need to include a detailed flood risk assessment noting the risk of fluvial flooding from the nearby River Lee and Salmons Brook systems, the risk of surface water flooding and the risk of reservoir flooding from the range of raised reservoirs along the Lee Valley. It is unlikely that any of these risks will present an in principle barrier to the proposed development, but it is likely that some aspects of the design will need to reflect the risks present, such as the height of the thermal stores being affected by an aquifer.

40 In the case of surface water management, London Plan Policy 5.13 and the sustainable drainage hierarchy contained within that policy should be applied to limit surface water discharge to the drainage system. Given the anticipated use of water on-site, the Mayor will expect that full consideration is given to a rainwater harvesting system, this should also present the opportunity to realise some cost savings over the lifetime of the proposed plant.

Water transport

41 The use of water transport should be investigated, in line with London Plan policy 7.26 and the Mayor's Transport Strategy. This should be investigated both in relation to the demolition/construction phase and to the operational waste delivery phase. The operational use of barges has been investigated at several points during the lifetime of the current plant but no successful delivery system has ever been put in place. The Mayor will look to the new plant to deliver a more viable approach to waterborne delivery of materials to/from the site.

Environmental mitigation (AQ, noise, water and biodiversity)

42 The height of the proposal is justified as being technically driven based on dispersion modelling. The siting of the facility is driven by the geology of the site and it is understood that the Environment Agency has a requirement for 5-8 metres below ground level to be maintained as it is London clay, and due to the siting of an aquifer.

43 With regards to visual/environmental impacts- the choice in cladding materials and the colour are being explored by the applicant to breakdown the height and massing of the building.

44 A visual buffer along the canal and landscaping is also proposed. The applicant has also proposed that the canal area will be a dark corridor with no light to prevent impact to nocturnal species.

45 A green roof is proposed on the tipping hall and a brown rood on the waste bunker to create and enhance biodiversity at the site. These will be visible on the eastern side of the site.

Transport

46 TfL has provided pre-application advice direct to NLWA on 9 September 2014. Issues where engagement with TfL is required relates to travel planning, traffic impact, construction impact, construction workers travel, safeguarding assets (property and operational), opportunity to use river for freight, and opportunity to review local bus services, local walking and cycling routes. All TfL issues should be dealt with through the transport assessment or via other engagement, which includes the following topics:

- Vehicle access / construction access;

- Context/ methodology;
- Car and cycle parking;
- Walking, cycling and public transport access;
- Freight including water (water freight study) and delivery and servicing planning;
- Transport impacts / mitigation;
- Construction impact and construction logistics plan;
- Public transport; and
- Travel plan.

47 TfL has only commented on scoping documents to date and will review and comment on material as submitted. TfL welcome early sight of draft documents so we can provide advice at an early stage.

48 The applicant was informed at the meeting that information on the construction period would be required, along with the likely increase in road traffic during and after construction when the plant begins to operate. A comparison of the current facility's traffic movements against those proposed should be demonstrated. To reduce the impact on the road network, the applicant was advised to further explore the options of waterbourne transportation of waste material. Reference to water transport is also made earlier in this report.

Conclusion

49 Having reviewed the consultation documents and after meeting with the applicant, GLA officers are of the view that the proposed facility will be an asset to London in achieving net self- sufficiency and will allow for energy gains to be achieved, as proposed by the Council's Lee Valley Heat network proposals. The applicant is asked to provide more information on how they will support NLWA's constituent boroughs to achieve its 50% recycling target, and that the ERF facility meets the Mayor's carbon intensity floor CO2 standard, in order to be considered in general conformity with London Plan waste policy.

50 Strategically, the proposal will facilitate the objectives set out in the Upper Lee Valley OAPF and the London Plan. The likely cumulative impacts from waste and energy processing; transportation and air quality /noise/flood risk impacts will need to be assessed once the NLWA has undertaken the necessary environmental and transport related assessment reports. The applicant will be required to apply the guidance set out in the Control of Dust and Emissions During Construction and Demolition SPG. This will meet the requirements of policy 7.14 of the London Plan.

51 Transportation of waste by river will need to be assessed by the applicant, as set out within the water transport /transport sections of this report. There are immense energy gains to be achieved from this proposal, not to mention waste diversion from landfill. The NLWA should continue to work with GLA officers in developing this proposal further to secure optimum decentralised energy opportunities from the energy/heat that will be generated at this site and address the energy matters raised within the report.

52 GLA officers would also welcome partnership involvement in the NLWAs work relating to the Development Infrastructure Funding (DIF) study it is currently undertaking with TfL, London Boroughs of Enfield, Haringey, Waltham Forest and Hackney. This study will be looking at opportunities to deliver the infrastructure that supports major new housing and employment projects in the Upper Lee Valley, including heat and power networks based around this project- as set out in the Upper Lee Valley Opportunity Area Planning Framework (ULV OAPF). (Please

contact [redacted] for further detail).

for further information, contact GLA Planning Unit (Development & Projects Team):

[redacted]

A3.3 Thames Water Utilities Ltd

From: [redacted]
Sent: 24 August 2015 15:19
To: POST
Cc: [redacted]
Subject: FW: IR 1013130940 - NLWA enquiry

Dear NLWA,

In response to your letter I can confirm that Thames Water has already included the provision, secured within the s106 agreement for the Deephams Sewage Works (STW) Upgrade project, for the future potential connection of flow and return pipes by incorporating appropriate flange plates in the heat rejection system for each Sewage Works CHP engine, and the safeguarding of a pipe route to the boundary of the STW site. At this time its unlikely we will need excess heat from the NLWA ERF plant, but instead we could potentially provide excessive heat to the network ourselves from the STW.

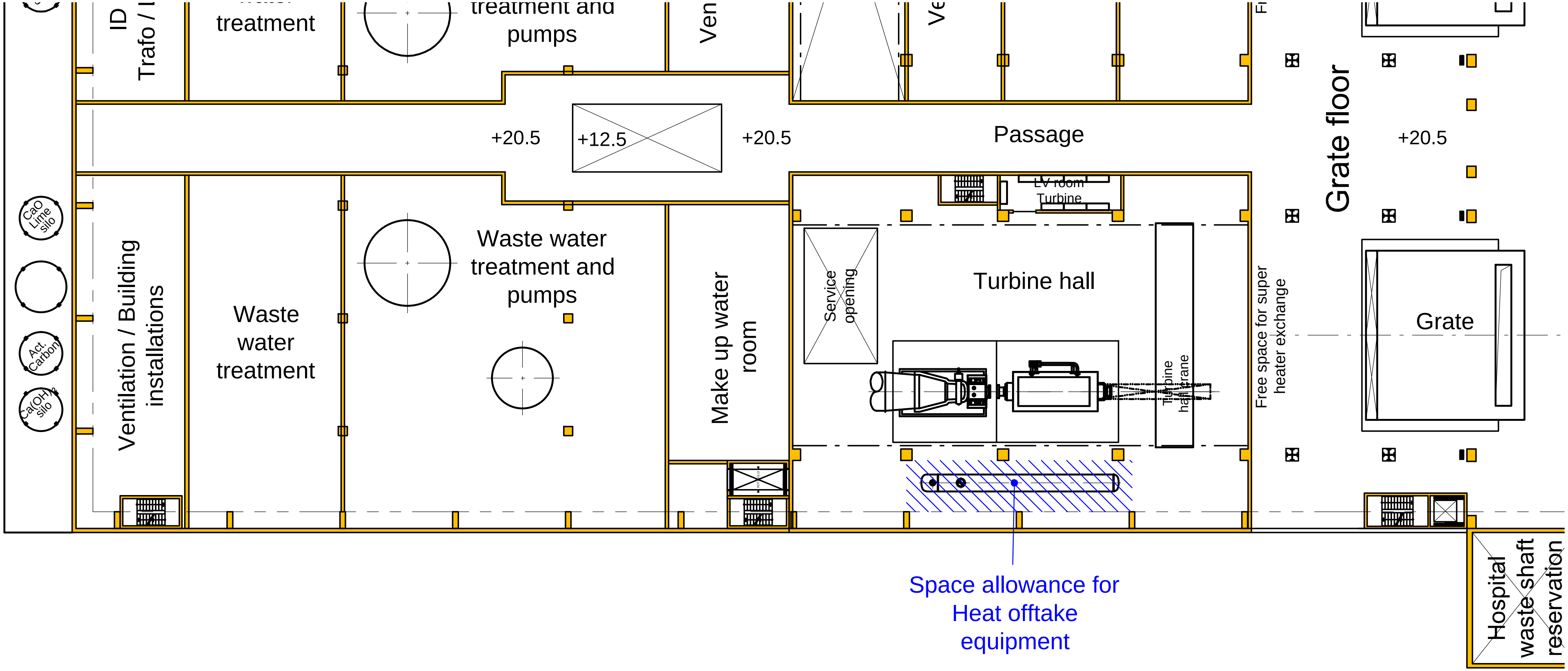
I trust this is helpful.

Cheers

[redacted]
Thames Water

[redacted]

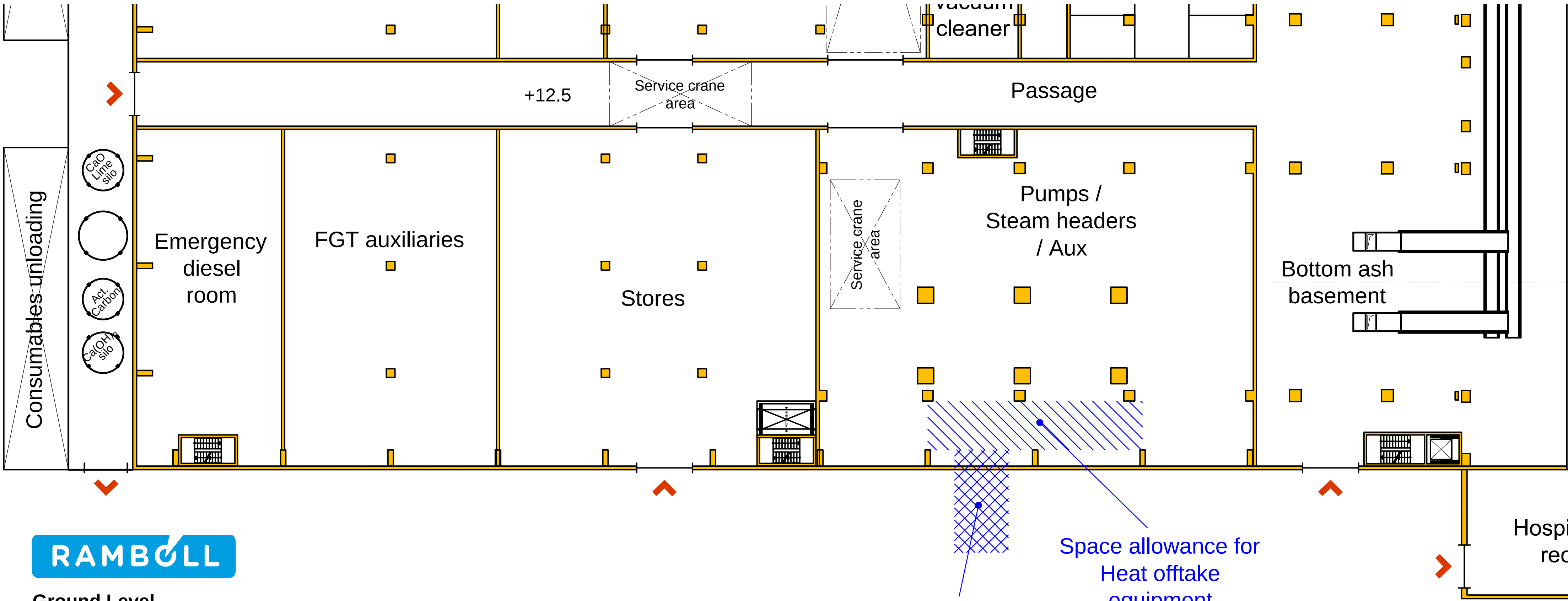
Appendix B – ERF Heat Off-take space allowance illustration



RAMBØLL

Turbine Hall Level
ERF Heat Off-take Space Allowance
Sketch

Not for construction - Internal layout of ERF
subject to amendment at detailed design.



Ground Level
ERF Heat Off-take Space Allowance Sketch

Not for construction - Internal layout of ERF subject to amendment at detailed design.

Appendix C – WRATE and Carbon Intensity Floor Modelling: Technical Report

North London Waste Authority

North London Heat and Power Project

WRATE and Carbon Intensity Floor Modelling: Technical Report

AD05.06 Appendix C

The Planning Act 2008 The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Regulation 5 (2) (q)

Issue | October 2015

Arup

ARUP

nlwa
north london waste authority

Contents

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Glossary

See Project Glossary (AD01.05)

Executive summary

i.i.i This report describes the life-cycle analysis (LCA) modelling work undertaken to assess the likely environmental performance of a new Energy Recovery Facility (ERF) at Edmonton EcoPark, which forms part of the North London Heat and Power Project (the Project).

i.i.ii The LCA modelling includes a comparison of four waste management scenarios for the residual waste collected by the seven north London boroughs (Constituent Boroughs), for the assessment year of 2025/26 (the expected first year of full operation for the new ERF). These scenarios are briefly defined as follows (more detail is given in Section 4.2 of this report):

a. sending all waste to landfill for disposal (Scenario A: Landfill comparator);

b. continuing with the current operation of waste incineration (Scenario B: current operations in 2025/26);

c. a new ERF operating in combined heat and power (CHP) (Scenario C: future operations); and

d. sending half of the waste abroad (in the form of Refuse Derived Fuel) to Amsterdam and the other half to landfill in the UK (Scenario D: alternative future operations).

i.i.iii Scenarios A to D are referred to as the ‘main analysis’ throughout this report.

i.i.iv This report also describes modelling work undertaken to assess whether Scenarios A to D would meet the Carbon Intensity Floor (CIF) of less than or equal to 400gCO_2e/kWh defined by the Greater London Authority (GLA). The CIF is a measure of the carbon impact of generating energy from waste.[1] It is calculated by dividing the direct emissions associated with energy generating waste treatment technologies by the gross electricity and heat generated by the said technologies. Waste authorities that are considering options for generating energy from waste need to demonstrate the CIF can be met.

i.i.v Environmental performance is defined in this context by the use of six environmental indicators, defined briefly here (more detail is given in Section 2.1.4 of this report):

a. global warming potential: the environmental impact from anthropogenic Greenhouse Gas (GHG) emissions.

b. acidification potential: the environmental impact from anthropogenic emissions of acidifying compounds that can damage ecosystems.

c. eutrophication potential: the environmental impact from anthropogenic emissions of nitrogenous compounds and phosphates that can cause increased plant growth and oxygen depredation in aquatic ecosystems.

[1] SLR (June 2011). Appendix 4b Determining the Costs of Meeting the EPS and Carbon Intensity Floor, Revision 2 (accessed 21st March 2014).

d. freshwater aquatic eco toxicity: the environmental impact (toxic effects) from anthropogenic emissions on freshwater ecosystems.

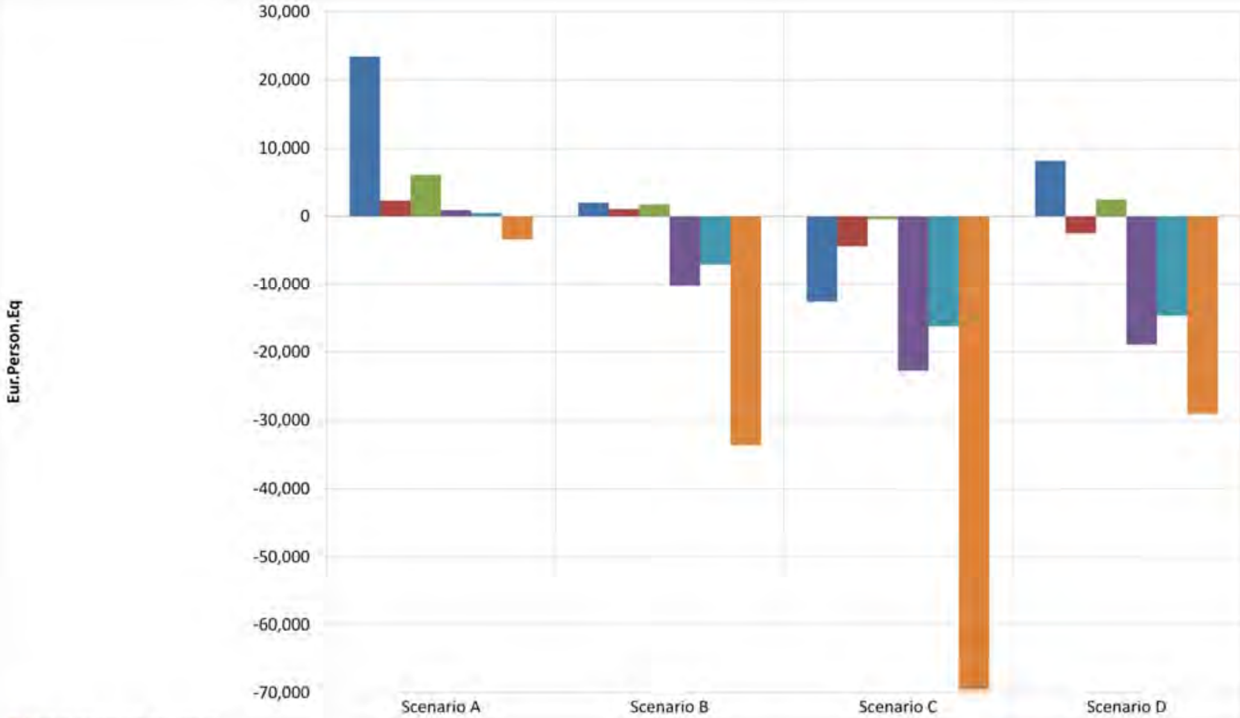
e. human toxicity: the environmental impact (toxic effects) from anthropogenic emission on human health.

f. abiotic resource depletion: the environmental impact from the use of abiotic (non-living) resources.

i.i.vi These environmental indicators give a broad reflection of the likely environmental benefit or dis-benefit that a defined waste management scenario would have over the course of a given assessment year.

i.i.vii The environmental indicators are derived through modelling scenarios using LCA. LCA expresses the environmental impact of a waste management scenario over its entire life-cycle. The Waste and Resource Assessment Tool for the Environment (WRATE) LCA model was used to compare the environmental indicators of four waste management scenarios.

i.i.viii The environmental performance indicators can be normalised to provide a quantification of the environmental impact caused annually by the activities of an average European person (Eur.Person.Eq). The modelling results for the main analysis are shown in the figure below.

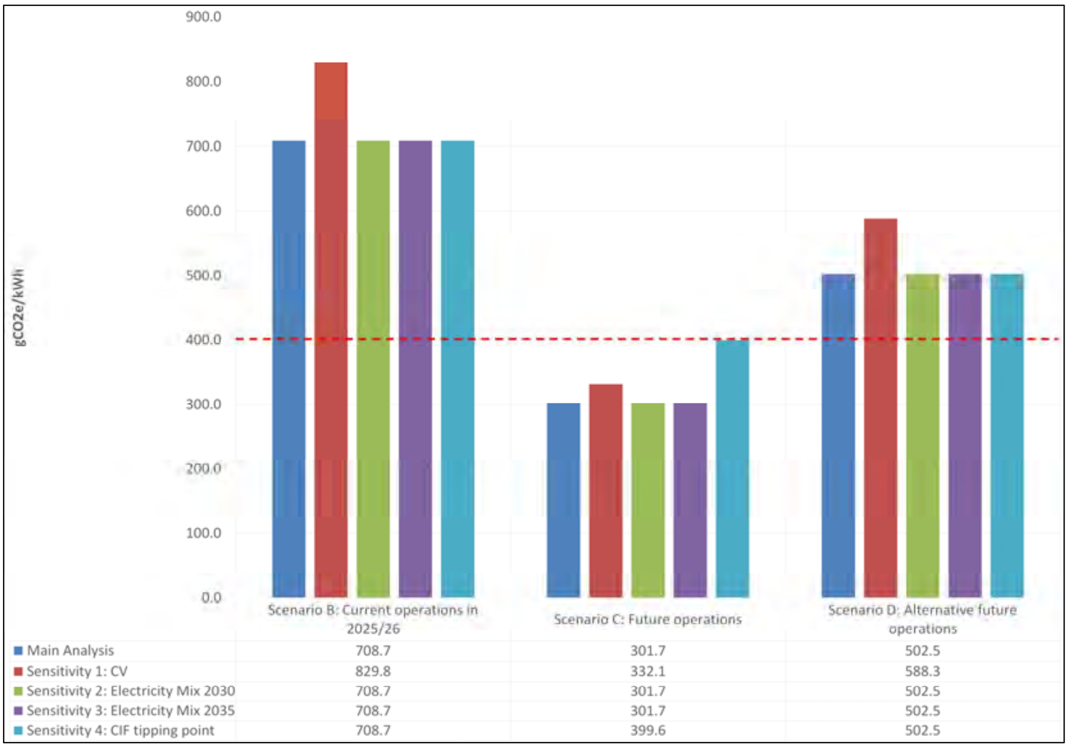


	Scenario A	Scenario B	Scenario C	Scenario D
Global Warming Potential	23,426	2,036	-12,585	8,180
Acidification Potential	2,300	1,082	-4,371	-2,467
Eutrophication Potential	6,086	1,782	-420	2,473
Freshwater Aquatic Ecotoxicity Potential	940	-10,190	-22,758	-18,903
Human Toxicity Potential	493	-7,081	-16,221	-14,649
Abiotic Resource Depletion Potential	-3,351	-33,578	-69,519	-29,046

i.i.ix Negative results represent an avoided impact and therefore an environmental performance benefit; conversely positive results represent a dis-benefit, and therefore a decrease in environmental performance. It can be seen in the figure above that Scenario C is the scenario with the best net environmental performance across all environmental indicators relative to the other three comparison waste management scenarios.

i.i.x The LCA and CIF modelling has been subject to various sensitivity analyses to consider the effect of changing the type of grid electricity mix against which energy generation is offset, as well as the amount of heat the new ERF would produce and the net calorific value (NCV) or the waste. Under all sensitivity analyses, the planned new ERF shows an environmental performance benefit. Sensitivity scenarios and associated modelling results are described in more detail in this report.

i.i.xi To determine if the waste incineration scenarios would meet the CIF, the 'Mayor of London's Greenhouse Gas (GHG) Calculator for Municipal Solid Waste (v2.1)'[2] was used. The CIF and the approach used are described in more detail within this report.



i.i.xii The figure above shows the CIF modelling results of the incineration scenarios. It can be seen that the new ERF (Scenario C) would meet the CIF at 302 CO_2e/kWh under the main analysis, and it would do under all sensitivity analyses also. Current operations (Scenario B) and alternative future operations (Scenario D) would not meet the CIF. Sending all waste to landfill (Scenario A) is not included as landfill emissions and energy capture from landfill gas are not within the scope of the CIF.

i.i.xiii In conclusion, subject to the assumptions and limitations of the LCA and CIF modelling methods used and the scope and definition of the waste management scenarios modelled, Scenario C (i.e. the proposed new ERF)

[2] Available on the Greater London Authority website at: http://www.london.gov.uk/priorities/environment/putting-waste-good-use/making-the-most-of-waste (accessed 21st March 2014. NB: Accessed again on the 30th March 2015 and appears to be no longer available to download).

demonstrates the best environmental performance compared to the other three waste management scenarios and would meet the CIF.

1 Introduction

1.1.1 This report has been prepared to support of the North London Waste Authority's (the Applicant's) application (the Application) for a Development Consent Order (DCO) for the development of a new Energy Recovery Facility (ERF) to treat residual waste at the Edmonton EcoPark. The Applicant has commissioned Ove Arup & Partners Ltd (Arup) to undertake waste management life-cycle modelling. There are two objectives of this modelling, as follows:

a. Objective 1: To assess the likely environmental performance of a new ERF, relative to current operation as well as sending all waste to landfill.

b. Objective 2: To assess under what scenarios an ERF would not meet the Carbon Intensity Floor (CIF) of less than or equal to 400gCO_2e/kWh defined by the Greater London Authority (GLA). This builds on earlier modelling work undertaken by Arup in April and August of 2014 ('the previous work').

1.1.2 Objective 1 makes use of the Waste and Resource Assessment Tool for the Environment (WRATE) (Approach 1). Objective 2 primarily makes use of the Mayor of London Green House Gas (GHG) tool (Approach 2), with WRATE used as a sense check for the CIF modelling results.

2 Discussion

2.1 Approach 1: WRATE environmental indicators

2.1.1 WRATE is a life-cycle analysis (LCA) tool which assesses the potential environmental impacts associated with specific integrated waste management scenarios, and is currently the foremost life-cycle assessment tool for waste management in the UK.

2.1.2 Four waste management scenarios were modelled within WRATE ('the main analysis') for the year of 2025:

a. Scenario A: Landfill comparator;

b. Scenario B: Current operations in 2025/26;

c. Scenario C: Future operations; and

d. Scenario D: Alternative future operations.

2.1.3 Four sensitivity analyses were also modelled; changing the electricity mix to the year 2030 and 2035, and changing the heat-off take for Scenario C to the CIF tipping point where it would no longer be met. All scenarios are defined in more detail in Section 4.2.

2.1.4 Approach 1 provides quantitative information on these impacts in the form of six default environmental indicators[3] described as follows:

a. global warming potential (GWP100a): this represents the environmental impact from anthropogenic GHG emissions, such as carbon dioxide and methane, contributing to global warming over a period of 100 years.

b. acidification potential: this represents the environmental impact from anthropogenic emissions to air, water and land of acidifying compounds such as sulphur dioxide and nitrogen oxides which can contribute to destructive impacts on ecosystems.

c. eutrophication potential: this represents the environmental impact from emission of nitrogenous compounds and phosphates which can stimulate increased plant growth to nutrient poor ecosystems as well as oxygen deprivation in water based ecosystems.

d. freshwater aquatic ecotoxicity: this represents the toxic effects from emissions/effluents on freshwater ecosystems.

e. human toxicity: this represents the toxic effects from emissions/effluents on human health.

f. abiotic resource depletion: this represents the use of abiotic (i.e. non-living) resources such as metals, minerals and fossil fuels.

2.1.5 The results from the WRATE modelling can be normalised so that they are comparable using the European Person Equivalent (Eur.Person.Eq)

[3] GWP100a, resource depletion and toxicity (human and freshwater aquatic) have the highest degree of certainty as environmental indicators, whereas acidification and eutrophication have a lesser degree of certainty. This should be borne in mind when interpreting results.

approach. This is a quantification of the environmental impact caused annually by the activities of an average European person.

2.1.6 Negative WRATE modelling results represent an avoided (or displaced) impact, whereas positive results represent an adverse impact (see Table 4.2). Therefore negative results represent a net improved environmental performance, and positive results represent a net reduced environmental performance.

2.1.7 The outcomes of the WRATE analysis should be used to inform the decision making process and not used as the sole basis for waste management scenario selection.

2.1.8 The WRATE model for this analysis has been independently peer reviewed by Frith Resource Management Ltd (FRM). FRM consider the WRATE model and all the User Defined Processes (UDPs) within the model to contain reasonable assumptions given the level of detail available for the model, and they state it has been undertaken with due care and diligence. The full peer review report is included in Appendix A.

2.2 Electricity generation mix sensitivity analysis

2.2.1 A further six analyses were modelled under Approach 1 to reflect alternative projections for the future UK electricity generation mix, based on the Department of Energy and Climate Change (DECC)[4] 'reference scenario' and the National Grid (NG)[5] 'gone green' projection. The DECC reference scenario was used as this is thought to represent the most likely outlook for the future UK electricity generation mix. The National Grid 'gone green' electricity generation mix was used as this represents an optimistic outlook for renewable electricity generation in the future, and therefore results in less of an environmental performance benefit for the energy offset for the new ERF. This was undertaken in addition to the default UK electricity generation mix projections within WRATE, which represent a more carbon intensive energy mix in future years[6]. These are discussed in more detail in Sections 4.1 and 4.2.

2.2.2 In addition, a further analysis was modelled under Approach 1 to reflect the electricity generation mix in the Netherlands, as the Energy from Waste (EfW) process included within Scenario D is located in Amsterdam.

[4] DECC Updated energy and emissions projections for 2014, available at: https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2014 (Accessed 5th May 2015).

[5] Part of the National Grid 2014 Future Energy Scenarios, available at: http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Future-Energy-Scenarios/ (Accessed 5th May 2015).

[6] This may be due to the categorisation of electricity generation sources. WRATE does not have electricity generation from coal with carbon capture storage (CCS) or gas with CCS category defined in its electricity mix. Therefore the increase in coal within the default WRATE UK electricity mix from 2025 to 2035 could be reflecting the increase in coal with CCS. However, the rationale behind the default WRATE electricity mix is not known.

2.3 Approach 2: Mayor of London GHG Calculator

2.3.1 The CIF is a measure of the carbon impact of generating energy from waste.[7] It is calculated by dividing the direct emissions associated with energy generating treatment technologies by the gross electricity and heat generated by the said technologies. It includes the parasitic load of the EfW facility; the benefits of heat production and subsequent use when operating in combined heat and power (CHP) mode; and fossil carbon emissions. However, the CIF excludes the following:

a. carbon dioxide (CO_2) benefits of materials capture and subsequent reprocessing;
b. emissions from any reject streams sent to landfill including associated transport;
c. parasitic load of fuel preparation facilities;
d. direct emissions from fuel preparation facilities;
e. capital burdens (i.e. construction material impacts from primary infrastructure); and
f. biogenic carbon emissions.

[7] SLR (June 2011). Appendix 4b Determining the Costs of Meeting the EPS and Carbon Intensity Floor, Revision 2 (accessed 21st March 2014).

3 Assumptions and limitations

3.1.1 The following key assumptions have been made in undertaking the modelling work under both Approaches 1 and 2 (for all input assumptions and parameters please see Appendix A3, Table 6.3 to Table 6.7.

a. the waste composition is as provided by the Applicant for residual municipal waste (presented in Table 6.1 in Appendix A2)[8], as per the previous work. As the default waste composition categories used in both Approaches are slightly different to the composition provided by the Applicant, it was assumed that 'misc combustibles' includes wood and absorbent hygiene products;

b. a net calorific value (NCV) of residual waste of 10 gigajoules per tonne has been specified by the Applicant. In addition, 8.54 gigajoules per tonne has also been modelled as a sensitivity analysis (this is the default NCV WRATE calculates for the given waste composition as it is not possible to edit the calorific value and NCV values within WRATE);

c. a total gross tonnage of residual waste of 572,856 tonnes per annum (tpa)[9,10];

d. a plant availability of 91.3 per cent (8,000 hours per annum);

e. a thermal efficiency of 90 per cent;

f. a 'Z' ratio for hot water of 6[11];

g. waste collection (both infrastructure and transport) from the seven north London boroughs of Barnet, Camden, Enfield, Hackney, Haringey, Islington and Waltham Forest (the Constituent Boroughs) is out of scope of the modelling;

h. recycling is out of scope of the modelling as it is collected by the Constituent Boroughs;

i. heat network infrastructure (for the heat output from the future ERF) is out of scope of the modelling; and

j. assessment year of 2025/26, as this is the expected first year of full operation for the future ERF.

[8] Note that the tonnage of 514,527 tonnes in Table 15 is for 2009 and therefore will not correspond to the tonnages used for modelling in this report.
[9] As presented in the Eunomia NLWA WFM v8 'central recycling scenario' for 2025/26.
[10] Corresponding to a biogenic carbon content of 15.81 per cent (Approach 1) and 15.71 per cent (Approach 2).
[11] Corresponding to hot water at 3 bar/134 degrees Celsius as in: CHPQA (2007). The Determination of Z Ratio, CHPQA Guide Note 28. Available at: https://www.chpqa.com/guidance_notes/GUIDANCE_NOTE_28.pdf (accessed 21st March 2014).

4 Methodology

4.1 Overview

4.1.1 The main analysis comprises of four main waste management scenarios, all based on the assessment year of 2025/26 as follows:

a. Scenario A: landfill comparator. This models sending all residual waste collected by Constituent Boroughs to landfill, and represents a worst case scenario relative to the waste hierarchy in terms of management of the waste stream that the Applicant is responsible for.

b. Scenario B: current operations in 2025/26. This models sending residual waste collected by the Constituent Boroughs to the current EfW facility (540,000 tonnes or 94.26 per cent) as well as landfill (32,856 tonnes or 5.74 per cent), as per current operations but for the year 2025/26. Incinerator bottom ash (IBA) (including metals) from the EfW facility is recycled on-site and air pollution control residue (APCr) is stabilised before disposal in non-hazardous landfill.

c. Scenario C: future operations. This models sending all residual waste collected by the Constituent Boroughs to the new ERF, which would be operating in CHP mode with hot water being used as heat for a local heat distribution network. IBA (including metals) from the ERF would be recycled off-site, and APCr is stabilised before disposal in non-hazardous landfill.

d. Scenario D: alternative future operations. This models sending 50 per cent of residual waste (i.e. 286,428tpa) to landfill, and the other 50 per cent (i.e. 268,428tpa) of residual waste collected by the Constituent Boroughs to a materials recovery facility (MRF). It is assumed that the MRF extracts 90 per cent of ferrous and non-ferrous metals then shreds and bails the remaining 278,245 tonnes of waste into a low-density refuse derived fuel (RDF). This RDF is then exported to the Netherlands, where it is burnt for heat and power at the AEB EfW plant. The AEB EfW plant was selected as it is one of the largest merchant EfW plants in Europe, and it is an existing destination for RDF exported from the UK.

4.1.2 Scenarios A to D are outlined in Table 6.3 in Appendix A3. Four additional sensitivity analyses (1 to 4) for the main analysis were undertaken considering the effect of changing the following key modelling parameters:

a. Sensitivity Analysis 1: changing the NCV.

b. Sensitivity Analyses 2 and 3: changing the grid electricity mix to 2030 and 2035 respectively (against which energy generation in the scenario is offset).

c. Sensitivity Analysis 4: changing the amount of heat off-take from CHP for Scenario C to the CIF ‘tipping point’ (i.e. $12MW_{th}$).

4.1.3 Seven additional sensitivity analyses (5 to 11) for the main analysis were prepared considering the effect of changing the grid electricity mix. WRATE uses a baseline mix (against which electricity use for waste treatment e.g. the ERF is offset) and a marginal electricity mix (against which electricity production from waste treatment e.g. the ERF or landfill is offset). Both the baseline and marginal electricity mix were amended as follows:

a. Sensitivity Analyses 5, 6 and 7: changing the grid electricity mix to reflect the DECC reference scenario for 2025, 2030 and 2035 respectively.

b. Sensitivity Analyses 8, 9 and 10: changing the grid electricity mix to reflect the National Grid ‘gone green’ scenario for 2025, 2030 and 2035 respectively.

c. Sensitivity Analysis 11: changing the electricity mix to reflect the default WRATE electricity mix for Netherlands generation in 2012.

4.1.4 All sensitivity analyses are summarised in Table 4.1.

Table 4.1: Summary description of the main analysis and all sensitivity analyses

sensitivity	description
Main Analysis	The main analysis including waste management Scenarios A to D
Sensitivity 1: NCV	NCV of the residual waste was reverted back to the WRATE default for the given NLWA waste composition, which is 8.54MJ/kg
Sensitivity 2: electricity mix 2030	Changing the grid electricity mix to 2030 (WRATE default) for the UK
Sensitivity 3: electricity mix 2035	Changing the grid electricity mix to 2035 (WRATE default) for the UK
Sensitivity 4: CIF tipping point	Changing the amount of heat off-take from CHP for Scenario C to the CIF ‘tipping point’ (i.e. $12MW_{th}$)
Sensitivity 5: DECC electricity mix 2025	Changing the grid electricity mix to reflect the DECC reference scenario for 2025
Sensitivity 6: DECC electricity mix 2030	Changing the grid electricity mix to reflect the DECC reference scenario for 2030
Sensitivity 7: DECC electricity mix 2035	Changing the grid electricity mix to reflect the DECC reference scenario for 2035
Sensitivity 8: NG electricity mix 2025	Changing the grid electricity mix to reflect the National Grid ‘gone green’ scenario for 2025
Sensitivity 9: NG electricity mix 2030	Changing the grid electricity mix to reflect the National Grid ‘gone green’ scenario for 2030
Sensitivity 10: NG electricity mix 2035	Changing the grid electricity mix to reflect the National Grid ‘gone green’ scenario for 2035
Sensitivity 11: Netherlands electricity mix 2012	Changing the grid electricity mix to reflect the Netherlands (WRATE default) for 2012

4.1.5 All scenarios are described in more detail in Section 4.2 and modelling results are summarised in Table 4.2 and Table 4.3.

4.1.6 As stated above, the results in Table 4.2 are normalised using Eur.Person.Eq[12]. The WRATE modelling results shaded in red indicate the highest value for that indicator whereas results shaded in green indicate the lowest values. Lower values (including negative numbers) indicate a better net environmental performance. It can be seen that the future operations (Scenario C) of the proposed new ERF would have a significantly better

[12] Characterised results are also presented in Appendix A7. Characterised results are calculated for each environmental indicator with findings presented in an appropriate common unit (i.e. through use of a reference substance such as $kgCO_2e$ for Global Warming Potential).

potential environmental performance than any of the other scenarios across all indicators and sensitivity analyses. The landfill comparator (Scenario A) is the worst performing scenario.

Table 4.2: Summary of normalised WRATE results for analyses performed (Approach 1)

Analysis description	Scenario A: landfill comparator	Scenario B: current operations in 2025/26	Scenario C: future operations	Scenario D: alternative future operations	Scenario C relative to Scenario A
Global Warming Potential (Eur.Person.Eq)					
Main analysis	23,426	2,036	-12,585	8,180	-36,011
Sensitivity 1: NCV	23,426	3,602	-10,117	9,366	-33,543
Sensitivity 2: electricity mix 2030	23,260	1,110	-14,024	7,492	-37,284
Sensitivity 3: electricity mix 2035	22,801	-1,443	-17,993	5,609	-40,794
Sensitivity 4: CIF tipping point	23,426	2,036	-8,953	8,180	-32,379
Sensitivity 5: DECC electricity mix 2025	23,543	2,681	-11,581	8,646	-35,124
Sensitivity 6: DECC electricity mix 2030	23,646	3,241	-10,706	9,039	-34,352
Sensitivity 7: DECC electricity Mix 2035	23,646	3,229	-10,719	9,011	-34,365
Sensitivity 8: NG electricity mix 2025	25,265	12,239	3,284	15,687	-21,981
Sensitivity 9: NG electricity mix 2030	25,271	12,258	3,318	15,676	-21,953
Sensitivity 10: NG electricity mix 2035	25,273	12,264	3,329	15,669	-21,944
Sensitivity 11: Netherland electricity mix 2012	22,554	-2,614	-19,882	5,090	-42,436
Acidification Potential (Eur.Person.Eq)					
Main analysis	2,300	1,082	-4,371	-2,467	-6,671
Sensitivity 1: NCV	2,300	1,283	-4,054	-2,315	-6,354
Sensitivity 2: electricity mix 2030	2,237	734	-4,911	-2,724	-7,148
Sensitivity 3: electricity mix 2035	2,065	-223	-6,401	-3,426	-8,466
Sensitivity 4: CIF tipping point	2,300	1,082	-3,823	-2,467	-6,123
Sensitivity 5: DECC electricity mix 2025	2,344	1,325	-3,993	-2,292	-6,337
Sensitivity 6: DECC electricity mix 2030	2,383	1,536	-3,663	-2,142	-6,046
Sensitivity 7: DECC electricity mix 2035	2,383	1,534	-3,665	-2,146	-6,048
Sensitivity 8: NG electricity mix 2025	2,423	1,764	-3,309	-1,972	-5,732
Sensitivity 9: NG electricity mix 2030	2,433	1,814	-3,229	-1,943	-5,662
Sensitivity 10: NG electricity mix 2035	2,438	1,841	-3,187	-1,924	-5,625
Sensitivity 11: Netherland electricity mix 2012	1,874	-1,239	-7,996	-4,100	-9,870
Eutrophication Potential (Eur.Person.Eq)					
Main Analysis	6,086	1,782	-420	2,473	-6,506
Sensitivity 1: NCV	6,086	1,872	-278	2,541	-6,364
Sensitivity 2: Electricity mix 2030	6,077	1,731	-499	2,434	-6,576
Sensitivity 3: Electricity mix 2035	6,052	1,591	-716	2,331	-6,768
Sensitivity 4: CIF tipping point	6,086	1,782	-308	2,473	-6,394
Sensitivity 5: DECC electricity mix 2025	6,092	1,817	-365	2,499	-6,457
Sensitivity 6: DECC electricity mix 2030	6,098	1,847	-318	2,519	-6,416
Sensitivity 7: DECC electricity mix 2035	6,098	1,847	-319	2,517	-6,417
Sensitivity 8: NG electricity mix 2025	6,118	1,962	-140	2,605	-6,258
Sensitivity 9: NG electricity mix 2030	6,128	2,012	-61	2,640	-6,189
Sensitivity 10: NG electricity mix 2035	6,133	2,043	-13	2,662	-6,146

Analysis description	Scenario A: landfill comparator	Scenario B: current operations in 2025/26	Scenario C: future operations	Scenario D: alternative future operations	Scenario C relative to Scenario A
Sensitivity 11: Netherlands electricity mix 2012	5,958	1,089	-1,503	1,987	-7,461
Freshwater Aquatic Ecotoxicity Potential (Eur.Person.Eq)					
Main analysis	940	-10,190	-22,758	-18,903	-23,698
Sensitivity 1: NCV	940	-9,725	-22,025	-18,551	-22,965
Sensitivity 2: electricity mix 2030	941	-10,184	-22,747	-18,903	-23,688
Sensitivity 3: electricity mix 2035	946	-10,162	-22,712	-18,893	-23,658
Sensitivity 4: CIF tipping point	940	-10,190	-22,191	-18,903	-23,131
Sensitivity 5: DECC electricity mix 2025	939	-10,197	-22,768	-18,908	-23,707
Sensitivity 6: DECC electricity mix 2030	938	-10,205	-22,779	-18,918	-23,717
Sensitivity 7: DECC electricity mix 2035	938	-10,208	-22,783	-18,926	-23,721
Sensitivity 8: NG electricity mix 2025	1,210	-8,690	-20,425	-17,794	-21,635
Sensitivity 9: NG electricity mix 2030	1,211	-8,684	-20,416	-17,792	-21,627
Sensitivity 10: NG electricity mix 2035	1,209	-8,697	-20,435	-17,803	-21,644
Sensitivity 11: Netherlands electricity mix 2012	-1,570	-23,860	-44,106	-28,515	-42,536
Human Toxicity Potential (Eur.Person.Eq)					
Main analysis	493	-7,081	-16,221	-14,649	-16,714
Sensitivity 1: NCV	493	-6,908	-15,949	-14,517	-16,442
Sensitivity 2: electricity mix 2030	492	-7,087	-16,230	-14,655	-16,722
Sensitivity 3: electricity mix 2035	490	-7,102	-16,253	-14,668	-16,743
Sensitivity 4: CIF tipping point	493	-7,081	-15,874	-14,649	-16,367
Sensitivity 5: DECC electricity mix 2025	494	-7,078	-16,216	-14,646	-16,710
Sensitivity 6: DECC electricity mix 2030	494	-7,076	-16,213	-14,647	-16,707
Sensitivity 7: DECC electricity mix 2035	494	-7,077	-16,214	-14,650	-16,708
Sensitivity 8: NG electricity mix 2025	547	-6,778	-15,751	-14,423	-16,298
Sensitivity 9: NG electricity mix 2030	551	-6,757	-15,718	-14,409	-16,269
Sensitivity 10: NG electricity mix 2035	552	-6,754	-15,713	-14,407	-16,265
Sensitivity 11: Netherlands electricity mix 2012	404	-7,560	-16,972	-14,976	-17,376
Abiotic Resource Depletion Potential (Eur.Person.Eq)					
Main Analysis	-3,351	-33,578	-69,519	-29,046	-66,168
Sensitivity 1: NCV	-3,351	-29,233	-62,671	-25,755	-59,320
Sensitivity 2: electricity mix 2030	-3,772	-35,929	-73,171	-30,793	-69,399
Sensitivity 3: electricity mix 2035	-4,938	-42,409	-83,245	-35,579	-78,307
Sensitivity 4: CIF tipping point	-3,351	-33,578	-59,553	-29,046	-56,202
Sensitivity 5: DECC electricity mix 2025	-3,054	-31,943	-66,971	-27,864	-63,917
Sensitivity 6: DECC electricity mix 2030	-2,792	-30,522	-64,752	-26,869	-61,960
Sensitivity 7: DECC electricity mix 2035	-2,792	-30,553	-64,789	-26,946	-61,997
Sensitivity 8: NG electricity mix 2025	1,897	-4,461	-24,235	-7,622	-26,132
Sensitivity 9: NG electricity mix 2030	1,896	-4,503	-24,287	-7,717	-26,183
Sensitivity 10: NG electricity mix 2035	1,891	-4,546	-24,347	-7,778	-26,238
Sensitivity 11: Netherlands electricity mix 2012	-5,289	-43,845	-85,657	-35,742	-80,368

4.1.7 In Table 4.3, CIF modelling results shaded in red indicate that the CIF ($400gCO_2e/kWh$ upper limit) has been exceeded and results shaded in green indicate that the CIF is being met. It can be seen that the new ERF (Scenario C) would meet the CIF under all sensitivity analyses. Scenario D does not meet the CIF, which is due to the relatively low heat and power output of the AEB EfW plant in the Netherlands. It is also important to note that the CIF excludes the impact of sending waste to landfill in Scenario D. Current operations (Scenario B) would fail to meet the CIF in 2025/26. Sensitivity Analyses 5 to 11 (i.e. modelling alternative DECC, NG and the Netherlands electricity generation mixes) have not been modelled under Approach 2 as they would give the same results as Analyses 2 and 3. This is because the CIF does not take into account energy offset.

Table 4.3: Summary of performance against the CIF in gCO_2e/kWh (Approach 2)

Analyses description	Scenario A: landfill comparator	Scenario B: current operations in 2025/26	Scenario C: future operations	Scenario D: alternative future operations
Main analysis	n/a	708.7	301.7	502.5
Sensitivity 1: NCV	n/a	829.8	332.1	588.3
Sensitivity 2: electricity mix 2030	n/a	708.7	301.7	502.5
Sensitivity 3: electricity mix 2035	n/a	708.7	301.7	502.5
Sensitivity 4: CIF tipping point	n/a	708.7	399.6	502.5

4.2 Approach 1: WRATE

Scenario A: landfill comparator

4.2.1 Scenario A (see Figure 4.1) is a worst case scenario where 100 per cent of the 572,856 tonnes of residual waste is sent to landfill, using the proportions, transport processes and distances in Table 4.4 that reflect the same arrangement as residual waste sent to landfill under current operation (Scenario B).

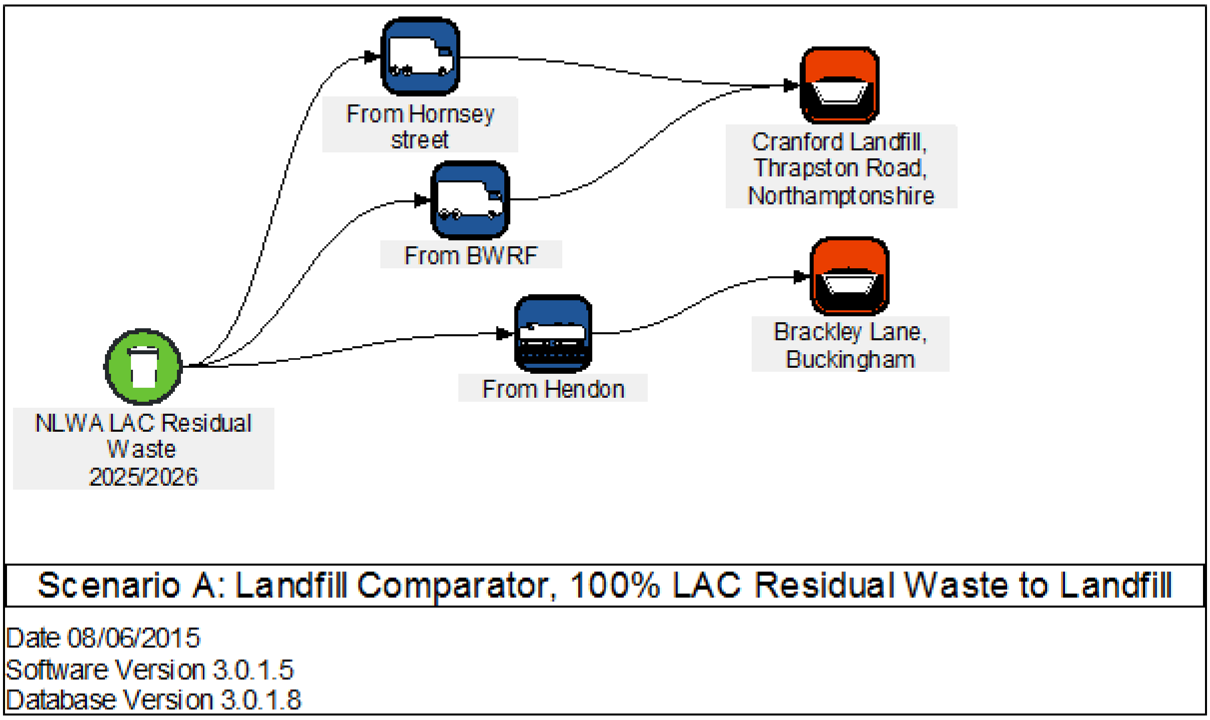


Figure 4.1: Schematic of Scenario A

4.2.2 In reality, residual waste is sent to a total of six different landfills via various routes, however for simplicity only the three main routes (and two landfills) were modelled as this accounts for over 97 per cent of waste to landfill (by weight) under current operation.

Table 4.4: Proportion and transport of waste to landfill

Origin	Tonnes (% of total)	Transport process (process ID)	A to B transport distance	Road split	Destination
From Hornsey Street	60,379 tonnes (10.54%)	Intermodal road transport v3 (ID#12026)	128km	Urban:33%, Rural: 33%, Motorway: 34%	Cranford Landfill
From Edmonton EcoPark BWRF	122,649 tonnes (21.41%)	Intermodal road transport v3 (ID#12026)	130km	Urban:33%, Rural: 33%, Motorway: 34%	Cranford Landfill
From Hendon	389,829 tonnes (68.05%)	Rail transport (ID#12072)	96km	N/A	Brackley Lane Landfill

4.2.3 Table 4.5 shows the modelling parameters used for the two landfills. It is unknown what the landfill gas (LFG) collection efficiency is at each site, therefore 50 per cent has been assumed as a reasonably conservative collection efficiency.

Table 4.5: Modelling parameters for landfill

Landfill	Process	Liner and cap type	Energy recovery
Cranford Landfill	Flexible landfill 5,000,000 tonnes (ID#11256)	Liner: Clay, Cap: HDPE (High Density Polyethylene)	Energy recovery from LFG at 50% gas collection efficiency
Brackley Lane Landfill	Flexible landfill 5,000,000 tonnes (ID#11256)	Liner: Clay, Cap: Clay	Energy recovery from LFG at 50% gas collection efficiency

Scenario B: Current operations in 2025/26

4.2.4 Scenario B (Figure 4.2) represents the current operation of the existing EfW facility at the Edmonton EcoPark in the year 2025/26. A total of 540,000 tonnes of waste is sent to the current EfW facility, with the remainder (i.e. 32,856 tonnes) sent to landfill. The landfill and associated transport is the same as per Scenario A, with the same proportions of waste. The current EfW facility is modelled using a user defined process (UDP) based on the default ‘Flexible Energy from Waste Process V3’ (ID#21849). The gross power efficiency has been set at 19.5 per cent (as a midpoint between the typical operating range of 19 to 20 per cent) resulting in a net power output of around 33MW_e. The flue gas cleaning system has been modelled as dry (the best fit for the ‘semi-dry’ system in use) and the reduction type as selective non-catalytic reduction.

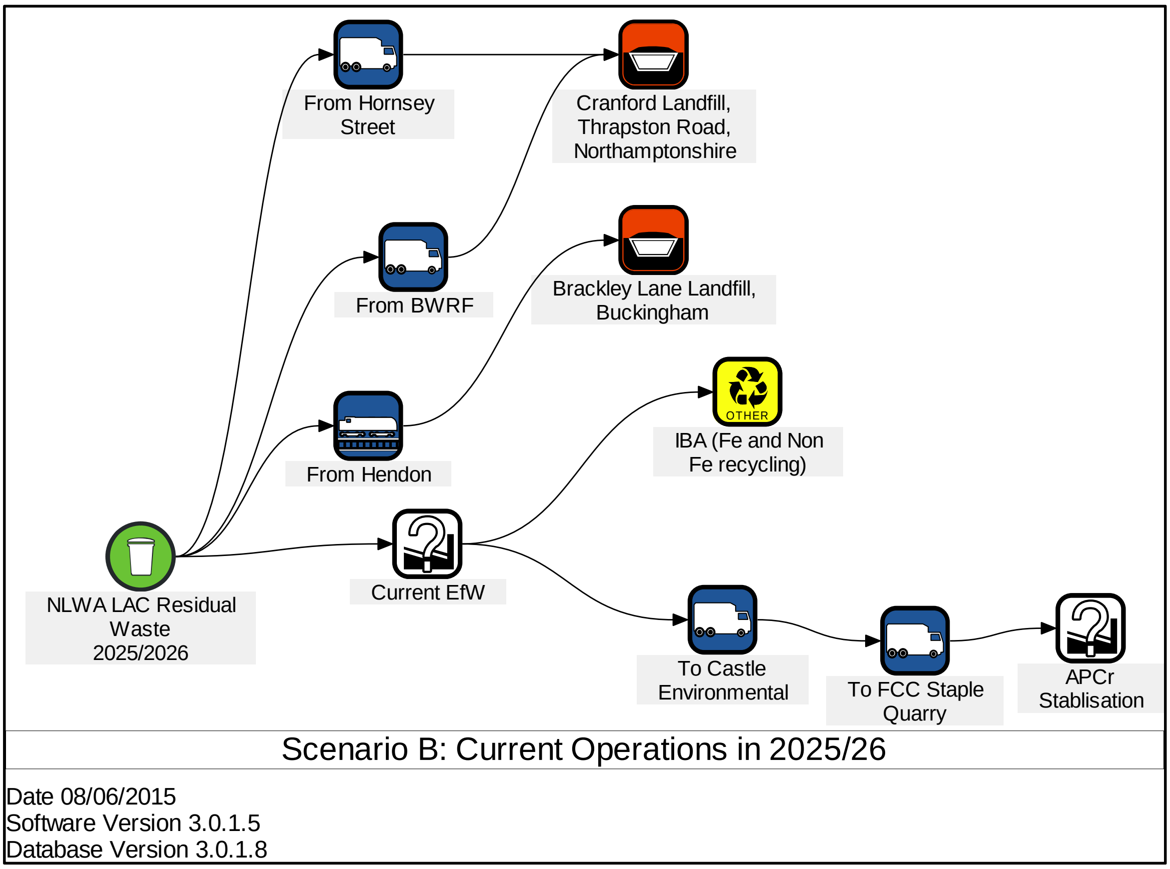


Figure 4.2: Schematic of Scenario B

4.2.5 The allocation rules for IBA, ferrous and non-ferrous metal IBA as well as APCr have also been amended to reflect current performance as shown in Table 4.6, where process waste outputs from the current EfW facility have been scaled from current mass balance data for 2013/14 according to the predicted tonnage of waste that would be incinerated in 2025/26 (a factor of 1.011).

Table 4.6: Waste process outputs from the current EfW

Waste process output from EfW	**2013/14 total (tonnes)**	**2025/26 proportioned (tonnes)**
IBA (net of metal)	74,756	75,596
Ferrous IBA	9,946	9,084[13]
Non-ferrous IBA	3,170	3,135
APCr	17,985	18,817

[13] If using the same pro-rata as the other waste process outputs the ferrous metal should be 10,058 tonnes. However, only 10,094 tonnes of ferrous metal enters the EfW facility with the given waste composition, which would be a capture rate of 99.6 per cent. Therefore there is a mismatch, probably due to additional, non-NLWA waste entering the EfW having a higher ferrous metal content or pre-sorting of waste that is not being taken into account. A 90 per cent capture rate has been assumed as a realistic (maximum) assumption resulting in 9,084 tonnes of ferrous metal in IBA.

4.2.6 As the current EfW facility does not collect any metal at the grate, all ferrous and non-ferrous metal capture is assumed to be via IBA processing.

4.2.7 All other EfW process parameters reflect the default WRATE process.

4.2.8 As there is no default WRATE process that models APCr recycling/stabilisation, APCr stabilisation is modelled using a UDP based on a 'waste minimisation' process, where the restriction on sending APCr to such a process has been removed. This process essentially removes the APCr from the model without any associated impact. Therefore the only impacts associated with the APCr stabilisation are the transport impacts to Castle Environmental and FCC Staple Quarry. This is a reasonable assumption as the alternative would be to send all APCr to hazardous landfill, which would result in a reduced environmental performance[14]. The transport is modelled 'before' the APCr stabilisation as WRATE does not allow onward transport from a waste minimisation process.

4.2.9 Refer to Table 6.3 to Table 6.7 in Appendix A3 for more information on the parameters used as well as the mass and energy balance.

Scenario C: Future operations

4.2.10 Scenario C (Figure 4.3) reflects future operations where all residual waste would be treated at the new ERF. The new ERF is modelled using a UDP based on the 'Flexible Energy from Waste Process v3'. Net heat and power efficiencies have been amended to 17.09 per cent and 25.71 per cent respectively. Under this scenario, $34MW_{th}$ would be provided to a local domestic heat distribution network with a corresponding $57MW_e$ of power output. Nitrous Oxide (NO_x) emissions have been amended to reflect a proposed environmental permit limit of $80mg/Nm^3$. All other emissions to air reflect the default process data and allocation when selective catalytic reduction and a wet flue gas treatment system is in place.

[14] A check was modelled in WRATE, and APCr sent to landfill does not result in any change in environmental performance with regards to global warming potential. However APCr sent to landfill within WRATE does result in a small reduction in environmental performance in relation to eutrophication potential, freshwater aquatic ecotoxicity potential and human toxicity potential. As WRATE models APCr as hazardous by default, and the APCr is stabilised to be non-hazardous in Scenario B and C before disposal to non-hazardous landfill, it is reasonable to model APCr via waste minimisation.

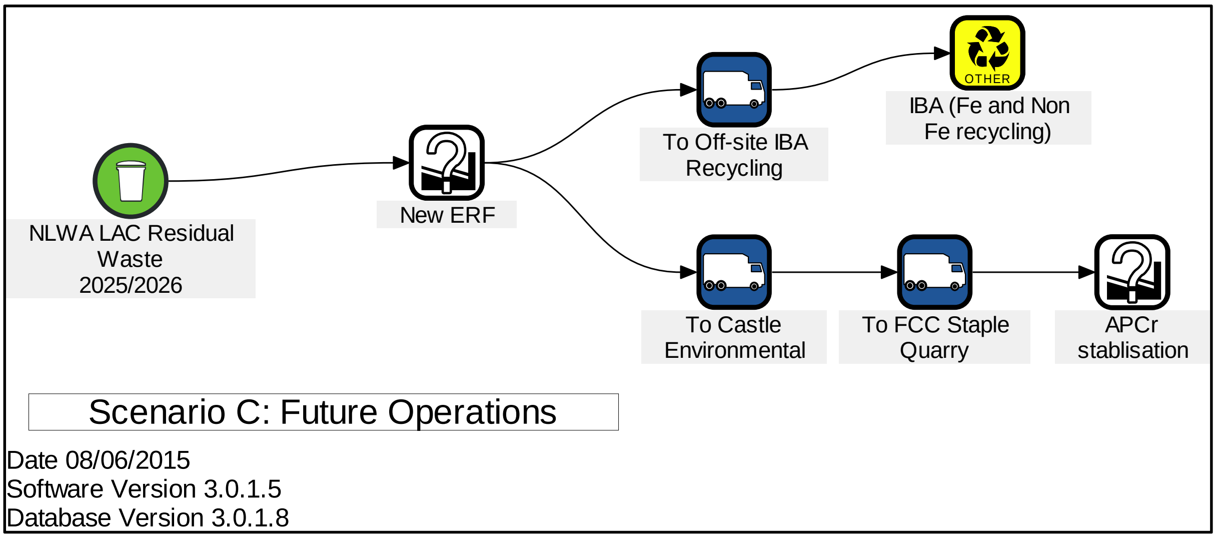


Figure 4.3: Schematic of Scenario C

4.2.11 All other ERF process parameters reflect the default WRATE process.

4.2.12 IBA recycling, including ferrous and non-ferrous metals, would take place off-site during future operation. It has been assumed this would be a maximum of 40km from the ERF. Intermodal road transport (ID#12026) and a road split of 33:33:34, Urban:Rural:Motorway has been assumed.

4.2.13 The APCr management is modelled as per Scenario B.

4.2.14 Refer to Table 6.3 to Table 6.7 in Appendix A3 for more information on the parameters used as well as the mass and energy balance.

Scenario D: Alternative future operations

4.2.15 In Scenario D (Figure 4.4), 50 per cent of all waste is sent to landfill (using the same proportions of waste to landfill and associated transport as Scenario B). The other 50 per cent of all waste is sent to a MRF. A UDP based on the 'MRF – RDF for cement kiln/gasifier/pyrolysis process ID# 12305' was created, and the allocation rules for metal capture (set at 90 per cent) were amended. Extracted metals are sent to metal recycling (assumed on-site). In addition, the allocation for RDF was amended so that all the remaining waste (minus 90 per cent of metals) is bailed into a low-density RDF[15]. This RDF is exported to the Netherlands, where it is burnt for heat and power at the AEB EfW plant. Road transport of 55km (using Intermodal road transport v3 (ID#12026)) from the Edmonton EcoPark (it is assumed the MRF would be co-located with the current EfW) to Gravesend Port has been assumed. The RDF is then shipped (using sea container transport (ID#21291)) 300km direct to Amsterdam port (i.e. the AEB EfW plant is located within the port).

[15] This should result in a change of NCV from 10MJ/kg to 10.28MJ/kg, as metal extraction accounts for 2.85 per cent of the waste by weight, but has no calorific value. WRATE calculates the RDF NCV as 10.43MJ/kg, however the basis of this adjustment is not known. As this is a minor difference and the NCV cannot be changed within WRATE, 10.34MJ/kg has been used.

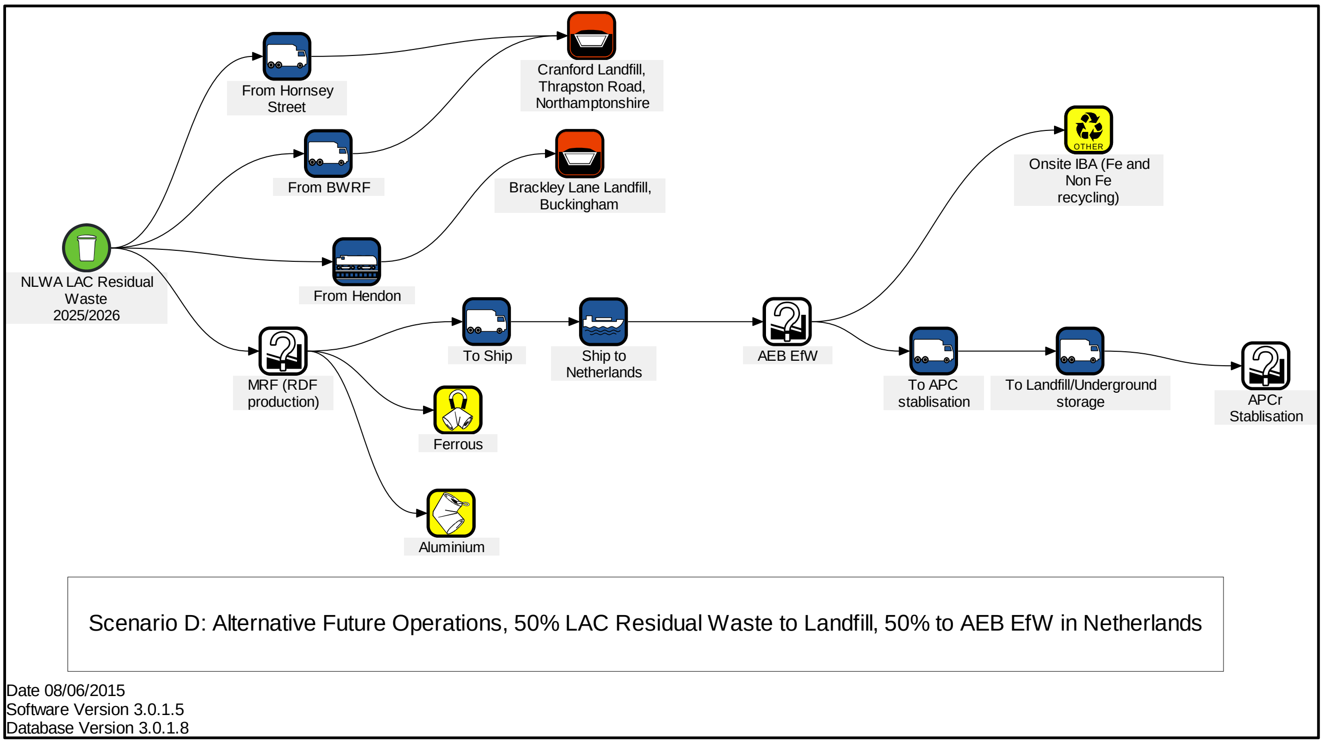


Figure 4.4: Schematic of Scenario D

4.2.16 To model the AEB EfW plant, a UDP was created based on the 'flexible energy from waste process v3'. Net heat efficiency was amended to 4.02 per cent and net power efficiency was amended to 24.68 per cent[16], resulting in 23.6MW$_e$ and 3.36MW$_{th}$ being generated respectively.

4.2.17 NO_x emissions have been amended to reflect 2013 operational data of 64mg/Nm^3. IBA output has been amended to reflect 2013 operational data. Metals in IBA are as per the standard process. All other emissions to air reflect the default process data and allocation when selective catalytic reduction and a wet flue gas treatment system are in operation.

4.2.18 All other AEB EfW process parameters and allocations reflect the default WRATE process.

4.2.19 Refer to Table 6.3 to Table 6.7 in Appendix A3 for more information on the parameters used as well as the mass and energy balance.

Sensitivity Analyses

4.2.20 As stated in Section 4.1, additional WRATE models were created to assess the effect of changing key parameters, as follows:

a. analyses A.1, B.1, C.1 and D.1 where the NCV of the residual waste was reverted back to the WRATE default for the given waste composition, which is 8.54MJ/kg;

b. analyses A.2, B.2, B.2 and D.2 where the electricity generation mix was set to 2030 (WRATE UK default);

[16] Derived from AEB HRC operational data for 2013, including an overall net efficiency of 24.50 per cent, available from the AEB website: http://www.aebduurzaamheidsverslag2013.nl/english/cijfers/key-statistics/ (Accessed 9th June 2015).

c. analyses A.3, B.3, C.3 and D.3 where the electricity generation mix was set to 2035[17] (WRATE UK default); and

d. analyses A.4, B.4, C.4 and D.4 where the heat output was changed to $12MW_{th}$[18] as the 'tipping point' where Scenario C would no longer meet the CIF with any less heat output.

4.2.21 Refer to Table 6.3 to Table 6.7 in Appendix A3 for more information on the parameters used as well as the mass and energy balance. Refer to Appendix A4 for the default UK WRATE electricity mixes.

Electricity generation mix sensitivity analyses

4.2.22 Six additional electricity generation mix sensitivity analyses were also modelled to assess how this may affect the environmental performance.

a. Analyses A.5 to A.7, B.5 to B.7, C.5 to C.7 and D.5 to D.7 where the baseline and marginal electricity mix were changed to reflect the DECC reference scenario. Due to differences in the WRATE and DECC electricity source categorisation, it has been assumed that coal and gas with carbon capture and storage (CCS) as well as natural gas in the DECC projection is equivalent to combined cycle gas turbine (CCGT) electricity generation in WRATE. The relative proportion of types of renewable electricity generation was kept the same as the WRATE default, but the overall percentage of renewables was amended to reflect the DECC scenario. The DECC projection was modelled in order to represent a less carbon intensive future projection (i.e. less electricity generation from coal compared to the default WRATE electricity mix).

b. Analyses A.8 to A.10, B.8 to B.10, C.8 to C.10 and D.8 to D.10 where the baseline electricity mix was changed to reflect the National Grid 'gone green' scenario. Due to differences in the WRATE and NG electricity source categorisation, it has been assumed that coal and gas with CCS and natural gas is equivalent to CCGT electricity generation in WRATE. The marginal mix was changed to reflect the proportions of renewables in the 'gone green' scenario. The NG projection was modelled as it is thought to represent the most optimistic scenario in terms of renewable energy for the future electricity generation mix, and would therefore represent the smallest carbon offset relative to the new ERF, which is a conservative assumption.

c. Analyses A.11, B.11, C.11 and D.11 where the baseline and marginal mix were changed to the default WRATE mix for the Netherlands in 2012 (the most recent year available), as the AEB EfW plant is located in Amsterdam and would therefore offset against a Netherlands grid electricity mix.

4.2.23 Refer to Table 6.3 to Table 6.7 in Appendix A3 for more information on the parameters used as well as the mass and energy balance. Refer to

[17] 2035 is the furthest year into the future that WRATE includes a projected electricity mix for. At the time of writing and as far as Arup are aware, there are no published projections for electricity mix past the year 2035 available from any other established sources (e.g. DECC).

[18] This has decreased from the previously identified 'tipping point' of $17MW_{th}$ in the previous work as the modelling parameters (e.g. tonnage decrease) have changed.

Appendices A4, A5 and A6 for the Netherlands, DECC and NG energy mixes.

4.3 Approach 2: Mayor of London GHG Calculator

4.3.1 The second modelling approach used the Mayor of London's GHG Calculator for municipal solid waste (v2.1)[19] to model all the Scenarios outlined in Section 2.2, with the exception of Scenario A (as landfill and transport emissions are not included in the CIF calculation so benchmarking against the CIF is not applicable. Also the CIF does not take into account any offset for energy generation, therefore sensitivity analyses 2, 3 and 5 to 11 have the same results as the main analysis.

The GHG Calculator is a MS Excel spreadsheet tool that has been developed to assist London local authorities in assessing GHG emissions when procuring new waste services. Using this tool on the Applicants behalf, all the scenarios were modelled by inputting waste tonnage, waste composition, and gross efficiencies for electricity and heat generation (see Table 6.3 to Table 6.7 in Appendix A3) under the 'incineration process'. NCV was user defined, based on Table 6.1 in Appendix A2.

[19] Available on the Greater London Authority website at: http://www.london.gov.uk/priorities/environment/putting-waste-good-use/making-the-most-of-waste (accessed 21st March 2014).

5 Modelling results

5.1 Overview

5.1.1 All modelling results from Approaches 1 and 2 are provided in Table 6.18 to in Appendix A7, discussed in Sections 5.2 and 5.3.

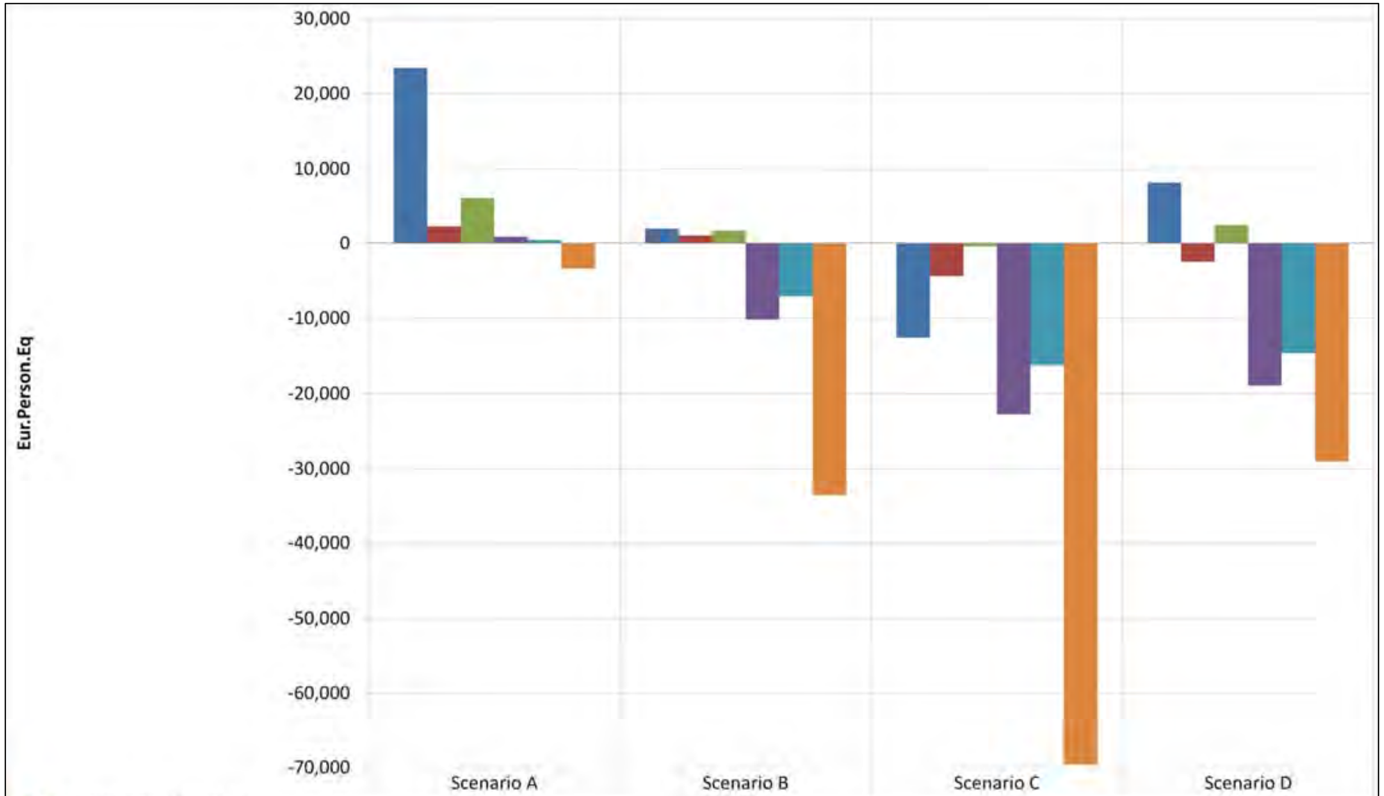
5.2 Environmental indicators (Approach 1)

Main analysis (Approach 1)

5.2.1 The six default environmental indicators are described in Section 2.1.4.

5.2.2 As stated in Section 2.1, negative results represent an avoided (or displaced) impact, and therefore a benefit, whereas positive results represent a created impact, and therefore a dis-benefit. Therefore negative results represent a net improved environmental performance, and positive results represent a net reduced environmental performance. Figure 5.1 shows the environmental indicators for the main analysis Scenarios (A to D), normalised so that they all represent the same unit of a European Person Equivalent (the functional unit being the impact one 'European Person' would have over the course of a year) and therefore compared to each other. The environmental indicators are also in their characterised form (e.g. kgCO_2e for GWP) in Appendix A7.

5.2.3 It can be seen from Figure 5.1 that the future operations (Scenario C) has the best potential environmental performance across all six environmental indicators when compared with the other three scenarios (a negative result indicates a lower potential environmental impact from its operation).



	Scenario A	Scenario B	Scenario C	Scenario D
Global Warming Potential	23,426	2,036	-12,585	8,180
Acidification Potential	2,300	1,082	-4,371	-2,467
Eutrophication Potential	6,086	1,782	-420	2,473
Freshwater Aquatic Ecotoxicity Potential	940	-10,190	-22,758	-18,903
Human Toxicity Potential	493	-7,081	-16,221	-14,649
Abiotic Resource Depletion Potential	-3,351	-33,578	-69,519	-29,046

Figure 5.1: Normalised environmental indicators for scenarios A to D (main analysis)

5.2.4 In Figure 5.2, it can be seen that the improved environmental performance of future operations (Scenario C) is due to treatment and recovery of waste (i.e. the ERF is offsetting heat and electricity production against the national electricity grid) and recycling (i.e. IBA recovery offsetting virgin material production).

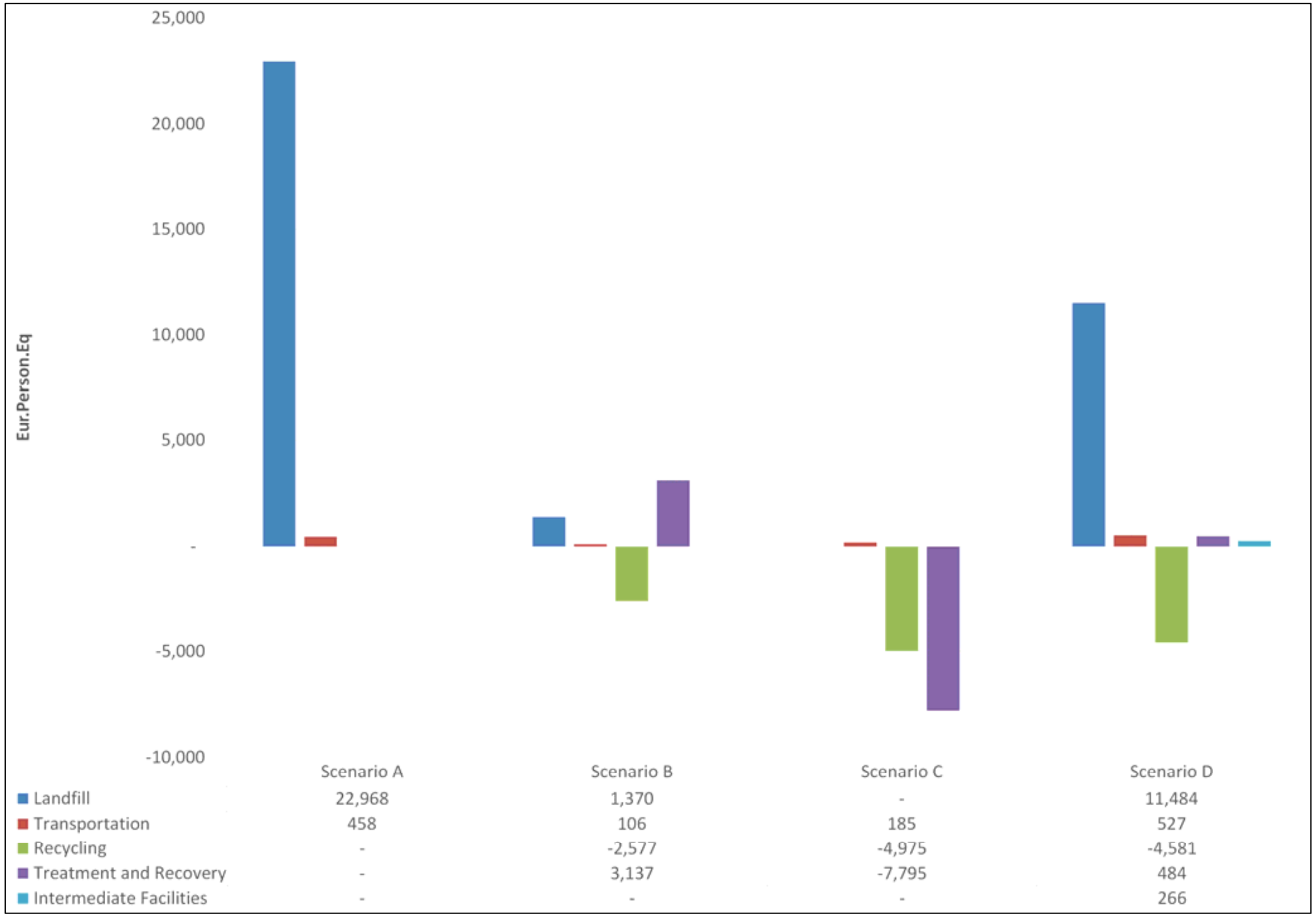


Figure 5.2: Normalised global warming potential indicator for scenarios A to D (main analysis)

5.2.5 Table 5.1 shows that relative to sending all waste to landfill (Scenario A) and current operation in 2025/26 (Scenario B), the future operations (Scenario C) of the proposed new ERF would be a relative positive impact of -36,011 or -14,621 Eur.Person.Eq for global warming potential (main analysis). This is due to the heat offset of the new ERF as well as the diversion of residual waste from landfill.

5.2.6 The other environmental indicators also all show a relative improved environmental performance for future operation (Scenario C). This reflects avoided resource use through displacement of virgin materials through recycling and displacing NG electricity generation (including fossil fuel use for energy) as well as avoided emissions and effluents from landfill, grid energy generation and virgin material manufacture.

Table 5.1: Normalised environmental indicators for Scenarios A to D (Eur.Person.Eq) (Year=2025)

Indicator	Scenario A	Scenario B	Scenario C	Scenario D	C relative to A	C relative to B	C relative to D
Global warming potential	23,426	2,036	-12,585	8,180	-36,011	-14,621	-20,765
Acidification potential	2,300	1,082	-4,371	-2,467	-6,671	-5,453	-1,904
Eutrophication potential	6,086	1,782	-420	2,473	-6,506	-2,202	-2,893
Freshwater aquatic ecotoxicity potential	940	-10,190	-22,758	-18,903	-23,698	-12,568	-3,855
Human toxicity potential	493	-7,081	-16,221	-14,649	-16,714	-9,140	-1,572
Abiotic resource depletion potential	-3,351	-33,578	-69,519	-29,046	-66,168	-35,941	-40,473

Sensitivity Analyses 1 to 4 (Approach 1)

5.2.7 Under Sensitivity Analysis 1 (Table 5.2) where the NCV is changed to 8.54 MJ/kg it can be seen that relative to the other scenarios, Scenario C (future operations) still has the largest negative impacts, and therefore the best potential environmental performance. The reduced negative impact of Scenario C (future operations) compared to the main analysis is due to reduced displacement against fossil fuel energy generation as less energy is generated.

Table 5.2: Normalised environmental indicators for Scenarios A.1, B.1, C.1 and D.1 (Eur.Person.Eq) (Year=2025)

Indicator	Scenario A.1	Scenario B.1	Scenario C.1	Scenario D.1	C.1 relative to A.1	C.1 relative to B.1	C.1 relative to D.1
Global warming potential	23,426	3,602	-10,117	9,366	-33,543	-13,719	-19,483
Acidification potential	2,300	1,283	-4,054	-2,315	-6,354	-5,337	-1,739
Eutrophication potential	6,086	1,872	-278	2,541	-6,364	-2,150	-2,819
Freshwater aquatic ecotoxicity potential	940	-9,725	-22,025	-18,551	-22,965	-12,300	-3,474
Human toxicity potential	493	-6,908	-15,949	-14,517	-16,442	-9,041	-1,432
Abiotic resource depletion potential	-3,351	-29,233	-62,671	-25,755	-59,320	-33,438	-36,916

5.2.8 Under Sensitivity Analysis 2 (Table 5.3) and 3 (Table 5.4), where the electricity mix was changed to 2030 and 2035 respectively, it can be seen that the negative impact (and therefore improved environmental performance) of Scenario C (future operations) increases with regard to the global warming impact, reflecting the projected increase of more carbon intensive coal generation in the marginal WRATE mix (refer to Table 6.8, and Table 6.10 in Appendix A4 for projected electricity mixes) for electricity generation.

5.2.9 All other environmental indicators also have an increased negative impact and therefore improved environmental performance.

Table 5.3: Normalised environmental indicators for Scenarios A.2, B.2, C.2 and D.2 (Eur.Person.Eq) (Year=2030)

Indicator	Scenario A.2	Scenario B.2	Scenario C.2	Scenario D.2	C.2 relative to A.2	C.2 relative to B.2	C.2 relative to D.2
Global warming potential	23,260	1,110	-14,024	7,492	-37,284	-15,134	-21,516
Acidification potential	2,237	734	-4,911	-2,724	-7,148	-5,645	-2,187
Eutrophication potential	6,077	1,731	-499	2,434	-6,576	-2,230	-2,933
Freshwater aquatic ecotoxicity potential	941	-10,184	-22,747	-18,903	-23,688	-12,563	-3,844
Human toxicity potential	492	-7,087	-16,230	-14,655	-16,722	-9,143	-1,575
Abiotic resource depletion potential	-3,772	-35,929	-73,171	-30,793	-69,399	-37,242	-42,378

Table 5.4: Normalised environmental indicators for Scenarios A.3, B.3, C.3 and D.3 (Eur.Person.Eq) (Year=2035)

Indicator	Scenario A.3	Scenario B.3	Scenario C.3	Scenario D.3	C.3 relative to A.3	C.3 relative to B.3	C.3 relative to D.3
Global warming potential	22,801	-1,443	-17,993	5,609	-40,794	-16,550	-23,602
Acidification potential	2,065	-223	-6,401	-3,426	-8,466	-6,178	-2,975
Eutrophication potential	6,052	1,591	-716	2,331	-6,768	-2,307	-3,047
Freshwater aquatic ecotoxicity potential	946	-10,162	-22,712	-18,893	-23,658	-12,550	-3,819
Human toxicity potential	490	-7,102	-16,253	-14,668	-16,743	-9,151	-1,585
Abiotic resource depletion potential	-4,938	-42,409	-83,245	-35,579	-78,307	-40,836	-47,666

5.2.10 Under Sensitivity Analysis 4 (i.e. a reduction of heat output to the CIF tipping point of $12MW_{th}$) in Table 5.5, it can be seen that relative to the landfill comparator (Scenario A) and current operations (Scenario B), the magnitude of the negative impact of the future operations (Scenario C) decreases relative to the main analysis, although it still has an environmental performance benefit across all environmental indicators. This reflects the decreased heat displacement against grid energy generation.

Table 5.5: Normalised environmental indicators for Scenarios A.4, B.4, C.4 and D.4 (Eur.Person.Eq) (Year=2025)

Indicator	Scenario A.4	Scenario B.4	Scenario C.4	Scenario D.4	C.4 relative to A.4	C.4 relative to B.4	C.4 relative to D.4
Global warming potential	23,426	2,036	-8,953	8,180	-32,379	-10,989	-17,133
Acidification potential	2,300	1,082	-3,823	-2,467	-6,123	-4,905	-1,356
Eutrophication potential	6,086	1,782	-308	2,473	-6,394	-2,090	-2,781
Freshwater aquatic ecotoxicity Potential	940	-10,190	-22,191	-18,903	-23,131	-12,001	-3,288
Human toxicity potential	493	-7,081	-15,874	-14,649	-16,367	-8,793	-1,225
Abiotic resource depletion potential	-3,351	-33,578	-59,553	-29,046	-56,202	-25,975	-30,507

Sensitivity Analyses 5 to 11 (Approach 1)

DECC reference scenario (Sensitivity Analyses 5 to 7)

5.2.11 Sensitivity Analyses 5 to 7 are used to represent changes made in the WRATE model, which reflect the DECC reference electricity mix for the years 2025, 2030 and 2035 respectively (i.e. a lower proportion of coal generation in the electricity mix relative to the main analysis).

5.2.12 Table 5.6, Table 5.7 and Table 5.8 show the modelling results for Sensitivity Analyses 5 to 7.

5.2.13 In Table 5.6 it can be seen that the negative impact of future operations (Scenario C) has decreased slightly compared to the main analysis across all environmental indicators, and therefore there is a reduced environmental performance benefit. This is due the lower proportion of electricity generation from coal (3.7 per cent compared to the default WRATE value of 8.1 per cent) and higher proportion of less carbon intensive CCGT electricity generation (96.2 per cent compared to the default WRATE value of 91.9 per cent), meaning that a less carbon intensive electricity mix is being offset against.

Table 5.6: Normalised environmental indicators for Scenarios A.5, B.5, C.5 and D.5 (Eur.Person.Eq) (Year=2025)

Indicator	Scenario A.5	Scenario B.5	Scenario C.5	Scenario D.5	C.5 relative to A.5	C.5 relative to B.5	C.5 relative to D.5
Global warming potential	23,543	2,681	-11,581	8,646	-35,124	-14,262	-20,227
Acidification potential	2,344	1,325	-3,993	-2,292	-6,337	-5,318	-1,701
Eutrophication potential	6,092	1,817	-365	2,499	-6,457	-2,182	-2,864

Indicator	Scenario A.5	Scenario B.5	Scenario C.5	Scenario D.5	C.5 relative to A.5	C.5 relative to B.5	C.5 relative to D.5
Freshwater aquatic ecotoxicity potential	939	-10,197	-22,768	-18,908	-23,707	-12,571	-3,860
Human toxicity potential	494	-7,078	-16,216	-14,646	-16,710	-9,138	-1,570
Abiotic resource depletion potential	-3,054	-31,943	-66,971	-27,864	-63,917	-35,028	-39,107

5.2.14 Table 5.7 shows that the negative impact of global warming potential, and therefore the environmental performance benefit, has decreased relative to the 2025 DECC electricity mix in Table 5.6. This reflects the marginal mix becoming less carbon intensive, with an increase in electricity generation using CCGT, and a decrease in electricity generation using coal.

Table 5.7: Normalised environmental indicators for Scenarios A.6, B.6, C.6 and D.6 (Eur.Person.Eq) (Year=2030)

Indicator	Scenario A.6	Scenario B.6	Scenario C.6	Scenario D.6	C.6 relative to A.6	C.6 relative to B.6	C.6 relative to D.6
Global warming potential	23,646	3,241	-10,706	9,039	-34,352	-13,947	-19,745
Acidification potential	2,383	1,536	-3,663	-2,142	-6,046	-5,199	-1,521
Eutrophication potential	6,098	1,847	-318	2,519	-6,416	-2,165	-2,837
Freshwater aquatic ecotoxicity potential	938	-10,205	-22,779	-18,918	-23,717	-12,574	-3,861
Human toxicity potential	494	-7,076	-16,213	-14,647	-16,707	-9,137	-1,566
Abiotic resource depletion potential	-2,792	-30,522	-64,752	-26,869	-61,960	-34,230	-37,883

5.2.15 Table 5.8 shows an increased positive impact of the global warming indicator for future operations (Scenario C), and therefore a slightly reduced environmental performance benefit. This is likely to be due to changes in the baseline mix, as the marginal electricity mix is the same (100 per cent CCGT electricity generation) as 2030.

Table 5.8: Normalised environmental indicators for Scenarios A.7, B.7, C.7 and D.7 (Eur.Person.Eq) (Year=2035)

Indicator	Scenario A.7	Scenario B.7	Scenario C.7	Scenario D.7	C.7 relative to A.7	C.7 relative to B.7	C.7 relative to D.7
Global Warming Potential	23,646	3,229	-10,719	9,011	-34,365	-13,948	-19,730
Acidification Potential	2,383	1,534	-3,665	-2,146	-6,048	-5,199	-1,519
Eutrophication Potential	6,098	1,847	-319	2,517	-6,417	-2,166	-2,836
Freshwater Aquatic Ecotoxicity Potential	938	-10,208	-22,783	-18,926	-23,721	-12,575	-3,857
Human Toxicity Potential	494	-7,077	-16,214	-14,650	-16,708	-9,137	-1,564
Abiotic Resource Depletion Potential	-2,792	-30,553	-64,789	-26,946	-61,997	-34,236	-37,843

National Grid 'gone green' scenario (Sensitivity Analyses 8 to 10)

5.2.16 Sensitivity Analyses 8 to 10 are used to represent changes made in the WRATE model, which reflect the National Grid 'gone green' electricity mix projection for the years 2025, 2030 and 2035 respectively (i.e. offsetting against only renewable sources of electricity in the marginal electricity mix).

5.2.17 Table 5.9, Table 5.10 and Table 5.11 show the modelling results for Sensitivity Analyses 8 to 10.

5.2.18 In Table 5.9, it can be seen that the positive impact of future operations has increased compared to the main analysis across all environmental indicators, which shows that the environmental performance benefit has decreased. This reflects the less carbon intensive, optimistic 'greener' renewable energy mix that is being offset against. However, relative to landfill (Scenario A), future operations (Scenario C) still has an environmental performance benefit across all environmental indicators.

Table 5.9: Normalised environmental indicators for Scenarios A.8, B.8, C.8 and D.8 (Eur.Person.Eq) (Year=2025)

Indicator	Scenario A.8	Scenario B.8	Scenario C.8	Scenario D.8	C.8 relative to A.8	C.8 relative to B.8	C.8 relative to D.8
Global Warming Potential	25,265	12,239	3,284	15,687	-21,981	-8,955	-12,403
Acidification potential	2,423	1,764	-3,309	-1,972	-5,732	-5,073	-1,337
Eutrophication potential	6,118	1,962	-140	2,605	-6,258	-2,102	-2,745
Freshwater aquatic ecotoxicity	1,210	-8,690	-20,425	-17,794	-21,635	-11,735	-2,631

Indicator	Scenario A.8	Scenario B.8	Scenario C.8	Scenario D.8	C.8 relative to A.8	C.8 relative to B.8	C.8 relative to D.8
Potential							
Human toxicity potential	547	-6,778	-15,751	-14,423	-16,298	-8,973	-1,328
Abiotic resource depletion potential	1,897	-4,461	-24,235	-7,622	-26,132	-19,774	-16,613

5.2.19 In Table 5.10, it can be seen that the environmental performance of future operations (Scenario C) has decreased slightly in 2030, reflecting a change in renewable electricity generation in the marginal electricity mix. Relative to landfill (Scenario A), future operations still has an environmental performance benefit across all indicators.

Table 5.10: Normalised environmental indicators for Scenarios A.9, B.9, C.9, D.9 (Eur.Person.Eq) (Year=2030)

Indicator	Scenario A.9	Scenario B.9	Scenario C.9	Scenario D.9	C.9 relative to A.9	C.9 relative to B.9	C.9 relative to D.9
Global warming potential	25,271	12,258	3,318	15,676	-21,953	-8,940	-12,358
Acidification potential	2,433	1,814	-3,229	-1,943	-5,662	-5,043	-1,286
Eutrophication potential	6,128	2,012	-61	2,640	-6,189	-2,073	-2,701
Freshwater aquatic ecotoxicity potential	1,211	-8,684	-20,416	-17,792	-21,627	-11,732	-2,624
Human toxicity potential	551	-6,757	-15,718	-14,409	-16,269	-8,961	-1,309
Abiotic resource depletion potential	1,896	-4,503	-24,287	-7,717	-26,183	-19,784	-16,570

5.2.20 In Table 5.11, it can be seen that the environmental performance of future operations (Scenario C) has decreased slightly in 2035, reflecting the change in renewable electricity generation in the marginal electricity mix. Relative to landfill (Scenario A), future operations still has an environmental performance benefit across all indicators.

Table 5.11: Normalised environmental indicators for Scenarios A.10, B.10, C.10 and D.10

Indicator	Scenario A.10	Scenario B.10	Scenario C.10	Scenario D.10	C.10 relative to A.10	C.10 relative to B.10	C.10 relative to D.10
Global warming potential	25,273	12,264	3,329	15,669	-21,944	-8,935	-12,340
Acidification potential	2,438	1,841	-3,187	-1,924	-5,625	-5,028	-1,263
Eutrophication potential	6,133	2,043	-13	2,662	-6,146	-2,056	-2,675
Freshwater aquatic ecotoxicity potential	1,209	-8,697	-20,435	-17,803	-21,644	-11,738	-2,632
Human toxicity potential	552	-6,754	-15,713	-14,407	-16,265	-8,959	-1,306
Abiotic resource depletion potential	1,891	-4,546	-24,347	-7,778	-26,238	-19,801	-16,569

The Netherlands 2012 electricity mix (Sensitivity Analysis 11)

5.2.21 Sensitivity Analysis 11 was used to represent changes made in the WRATE model, which reflect the Netherlands 2012 electricity mix. This was done to assess the effect that using the Netherland electricity mix has on the model, as the AEB EfW plant is located within the Netherlands and not the UK – and therefore in reality would be offsetting against a Netherlands grid electricity mix. However, this is complicated by the fact that in Scenario D the landfill gas recovery (and subsequent offset) occurs in the UK[20], although the landfill gas recovery only generates about 11 percent of the total energy produced.

5.2.22 Table 5.12 shows the results for modelling Sensitivity Analysis 11. Compared to Scenario D in the main analysis in Table 5.1 it can be seen that Scenario D under Sensitivity Analysis 11 has a higher environmental performance benefit across all indicators. This reflects the more carbon intensive and 'dirtier' change in the marginal electricity mix, comprising 27.7 per cent coal for Sensitivity Analysis 11 compared to 8.06 per cent coal for the main analysis, meaning there is a bigger offset from electricity generation. Comparing Scenario D under Sensitivity Analysis 11 to Scenario C under the main analysis, Scenario C still has a relative environmental performance benefit (-17,675 Eur.Person.Eq) for global warming potential[21], as well as for all the other environmental indicators with the exception of freshwater aquatic ecotoxicity potential, which is -28,515 Eur.Person.Eq under Sensitivity Analysis 11 for Scenario D and

[20] The total energy recovered in Scenario D is 796,345,823MJ. Of this total, 710,698,921MJ (about 89 per cent) is recovered at the AEB EfW plant, and 85,646,902MJ (about 11 per cent) is recovered from landfill gas in the UK.
[21] 5,090 Eur.Person.Eq subtracted from -12,585 Eur.Person.Eq subtract gives a relative performance benefit of -17,675 Eur.Person.Eq.

-22,758 Eur.Person.Eq under the main analysis for Scenario C. This is also due to the more carbon intensive and 'dirtier' electricity mix for the Netherlands, which means there is more of an offset benefit from electricity production from the EfW in Scenario D in Sensitivity Analysis 11 than under the main analysis.

5.2.23 The environmental indicators for Scenarios A, B and C are not shown as the scope of these three waste management scenarios is confined to the UK. Only Scenario D.11 has processes that would incur energy offsets in the Netherlands.

Table 5.12: Normalised environmental indicators for Scenario D.11 (Eur.Person.Eq)

Indicator	Scenario D.11
Global warming potential	5,090
Acidification potential	-4,100
Eutrophication potential	1,987
Freshwater aquatic ecotoxicity potential	-28,515
Human toxicity potential	-14,976
Abiotic resource depletion potential	-35,742

5.3 Performance against Carbon Intensity Floor (Approaches 1 & 2)

5.3.1 As in the previous work, using Approach 1 (WRATE) to model performance against the CIF [22] consistently showed more optimistic results (between 10 per cent to 20 per cent lower) compared to Approach 2[23].

5.3.2 As Approach 2 is provided by the GLA for the explicit purpose of benchmarking performance against the CIF, and it is also the more conservative approach, it is these results that are being used for this assessment although the results from Approach 1 are useful as a sense-check.

5.3.3 As discussed in Section 4.3, Approach 2 uses the 'Mayor of London's GHG Calculator for Municipal Solid Waste (v2.1)'[24] to model all the Scenarios outlined in Section 2.2, with the exception of Scenario A (as landfill and transport emissions are

[22] The 'direct process burdens', which are the carbon dioxide equivalent emissions of the EfW process in gCO_2e (converted from $kgCO_2e$), and the 'energy generated' in kWh (converted from MJ) were then used from the model to calculate the CIF for each scenario.
[23] This is likely to be due to differences in the latest WRATE software (software v3.0.5, database v.3.0.8) used by Arup, and the earlier WRATE software (v2) used as the source for datasets in the GHG tool, with regard to carbon emission factors and process data.
[24] Available on the Greater London Authority website at: http://www.london.gov.uk/priorities/environment/putting-waste-good-use/making-the-most-of-waste (accessed 21st March 2014)

not included in the CIF calculation so benchmarking against the CIF is not applicable. Also the CIF does not take into account any offset for energy generation, therefore Sensitivity Analyses 2, 3 and 5 to 11 have the same results as the main analysis.

5.3.4 Under Approach 2 only Scenario C (current operations) meets the CIF at 302gCO_2e/kWh. Scenario B (current operations in 2025/26) and Scenario D (alternative future operations) did not meet the CIF at 709gCO_2e/kWh and 503gCO_2e/kWh respectively. Approach 1 also reflected this trend; Scenario C met the CIF but Scenarios B and D failed to meet the CIF. See Figure 5.3 for summary of the results.

5.3.5 All iterations of Scenario C under the sensitivity analyses also met the CIF under Approaches 1 and 2 (see Figure 5.3). The CIF results do not change for Sensitivity Analyses 2 to 3 and 5 to 11 (Sensitivity 4 reflects the CIF tipping point). The sensitivity parameters (i.e. electricity mix to offset against) are not within the scope of the CIF calculation.

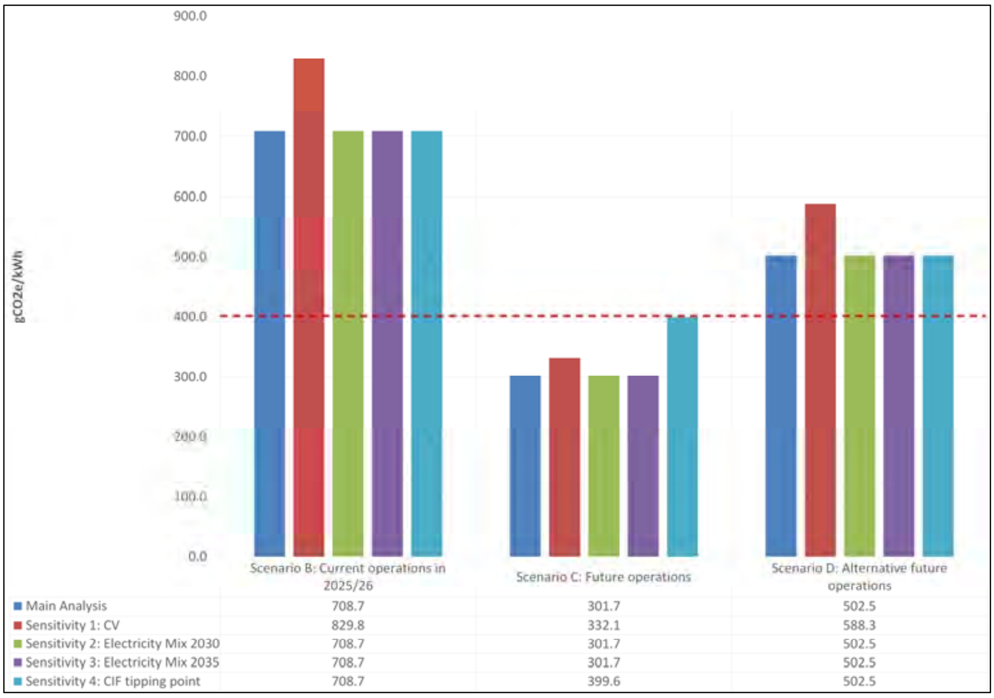


Figure 5.3: Summary of performance against the CIF

6 Conclusions and recommendations

6.1.1 In summary, the future operations (Scenario C) of the proposed ERF, when operating in CHP mode producing around 34MW_{th} of heat output (in the form of hot water) would have a better environmental performance than all other scenarios modelled, with the largest environmental benefit being relative to the landfill comparator (Scenario A) of sending all waste to landfill.

6.1.2 In order to assess the effect of a less carbon intensive electricity mix, which the electricity generation of Scenario C is offset against in the future, the WRATE model was amended to reflect the DECC reference scenario and the National Grid 'gone green' scenario as discussed in **Sections 2.2 and 4.1**. Depending on the electricity generation mix assumed, the environmental performance benefit relative to Scenario A would result in a global warming potential offset of:

- -35,124 Eur.Person.Eq (DECC electricity mix) to -21,981 Eur.Person.Eq (National Grid electricity mix) in 2025;
- -34,352 Eur.Person.Eq (DECC electricity mix) and -21,953 Eur.Person.Eq (National Grid electricity mix) for 2030; and
- -34,365 Eur.Person.Eq (DECC electricity mix) and -21,944 Eur.Person.Eq (National Grid electricity mix).

6.1.3 When applying the NG 'gone green' electricity mix to Scenarios A to D, the results show a lower environmental performance benefit for all four waste management scenarios as the 'gone green' electricity mix assumes an optimistic 100 per cent renewable marginal electricity mix. This means that the benefit from burning waste to produce electricity is reduced. In the case of Sensitivity Analyses 8 to 10 where the 'gone green' electricity mix is used, this results in a reduced environmental performance relative to grid electricity mix for Scenario C. However, relative to the other three scenarios (i.e. Scenarios A, B and D), Scenario C still shows an environmental performance benefit, and is the best performing waste management scenario overall.

6.1.4 All other environmental indicators (i.e. acidification potential, eutrophication potential, freshwater aquatic ecotoxicity potential, human toxicity potential and abiotic resource potential) show environmental performance benefits for Scenario C compared to landfill and the other waste management scenarios for all modelled sensitivity analyses, as shown in Table 4.1.

6.1.5 When comparing Scenario C for the main analysis to the alternative future operations (Scenario D) under Sensitivity Analysis 11 (where the Netherlands electricity mix is used), Scenario C still has a relative environmental performance benefit of -17,675 Eur.Person.Eq for global warming potential, and all other environmental indicators show a higher environmental performance benefit than Scenario D with the exception of fresh water aquatic ecotoxicity potential.

6.1.6 For current operation 2025/26 (Scenario B) there is still an environmental performance benefit across all environmental indicators when compared with Scenario A.

6.1.7 Scenario C would meet the CIF, and would continue to do so as long as a minimum of $12MW_{th}$ of heat is being used.

6.1.8 It is recommended that once more detailed design and operational data is available for Scenario C, the modelling is refined and updated. This data would primarily relate to the ERF process including construction and maintenance material requirements, fuel inputs, water requirements and emission and effluent concentrations.

Appendix A

A1 Appendix 1: FRM peer review report

frith resource management

Waste Strategy, Carbon Management & Research Consultancy

North London Waste Authority: New Edmonton ERF

ARUP WRATE Life Cycle Assessment

Independent Peer Review of WRATE Model and Processes

8th June 2015

Paul Frith

Contents

1 Introduction

1.1 This document

Frith Resource Management (FRM) were approached by Arup (herein referred to as 'the client') to perform a peer-review of their WRATE (Waste and Resources Assessment Tool for the Environment) model including user-defined processes. WRATE is a life cycle assessment tool designed to support the analysis of waste management systems and technologies.

This project concerns the proposed development of a new Energy from Waste (EfW) plant, termed an Energy Recovery Facility (ERF) in this instance. The facility is modelled to process Local Authority Collected (LAC) waste. The project is proposed in Edmonton which is under the North London Waste Authority (NLWA) jurisdiction.

FRM has been informed that as this stage of the proposed development most of the detailed design parameters are still to be confirmed. Therefore waste treatment process data mainly uses the default values and allocation rules found within the template processes within WRATE. There are also elements of waste management infrastructure, such as waste transfer stations, that are currently assumed out of scope. This external peer review is undertaken in that light, and the comments should be seen in that context.

Paul Frith (PF) conducted this peer-review of the ERF solution. Paul is experienced and trained using the most recent WRATE software (version 3.0.1.5, with database update 3.0.1.8) at an 'expert' level.

A number of parameters were reviewed, including, but not limited to:

- The WRATE model as a whole, four central scenarios plus the eleven sensitivity variations of each scenario, meaning a total of twenty eight scenarios were reviewed.
- Background spreadsheet containing the calculations for the NO_x emission amendment on the proposed ERF.
- Background spreadsheet containing the calculations for the NO_x emission amendment on the Netherlands ERF in scenario D.
- Background spreadsheet containing a summary of the proposed amendments to the ERF technology.
- Correspondence with Arup w/c 23rd March 2015 – w/c 1st June 2015.
- Review of the allocation tables for all user defined processes.
- Evaluation against comparator default WRATE processes where appropriate.
- Correspondence with Arup w/c 27th April 2015.

All data entry aspects were checked across each of the scenarios.

In terms of the process an external review report was issued by FRM to Arup on 30/03/2015. This contained seven queries and the supporting comment as included in this document. Arup responded to the queries and made the changes indicated in this report, reissuing the model in the process on 31/03/2015. Further modifications have been made to the WRATE model culminating in a second issue of the report. Further modelling has been conducted by Arup to address issues in the background electricity mix of WRATE. A further six scenarios have been modelled for two alternative electricity mixes for three projected years. A variation to the Scenario D was added to include a dirty MRF preparing an RDF fraction for export to an Energy from Waste facility in the Netherlands. This MRF has been user defined and was also checked in the latest iteration of the modelling (w/c 1st June). FRM have checked the changes and additions made and this report concludes the peer review process.

1.2 Description of the model

The ERF solution proposes to process the project waste streams (composition and tonnage) as identified by NLWA for the period 2025/26. NLWA's waste flow assumptions, based on the composition as identified differ from WRATE defaults in terms of the calorific value of the waste. As a consequence, the central WRATE model is altered to reflect the energy output derived from the NLWA calorific value (CV) estimate and the energy recovery performance of the ERF has been amended accordingly to match this CV. A calculation table has been provided by Arup to demonstrate the energy balance and the corresponding impact on the ERF efficiency. There is a sensitivity analysis (Sensitivity 1) that considers the impact of processing a lower CV waste feedstock (the default WRATE composition).

There is no default method to adjust background CV values within WRATE and therefore an alternative method is required in order to approximate and model the 10MJ/kg net CV as requested by NLWA. This has been done by increasing the net heat and net power efficiencies of the treatment technologies by a factor of 1.17 to account for the difference in net CVs; the default net CV in WRATE is 8.54MJ/kg when using the NLWA waste composition. The degree of energy recovery within the model is one of the most significant aspects influencing the global warming potential (GWP) environmental indicator in WRATE, and therefore the approach by the client of amending energy outputs (by amending net efficiencies) to match the energy balance predicted through the ERF solution is appropriate. In recognition of the point that this method of approximating GWP only considers the energy output calculation, the client has also included Sensitivity 1 which uses the default WRATE CV (of 8.54MJ/kg) for the given waste composition. This sensitivity should be applied in circumstances where the WRATE model is compared against other life cycle assessments undertaken in WRATE to ensure comparability. The method applied by Arup for correcting efficiency to match the NLWA CV has been applied correctly based on the reported CV of 10GJ/tonne (or 10MJ/kg) and the net energy recovery efficiency reported by the technology provider.

The WRATE model for this project was provided by the client to FRM – alongside some background data including outline process / scenario and sensitivity descriptions and justifications – to undertake this peer-review.

Sensitivity analyses two and three apply different background energy mixes to reflect default WRATE estimates in the years 2030 and 2035 respectively.

Sensitivity analysis four considers the future scenarios (C – 100% ERF treatment, and D – 50% ERF treatment in the Netherlands, 50% landfill disposal) only, with regard to the degree of energy recovery they would be required to undertake to meet the requirements of the Carbon Intensity Floor (CIF)[1] in 2025/26. This is calculated through a separate model to WRATE which has not been provided (the GLA Greenhouse Gas Calculator). By adopting the same methodology using the WRATE scenarios provided the Scenario C appears to fall below the target of 400gCO_2e/kWh of energy generated, however this applies a different dataset in terms of marginal energy mix, CV and a more recent Life Cycle Inventory than the Greenhouse Gas Calculator. Therefore FRM have not been able to assess this part of the model within this peer review.

Sensitivities 5, 6 and 7 are a variation on the baseline model whereby the background electricity mix has been altered to reflect latest DECC projections for 2025, 2030 and 2035 respectively. This has been done due to the default WRATE electricity mixes showing an increase in coal use over time, which is contrary to DECC projections and energy policy. Arup have approached the WRATE helpdesk for clarification behind this reasoning; however have not been provided with an explanation. Sensitivities 8, 9 and 10 have been conducted for the same years using the National Grid's 'Gone Green' energy projections to inform the background electricity mixes. Sensitivity 11 uses the Netherland's 2012 (most recent available in WRATE) energy mix to reflect differences in marginal energy mix between the UK and the Netherlands, and the subsequent difference in environmental impact of energy recovery technology in the two countries.

This peer-review report considers the whole of each scenario but provides particular attention to the user-defined processes within the WRATE model, as these are the elements for which changes have been made from the peer reviewed default processes in WRATE. The user defined processes are therefore the ERF (and variations thereof), the Materials Recovery Facility (in Scenario D) and the Air Pollution Control residue (APCr) processing facility. The following sections will discuss any observations and queries that were raised as part of this process.

[1] A Greater London Authority energy recovery requirement of ≤400gCO_2e/kwh.

2 Review of the model

2.1 Model background

The model background information has been programmed as displayed in Table 1.

Table 1: Summary of WRATE model background assumptions

Parameter	Main Model	Sensitivity 1	Sensitivity 2	Sensitivity 3	Sensitivity 4	Sensitivities 5, 6 & 7	Sensitivities 8, 9 & 10	Sensitivity 11
Studied Year	2025	2025	2030	2035	2025	-	-	2012
Population	0							
No of Persons per Household	0							
Electricity Mix	UK 2025	UK 2025	UK 2030	UK 2035	UK 2025	DECC 2025 / 30 / 35	N Grid 2025 / 30 / 35	Netherlands 2012
Waste Tonnage	572856 tonnes							
Waste Composition	As modelled in waste projections. Same for all sensitivities.							

The year studied in for the NLWA proposal is 2025. This is a fair assumption. In each case the electricity mix selected is UK, with the exception of the user defined energy mixes used in sensitivities 5 - 10 (user defined) and 11 (Netherlands, 2012). This is a fair assumption. The electricity mix year corresponds with the studied year in each sensitivity.

A population and number of persons per household of nil have been selected in the model and all sensitivities. This is an appropriate assumption because collection activities (collection methods and transportation) are outside the scope of this model. This is the case in all scenarios and sensitivities meaning each is a comparable and fair assessment.

Waste tonnages and compositions are derived from waste projections conducted by NLWA. These are unaltered between scenarios and sensitivities meaning each is a comparable and fair assessment. There are four scenarios (A-D) as described in Sections 2.2 – 2.5, following, and in addition eleven sensitivity analyses have been performed, where one variable has been changed to determine the effect on each scenario.

Sensitivity 1 accounts for use energy outputs when using standard WRATE calorific values (CVs) rather than projected NLWA waste CVs, as discussed in section 1.2. Sensitivities 2 and 3 are simple modifications of the modelled year. These do not impact the direct process burdens of the scenarios (compared with the main model) however have an impact when compared with the offset emissions of cleaner energy mixes in the later years. Sensitivity 4 explores the required energy recovery levels to meet the Greater London Authority's Carbon Intensity Floor, for reasons noted in section 1.2 this sensitivity could not be fully explored.

Sensitivities 5, 6 and 7 explore the effect of using DECCs energy mix projections, and 8, 9 and 10 of using the national grid energy mix projections for 2025, 2030 and 2035 respectively in each case. For sensitivities 5, 6 and 7 the (updated) DECC energy projections published in September 2014 have been used. Arup have maintained the WRATE default energy generation efficiencies, however have updated the baseline and marginal fuel mix figures for CCGT and coal to reflect the DECC projections. These changes have been applied correctly for each of the three sensitivities, with workings provided to demonstrate the calculations used.

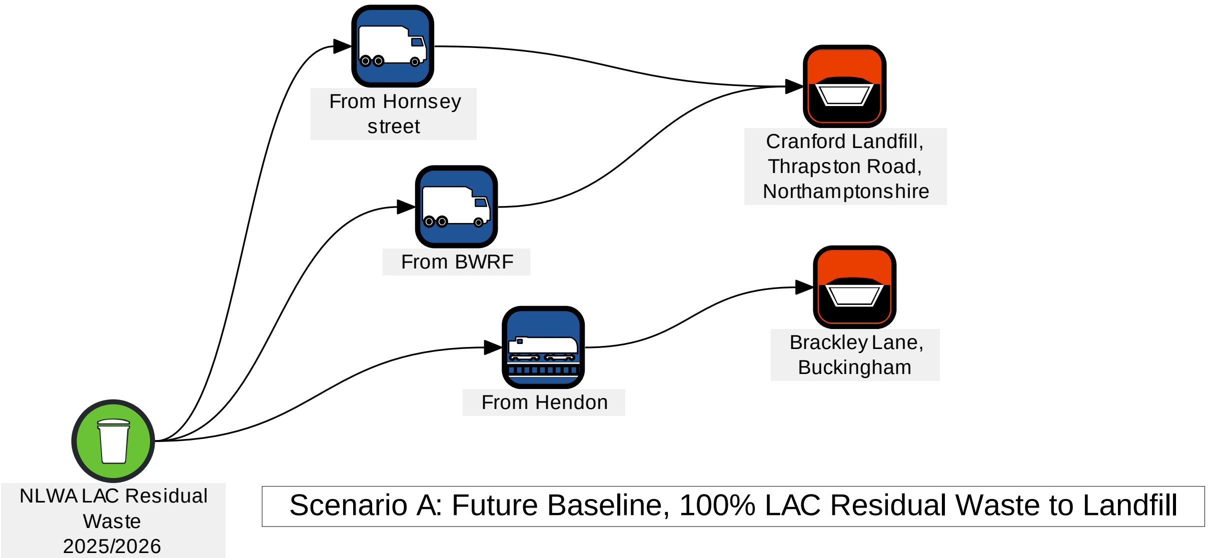
A similar exercise has been undertaken for sensitivities 8, 9 and 10 using the national grid's 'Gone Green' UK energy projections (2014). In this instance the energy generation efficiencies have been maintained with the baseline fuel mix changed (for all parameters) to reflect the national grid projections. The marginal fuel mix, used by WRATE to calculate emissions associated with the source of displaced energy, is changed in this case to a worst case scenario whereby only renewable energy is displaced. This has been done in the ration of projected renewable energy sources. These changes have been applied correctly for each of the three sensitivities, with workings provided to demonstrate the calculations used. As noted by Arup, the makeup of the marginal fuel mix in these sensitivities means these models are rightly marked as a worst case scenario as it is probable that the energy source displaced by the development will be 'dirtier' in composition.

There is an additional sensitivity concerning scenario D (where 50% of the waste is exported for energy recovery in the Netherlands), in this sensitivity (no. 11D) the background energy mix was changed to reflect the Netherlands energy mix from WRATE. In this instance WRATE only has electricity mixes available for 2002 and 2012; therefore 2012 has been selected as the closest relevant electricity mix.

2.2 Scenario A: Baseline

Scenario A assumes that all project waste is disposed to landfill. This scenario is identical for all sensitivities, notwithstanding alterations to the project background information as discussed previously. Waste is distributed in a ratio of 10.54%, 21.41% and 68.05% from Hornsey Street (road transfer station), BWRF (road transfer station) and Hendon (rail transfer station) respectively. Transfer stations are not modelled in this scenario. This is a consistent approach with all other scenarios and sensitivities. Query 1, as detailed below, concerns the appropriateness of this approach.

Figure 1: Schematic of scenario A – all sensitivities



Hornsey Street transport is modelled using the standard WRATE process 'Intermodal road transport v3 (12026)' with a trip distance of 128km and a urban:rural:motorway mix of 33:33:34. The selected WRATE default process is the most appropriate transport method for waste from a transfer station to a disposal site and therefore is modelled suitably. The trip distance has been verified using google mapping software. A road mix of 33:33:34 is appropriate for a high level assessment[2] such as this. Alterations to this road mix would have small impacts on the climate change and NO_x impacts of the model; these are not substantial in comparison to process emissions and offsets from landfill/EfW processes.

BWRF transport is modelled using the standard WRATE process 'Intermodal road transport v3 (12026)' with a trip distance of 130km and a urban:rural:motorway mix of 33:33:34. The selected WRATE default process is the most appropriate transport method for waste from a transfer station to a disposal site and therefore is modelled suitably. The trip distance has been verified using google mapping software. A road mix of 33%, 33% and % 34[3] (rural, urban and motorway respectively) is appropriate for a high level assessment such as this. Alterations to this road mix would have small

[2] See note in section 1.1

[3] All further road transport processes for all scenarios and sensitivities use default WRATE road mixes. As stated this are suitable for a high level model such as this, and therefore are not refereed to separately in each instance in this report.

impacts on the climate change and NO_x impacts of the model; however these are not substantial in comparison to process emissions / offsets from landfill/EfW processes.

Hendon transport is modelled using the standard WRATE process 'Rail transport v3 (12072)' with a trip distance of 96km. The selected WRATE default process is the most appropriate transport method for waste from a rail transfer station to a disposal site and therefore is modelled suitably. The trip distance has been verified using google mapping software.

Query 1: Transfer station infrastructure

FRM Query	The inclusion of transfer station processes in the model will allow the model to assess the difference in burdens between use of rail and road transport transfer facilities. The high burdens associated with infrastructure at rail transfer stations will have a greater impact on some scenarios compared with others. Consider including transfer facilities in the scope of assessment.
ARUP Response	The client has confirmed that transfer station infrastructure is out of scope at this stage. Transfer transport processes have not been included.
FRM Comment	This response and approach is acceptable for a high level assessment. If more detailed life cycle assessment is required at a later stage transfer facility burdens should be included within the scope of an assessment.

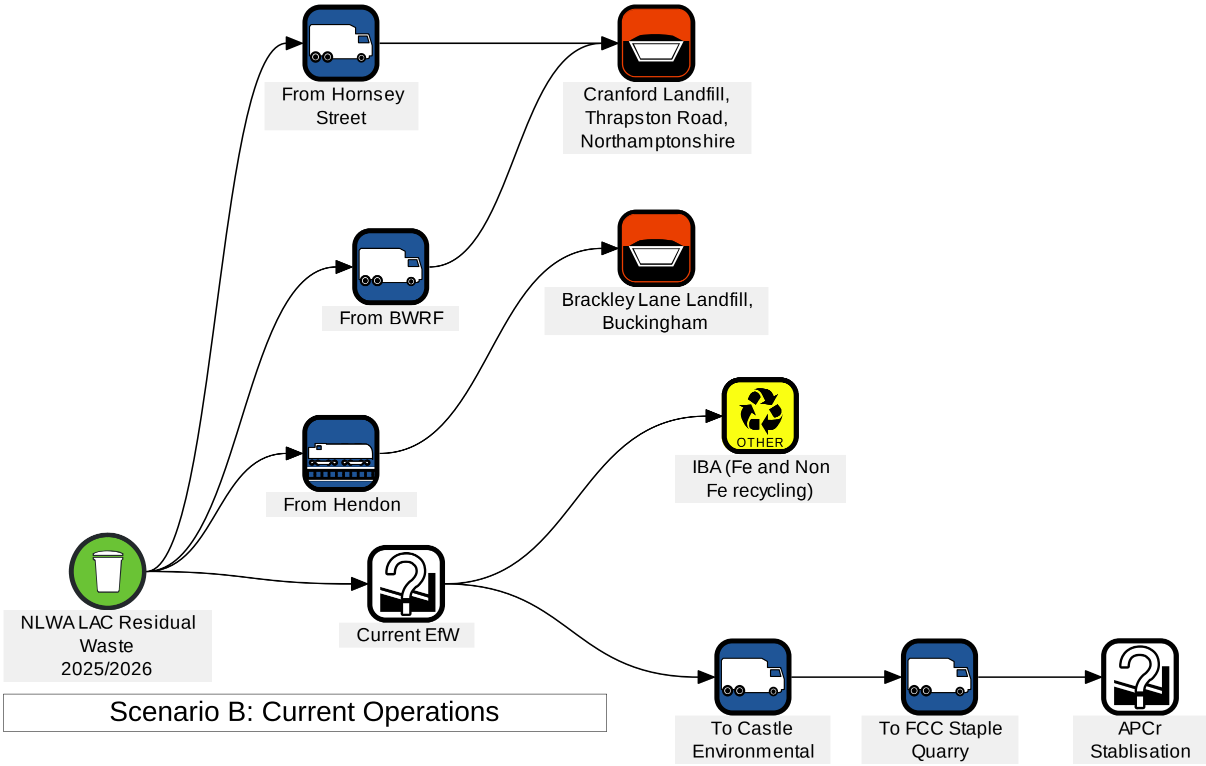
Waste disposal is modelled through two landfill sites at Cranford (Northamptonshire) for waste transported by road from Hornsey Street and BWRF, and Brackley Lane (Buckinghamshire) for waste from Hendon transported by rail. Both facilities use the WRATE default process 'Flexible landfill 5000000 tonnes (11256)' with an assumed landfill gas efficiency of 50% in the absence of provided data. The recovered gas is used for energy recovery purposes. This is an appropriate assumption for a moderately performing landfill, and for the purposes of a high level assessment is a sufficient assumption. Both facilities are appropriately scaled to incoming waste. In both cases it has been assumed that a clay liner is used at the landfill sites. This is a conservative assumption as plastic liners and caps will improve landfill performance. At Brackley Lane a clay cap has been assumed, again as a conservative estimate. For Cranford Landfill a HDPE cap has been used as a proxy for LDPE cap. This is an appropriate assumption and most closely reflects the landfill operation and burdens. This approach has been applied consistently and for the purposes of a high level assessment is an appropriate assumption.

Each of the ten sensitivities for the baseline scenario has been tested to ensure that no changes have been made. This assessment has highlighted no alterations and therefore the sensitivities are comparable on a like for like basis.

2.3 Scenario B: Current operation

Scenario B models the current treatment of the NLWA targeted waste stream. This is treated through an established EfW facility that produces electricity for export to the national grid. Waste is distributed so that the majority (94.265%) is treated through the EfW plant, with the remaining quantity (5.735%) disposed of to landfill. The remaining quantity of waste retains the distribution ratio of 10.54%, 21.41% and 68.05% from Hornsey Street (road transfer station), BWRF (road transfer station) and Hendon (rail transfer station) as used in Scenario A. Transfer stations are not modelled in this scenario. This is a consistent approach with all other scenarios and sensitivities.

Figure 2: Schematic of scenario B – all sensitivities



Waste sent directly to landfill processes is treated using the same transport parameters (including distances and default processes) and landfill facilities as described in Scenario A. The majority of the waste is modelled through an adapted EfW facility based on the default WRATE flexible EfW process. For this scenario the process (ID. 11356) is adapted to reflect changes to the energy efficiency and waste production of the facility. The process has been modelled selecting a dry SNCR flue gas treatment with a net electrical efficiency of 20.3427% applied, as specified by supporting energy balance documentation. Metal extraction has been removed from the process reflecting current operation where metals are recovered at a later stage elsewhere on the Edmonton site. APCr output has been amended using actual data. A summary of changes to the allocations is provided in Table 2.

Table 2: User defined process for current EfW

Parameter	User Defined WRATE process	Default WRATE process	Comment
Lifespan	55 years	25 years	See Query 2.
Energy Recovered	=[USER_TOTAL.NET_CV]*0.203427	User defined variable (front screen)	Changed to reflect reported actual energy outputs. Source ARUP Energy Balance.
Process Output > Non Ferrous Metals	0	User defined variable (front screen)	Changed to reflect later removal at IBA treatment facility.
Process Output > Ferrous Metals	0	User defined variable (front screen)	Changed to reflect later removal at IBA treatment facility.
Electricity to Grid	=[USER_TOTAL.NET_CV]*0.203189	User defined variable (front screen)	Slight discrepancies in factors used, see Query 3.
Process Waste Output > Bottom Ash (IBA)	=[USER_WASTE_FRACTIONS_TOTAL]*0.13999	=([USER_TOTAL.ASH]*0.91+([USER_WASTE_FRACTIONS.NON_FERROUS]+[USER_WASTE_FRACTIONS.RDF_1_12])*0.05+0.2*((([USER_WASTE_FRACTIONS.FERROUS_METAL]+[USER_WASTE_FRACTIONS.RDF_1_11])*(1-[USER_PROCESS_PARAM.FE_RECOVERY]))+([USER_TOTAL.ASH]*0.91)+(([USER_WASTE_FRACTIONS.NON_FERROUS]+[USER_WASTE_FRACTIONS.RDF_1_12])*(1-[USER_PROCESS_PARAM.NON_FE_RECOVERY]))))	See Query 4.
Process Waste Output > Bottom Ash Ferrous	=[USER_WASTE_FRACTIONS.FERROUS_METAL]*0.90	User defined variable (front screen)	Within acceptable industry practice range. Mass flow provided by NLWA would require factor of 1.0; 0.9 used as realistic maximum.
Process Waste Output > Bottom Ash Non Ferrous	=[USER_WASTE_FRACTIONS.NON_FERROUS]*0.0.31137	User defined variable (front screen)	Within acceptable industry practice range.
Process Waste Output > Air	=[USER_WASTE_FRACTIONS_T	=ifequal([USER_PROCESS_PARAM.SCRUBBER_TYPE],[SCRUBBER_TYPE.DRY],(	See Query 5.

Pollution Control	OTAL]*.03368	[USER_TOTAL.ASH]*0.09)+([USER_WASTE_FRACTIONS_TOTAL]*0.02875),([USER_TOTAL.ASH]*0.09)+([USER_WASTE_FRACTIONS_TOTAL]*0.025))	

Query 2: Lifespan of current EfW

FRM Query	The extended life of the facility to 55 years will reduce the annualised impact of construction burdens. The current facility will have been refurbished during its current lifespan and would therefore have required major reconstruction works, and therefore it is suggested to revert back to the default 25 year lifespan.
ARUP Response	Agreed. This has been changed back to 25 years to provide a fairer like for like comparison.
FRM Comment	This response is noted and the amended approach is appropriate.

Query 3: Discrepancies between WRATE process net efficiencies and supporting net efficiencies

FRM Query	The electrical efficiency modelled in WRATE for the headline energy output indicator is 20.3427% which differs from the electricity to grid factor of 20.3189%. Consider updating 'electricity to grid' factor to match energy output in order to correctly measure carbon equivalent impacts of offset energy use.
ARUP Response	Amended to match 20.3427%.
FRM Comment	This response and the amended approach are acceptable.

Query 4: Incinerator Bottom Ash (IBA) output

FRM Query	The calculated IBA output (non-metals) is lower than the default WRATE process. We would expect an IBA output (total including metals) of between 20 and 30% of input material. In this scenario a return of 13.999% is achieved. We would suggest that the output of non-metal IBA is increased in line with the default WRATE flexible EfW process.
ARUP Response	Agreed that bottom ash seems low compared to typical values for similar facilities. However 13.999% of input material reflects the mass balance data for 2013/14 as provided by NLWA for the current EfW facility.
FRM Comment	This response is acceptable as the IBA from the current EfW is measured rather than estimated in the 2013/14 data. Therefore FRM agree that, although lower than standard EfW performance, this is an acceptable approach to modelling in WRATE having been provided with evidenced mass balance data.

Query 5: APCr output

FRM Query	The calculated APC residues output is lower than the default WRATE process. We would expect an APCr output of between 3.5 and 4.5% of input material depending on the abatement control method selected. In this scenario a return of 3.368% is achieved. We would suggest that the output APCr is increased in line with the default WRATE flexible EfW process.
ARUP Response	Mass of APCr (info as provided by NLWA) for 2013/14 from current EfW is

	17,985 tonnes. Factored to current operations in 2025 (factor of 1.011 compared to 2013/14) this gives 18,187 tonnes of APCr or 3.368% of input material.
FRM Comment	This response is acceptable as the APCr from the current EfW is measured rather than estimated in the 2013/14 data. Therefore FRM agree that, although lower than standard EfW performance, this is an acceptable approach to modelling in WRATE having been provided with evidenced mass balance data. Further, although the figure falls outside values modelled by the WRATE default processes, it is still within industry ranges and therefore an acceptable use of the WRATE model.

The current scenario involves treatment of IBA on site therefore no transport is included. The WRATE default process 'IBA rec & FE/nonFe recovery v3 (12028)' is used. This is the most appropriate process for this treatment.

The APCr stabilisation process (modelled using the WRATE waste minimisation process) has been altered with waste restrictions amended to allow APC residues. This change has been correctly implemented in the WRATE model. The management of APCr is via a treatment/recycling process which is not represented as a default technology in WRATE. It is likely to be environmentally more preferable than landfill and therefore in discussion with ARUP we concur that a waste minimisation process is appropriate for the management of this waste stream given the current level of information available. A waste minimisation process removes both positive and negative impacts from the management of APCr. It should also be noted that the same assumption has been applied across all scenarios where APCr is managed.

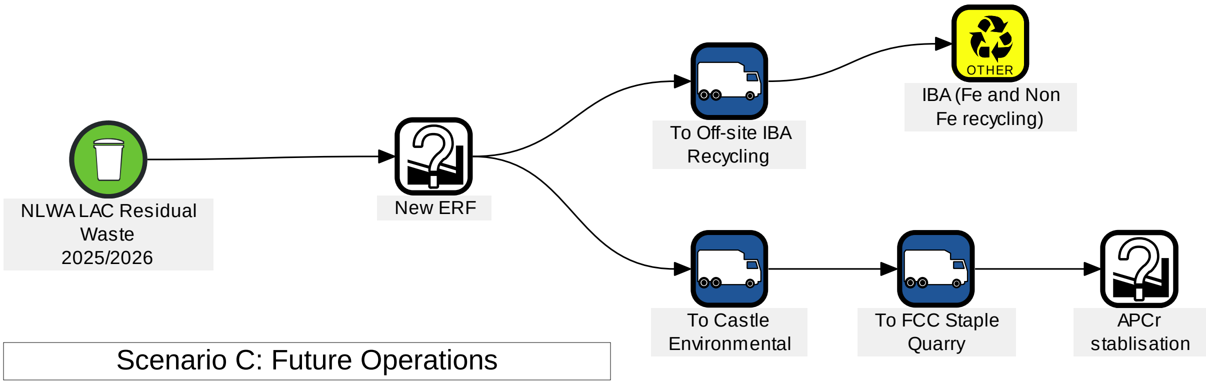
APCr is transported for offsite treatment at the APCr stabilisation facility detailed above. This involves onward treatment (Query 5 re. quantity of material). WRATE does not allow onward transport of stabilised APCr (i.e. post-minimisation process) and therefore two transport elements are included before the APCr stabilisation process in the model. This is an appropriate use of the WRATE model. Distances for transport post- and pre-treatment are 130km using 'intermodal road transport v3 (12026)' – the most appropriate WRATE process for this transportation. These distances have been cross checked using Google mapping software and are correct.

For each sensitivity the correct electricity recovery efficiency has been applied (this is unchanged for Sensitivities 2-4 and 5-10). A net electrical energy efficiency of 17.366% has been applied in Sensitivity 1 to account for default WRATE calorific values. This has been applied correctly in accordance with the energy balance calculations provided by the client. All other processes have been unaltered from the main model with the exception of changes to background electricity mixes as previously recorded.

2.4 Scenario C: Future operations

Scenario C models the future treatment of the NLWA targeted waste stream exclusively through a new ERF. The proposed ERF recovers both electrical and thermal energy for export. This is a consistent approach with all other sensitivities of the future operation.

Figure 3: Schematic of Scenario C – all sensitivities



The waste is modelled through an adapted ERF technology based on the default WRATE flexible EfW process. For this scenario the 'Flexible EfW v3 process (ID. 11362)' is adapted to reflect changes to the energy efficiency and waste production of the facility. The process has been modelled selecting a wet SCR flue gas treatment system. The ERF has a net electrical efficiency of 30.083% and net thermal efficiency of 20% applied (with the exception of sensitivities 1 and 4). This would represent best practice levels of performance (in terms of electrical efficiency). These efficiencies differ slightly from the specified values presented in the supplied energy balance documentation (see query 6 below). Metal extraction has been removed from the process reflecting expected operation where metals are recovered at a later stage rather than at the grate. A summary of changes to the allocations is provided in Table 3.

Table 3: User defined process for proposed ERF

Parameter	User Defined WRATE process	Default WRATE process	Comment
Energy Recovered	=([USER_TOTAL.NET_CV]*0.30083)+([USER_TOTAL.NET_CV]*0.2)	User defined variable (front screen)	Changed to reflect reported actual energy outputs. Source ARUP Energy Balance. Slight discrepancy, see Query 6.
External Heat	=[USER_TOTAL.NET_CV]*0.2000	User defined variable (front screen)	See Query 6 below.
Electricity to the Grid	=[USER_TOTAL.NET_CV]*0.30083	User defined variable (front screen)	See Query 6 below.
Process Emissions > Nitrogen Oxides to Air	259782 kg	Calculated	See text below.

Query 6: ERF process energy efficiency discrepancy

FRM Query	There is a discrepancy between the user defined WRATE process efficiencies and those presented in the energy balance. For the main model, and Sensitivities 2 and 3, the WRATE process is modelled with efficiencies of 30.083% (electrical) and 20% (thermal), whilst the calculated energy balance figures are 30.1184% and 20.0223% respectively. This results in the WRATE model being more conservative with a 0.12% reduction in energy generation compared to the calculated output in the energy balance. There will be associated, albeit small, impacts on avoided emissions as a result of this also negatively affecting the solutions modelled performance. For Sensitivity 1 the thermal efficiency input in WRATE is 19.99%, whereas the energy balance suggests an efficiency of 20.02%, again resulting in a conservative energy output. Sensitivity 4 is modelled in line with the energy balance with regards energy efficiencies of the technology. It is recommended that the efficiencies are updated to match the energy balance provided.
ARUP Response	This is in part due to net CV within WRATE changing. Based on the NLWA waste composition WRATE originally calculated the net CV as 8.55 MJ/kg. For reasons unknown WRATE now calculates the net CV MJ/kg as 8.54, and seems to have stabilised as this value after repeat re-calculations of the model. It may be a rounding error within the software. This discrepancy makes a slight difference to the factor applied to the efficiencies to mimic a CV of 10 MJ/kg. All values amended and checked so now correct and consistent.
FRM Comment	This response is noted and the amended approach is appropriate.

It should be noted whilst heat is recovered from the ERF it has been agreed with the client (correspondence with ARUP 25/03/2015) that no district heating infrastructure will be included within the WRATE model. The reasoning behind this is that there is some uncertainty surrounding potential users of the heat, and the potential for a single high energy user being available near to the site. Again, in the light of a high level study, we believe that this is a reasonable position.

The level of performance achieved by the Selective Catalytic Reduction (SCR) flue gas treatment equipment for NO_x emissions has been modelled as delivering 80mg/Nm^3. This is a conservative figure and is within the bounds of expected performance. In the light of the nature of this study it is considered appropriate to retain this assumption; however as more detailed investigations of the proposal move forward it would be recommended that further evidence is provided to confirm and accurately model NO_x emission levels.

The future scenario involves treatment of IBA off site therefore the WRATE transport process 'Intermodal road transport v3 (12026)' has been used with an assumed distance of 40km as no site has been identified. This is a reasonable assumption as there is currently at least one other IBA treatment facilities within this radius. The WRATE default process 'IBA rec & FE/non Fe recovery v3 (12028)' is used. This is the most appropriate process for this treatment. IBA output from the process is 22%, which is within the expected bounds of an ERF technology and is unchanged from the standard WRATE flexible EfW facility.

APCr is transported for off-site treatment at the APCr stabilisation facility as detailed in Scenario B. WRATE does not allow onward transport of stabilised APCr (i.e. post-minimisation process) and therefore two transport elements are included before the APCr stabilisation process as with Scenario B. This is an appropriate use of the WRATE model. Distances for transport post-treatment is 201.8km and 51.2km respectively using 'intermodal road transport v3 (12026)' – the most appropriate WRATE process for this transportation. These distances have been cross checked using Google mapping software and are correct. APCr output from the ERF is approximately 4% of input waste, which is within the expected bounds of an ERF technology and is unchanged from the standard WRATE flexible EfW facility.

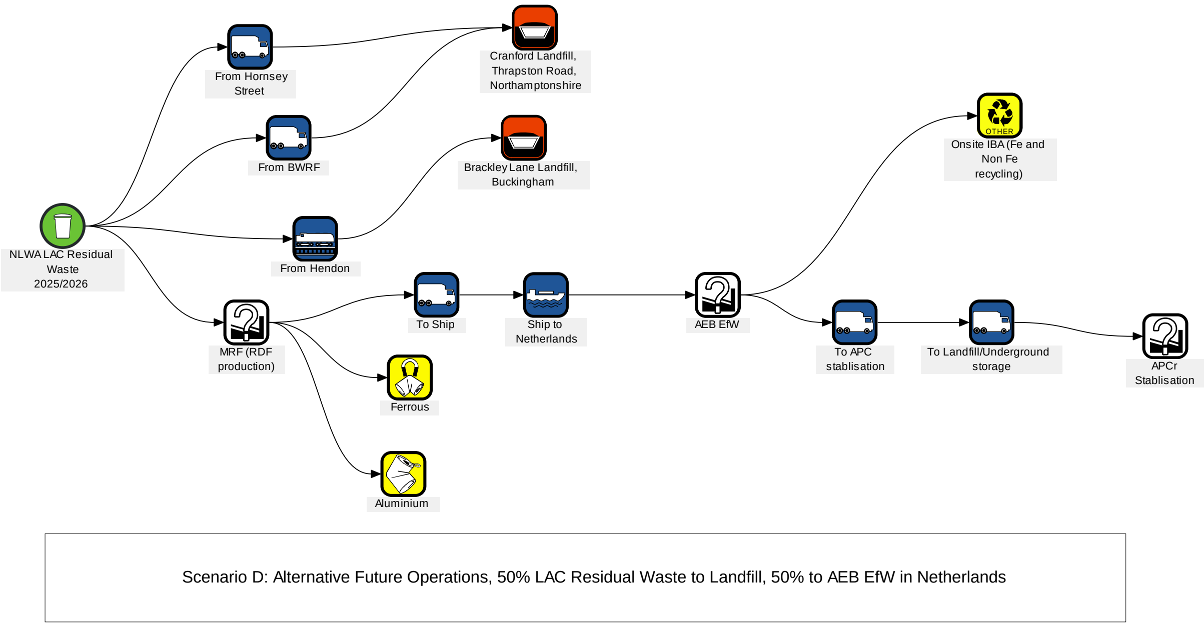
2.5 Scenario D: Alternative future baseline

Scenario D models the future treatment of the NLWA targeted waste stream with an ERF in Amsterdam treating 50% of the waste stream (after a sorting / RDF preparation stage) and the remainder being sent to landfill at the current ratio as discussed in Scenario A. A modelling error has been made whereby waste distribution to the separate landfill routes appears to have been misapplied (see Query 7). The proposed ERF to be used recovers both electrical and thermal energy for export. This is a consistent approach with all other sensitivities of the future operation.

Query 7: Miscellaneous waste distribution

FRM Query	In previous scenarios waste has been distributed 10.54:21.41:68.05 to Hornsey Street (road transfer station), BWRF (road transfer station) and Hendon (rail transfer station) respectively. In Scenario D Hendon street is modelled correctly, however waste destined for BWRF appears to have been erroneously modelled through Hendon and vice versa. This error requires remodelling of the scenario and all associated sensitivities.
ARUP Response	This has been corrected.
FRM Comment	This response is noted and the amended approach is appropriate.

Figure 4: Schematic of Scenario D – all sensitivities



This scenario has been amended from a previous version, to include a dirty MRF to extract metals and form a crude RDF for export to the AEB Energy from Waste plant in Amsterdam. The energy balance has been changed to reflect the AEB plant, handling 50% of the contract waste. The remodelled ERF process has WRATE ID 11381, and is detailed in

The MRF process has WRATE ID 11388, is based on the default WRATE process MRF (for cement kiln/gasifier/pyrolysis) v3, and is amended as detailed in

Table 5.

Table 4: User defined process for proposed ERF (Scenario D)

Parameter	User Defined WRATE process	Default WRATE process	Comment
Energy Recovered	=([USER_TOTAL.NET_CV]*0.29894)+([USER_TOTAL.NET_CV]*0.4)	User defined variable (front screen)	Changed to reflect reported actual energy outputs. Source ARUP Energy Balance.
Electricity to Grid	=[USER_TOTAL.NET_CV]*0.29894	User defined variable (front screen)	
External Heat	=[USER_TOTAL.NET_CV]*0.4000	User defined variable (front screen)	
Process Emissions > Nitrogen Oxides to Air	129891 kg	Calculated	See comments re. Scenario C NO_x.

Table 5: User defined process for proposed dirty MRF (Scenario D)

Parameter	User Defined WRATE process	Default WRATE process	Comment
Energy Input	3888000.0 MJ =([USER_WASTE_FRACTIONS_TOTAL]/[PROCESS_PARAM.CAPACITY])*[PROC_ENERGY_INPUTS.GRID.MACHINERIES]	3888000.00 MJ [Missing allocation rule]	Allocation rule inserted to fix inbuilt error in WRATE process: 30 kwh per tonne input. Calculated on a monthly basis over a two year period (2001-2003) x 36000 tpa
Material Outputs	=[USER_WASTE_FRACTIONS.FINE_MATERIAL]-[USER_FINE_MATERIAL.MOISTURE Same formula for all replacement RDF fractions	=(0.41*([USER_WASTE_FRACTIONS.FINE_MATERIAL]-[USER_FINE_MATERIAL.MOISTURE])) Same formula for all fractions with exception of metals factor	Allocation rules changed to reflect that all materials out is an RDF fraction for recovery with the exception of metals. Only metals are recovered for recycling.
Material Waste Outputs	Allocations removed Same formula for all fractions	=([USER_WASTE_FRACTIONS.FINE_MATERIAL]/[WASTE_FRACTIONS.FINE_MATERIAL])*[PROC_WASTES.LANDFILL.FINE_MATERIAL.ROAD] Same formula for all fractions	As above, all material is recovered as an RDF or recyclate, therefore no process waste out.

All transport components of the scenario have been checked and match the details modelled for previous scenarios. They have been copied correctly for all sensitivities.

3 Conclusions

FRM has conducted a peer review of the Arup WRATE model (and sensitivities) and find that the methodology and construction of the model have been appropriately applied.

The review has been undertaken in the light that this is a high level model to facilitate comparison between options (with a degree of sensitivity analysis). It is recommended that a more thorough modelling exercise, including a greater degree of technical substantiation, is provided for any more detailed assessment e.g. as part of a procurement exercise or to support a funding application.

We note that there is a discrepancy between the WRATE default calorific value for the given waste composition and the NLWA reported calorific value for the same waste composition. This discrepancy has been addressed by Arup through modelling both the NLWA and default CVs (the main WRATE project file and Sensitivity 1 respectively).

We could only partially review Sensitivity 4 (carbon intensity floor calculation) as this a policy driven factor that is calculated using the GLA Greenhouse Gas Calculator rather than WRATE. We are informed that this calculator will be submitted in parallel with the WRATE report. We have, however, undertaken a check of the direct process burdens of the ERF for the amount of energy recovered in this sensitivity and WRATE reports that it is below the maximum CIF threshold of 400gCO_2e/kWh.

Overall FRM consider that the model and choice of sensitivities are appropriate and has been conducted using reasonable assumptions and due care and diligence.

A2 Appendix 2: Waste composition and NCV data

Table 6.1: NLWA residual waste composition (2009)

Material type	**Residual**	
	%	**Quantity (tonnes)**
Paper and card		
Unspecified paper	0	0
Newspapers	3.53626	18195
Magazines	2.27257	11693
Recyclable paper	2.64787	13624
Other paper	5.06776	26075
Card packaging	7.91465	40723
Other card	0.0789074	406
Plastic film		
Unspecified plastic film	0	0
Bags	0	0
Packaging film	2.66905	13733
Other film plastic	3.25017	16723
Dense plastic		
Unspecified dense plastic	0	0
Drinks bottles	2.182	11227
Other bottles	0	0
Other packaging	2.63115	13538
Other dense plastic	1.82614	9396
Textiles		
Unspecified textiles	3.14425	16178
Artificial textiles	0	0
Natural textiles	0	0
Absorbent hygiene products		
Unspecified absorbent hygiene products	0	0
Disposable nappies	4.16169	21413
Other (sanpro and dressings)	0	0
Wood		
Unspecified wood	2.62416	13502
Wood packaging	0	0
Non-packaging wood	0	0
Combustibles		

Material type	Residual	
	%	Quantity (tonnes)
Unspecified combustibles	0	0
Shoes	0	0
Carpet/underlay	0.750398	3861
Furniture	1.29148	6645
Other combustibles	2.73261	14060
Non-combustibles		
Unspecified non-combustibles	0	0
Bricks, blocks, plaster	0.773915	3982
Soil	0.761087	3916
Inorganic pet litter	0	0
Other non-combustibles	1.09732	5646
Glass		
Unspecified glass	0	0
Packaging	4.09502	21070
Non-packaging glass	0.232252	1195
Green bottles	0	0
Clear bottles	0	0
Brown bottles	0	0
Jars	1.04445	5374
Organic		
Unspecified organic	0	0
Garden waste	8.01396	41234
Food waste	22.463	115578
Organic pet bedding/litter	0	0
Other organics	1.62266	8349
Ferrous metal		
Unspecified ferrous metal	0	0
Steel food and drink cans	0.87595	4507
Other ferrous metal	0.99334	5111
Non-ferrous metal		
Unspecified non-ferrous metal	0	0
Aluminium drinks cans	0.638645	3286
Foil	0	0
Other non-ferrous metal	0.666437	3429
Fine material <10mm		

Material type	Residual	
	%	Quantity (tonnes)
Unspecified fine material	6.16022	31696
Waste electrical and electronic equipment		
Unspecified WEEE	0	0
White goods	0.614934	3164
Large electronic goods (excluding CRT TVs and monitors)	0.0967879	498
CRT TVs and monitors	0.117001	602
Other WEEE	0.572759	2947
Specific hazardous household		
Unspecified hazardous household waste items	0.140129	721
Batteries	0.14285	735
Clinical waste	0.0412029	212
Paint/varnish	0	0
Oil	0.055002	283
Garden herbicides & pesticides	0	0
Processed Materials		
Compost PAS 100	0	0
Compost APEX	0	0
Home compost	0	0
Other Compost	0	0
RDF 1.1	0	0
RDF 1.2	0	0
RDF 1.3	0	0
RDF 1.4	0	0
RDF 1.5	0	0
RDF 1.6	0	0
RDF 1.7	0	0
RDF 1.8	0	0
RDF 1.9	0	0
RDF 1.10	0	0
RDF 1.11	0	0
RDF 1.12	0	0
RDF 1.13	0	0
RDF 1.14	0	0
RDF 1.15	0	0

Material type	**Residual**	
	%	**Quantity (tonnes)**
RDF 1.16	0	0
Fiber 1.1	0	0
Fiber 1.2	0	0
Fiber 1.3	0	0
Fiber 1.4	0	0
Fiber 1.5	0	0
Fiber 1.6	0	0
Fiber 1.7	0	0
Fiber 1.8	0	0
Fiber 1.9	0	0
Fiber 1.10	0	0
Fiber 1.11	0	0
Fiber 1.12	0	0
Fiber 1.13	0	0
Fiber 1.14	0	0
Fiber 1.15	0	0
Fiber 1.16	0	0
Stabilite S1	0	0
Stabilite S2	0	0
Stabilite S3	0	0
Stabilite S4	0	0
Stabilite S5	0	0
Stabilite S6	0	0
Stabilite S7	0	0
Stabilite S8	0	0
Stabilite S9	0	0
Stabilite S10	0	0
Stabilite S11	0	0
Stabilite S12	0	0
Stabilite S13	0	0
Stabilite S14	0	0
Stabilite S15	0	0
IBA	0	0
IBA ferrous	0	0
IBA non-ferrous	0	0

Material type	Residual	
	%	Quantity (tonnes)
APCr APC 1	0	0
APCr APC 2	0	0
APCr APC 3	0	0
Non-municipal solid waste		
Sewage sludge (dry basis)	0	0
Waste oils	0	0
Tyres	0	0
Wheat straw	0	0
Meat and bone meal	0	0
AWDF (rendered hoofs, horns, blood etc)	0	0
Untreated willow	0	0
Total	**100**	**514,527**

Table 6.2: NCV data used to model Scenarios under Approach 2

Waste fraction	NCV (MJ/kg)	NCV prorated for 10MJ/kg
Paper/card	10.21	11.96
Non-recyclable paper	9.24	10.82
Dense plastic	23.44	27.45
Plastic film	20.21	23.67
Textiles	13.61	15.94
Misc. combustibles	13.88	16.25
Misc. non-combustibles	2.44	2.86
Glass	1.34	1.57
Ferrous metal	0.00	0.00
Non-ferrous metal	0.00	0.00
Kitchen organics	3.29	3.85
Garden organics	4.00	4.68
Electrical/electronic equipment	6.71	7.85
Potentially hazardous	0.00	0.00
Fines	3.31	3.87
NCV of municipal solid waste	8.54	10.00

A3 Appendix 3: Modelling parameters and energy/mass balance

Table 6.3: Modelling parameters and energy/mass balance for main analysis Scenario and Sensitivity Analysis 1

Modelling year: 2025		Main Analysis				Sensitivity Analysis, Calorific Value (default from WRATE calculation @ 8.54 GJ/tonne)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A	Scenario B	Scenario C	Scenario D	Scenario A.1	Scenario B.1	Scenario C.1	Scenario D.1
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Max capacity ERF/EfW									
Total Capacity	tonnes per year	n/a	540,000	700,000	1,400,000	n/a	540,000	700,000	700,000
WRATE Modelling Parameters									
Electricity Mix	year	2025	2025	2025	2025	2025	2025	2025	2025
Project Name	-	NLWA	NLWA	NLWA	NLWA	NLWA.1	NLWA.1	NLWA.1	NLWA.1
Waste compostion	-	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Original NLWA (2009)	Original NLWA (2009)	Original NLWA (2009)	Original NLWA (2009)
Total LAC waste managed	tonnes per year	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856
Energy and Mass Balance in WRATE									
Process Name	-	n/a	Current EfW	New ERF	AEB EfW	n/a	Current EfW	New ERF	AEB EfW
Pre-treatment		n/a	n/a	n/a	MRF (RDF production)	n/a	n/a	n/a	MRF (RDF production)
MRF process ID#		n/a	n/a	n/a	**11388**	n/a	n/a	**n/a**	11388
EfW/ERF Process ID #	-	n/a	**11382**	**11371**	**11392**	**n/a**	**11389**	**11348**	**11387**
LAC residual waste to EfW/ERF	%	n/a	94.26%	100.00%	48.57%	n/a	94.26%	100.00%	48.57%
LAC residual waste to EfW/ERF	tonnes per year	n/a	540,000	572,856	278,245	n/a	540,000	572,856	278,245
Waste throughput	tonnes per hour	n/a	67.50	71.61	33.86	n/a	67.50	71.61	33.86
Net Calorific Value	GJ/tonne	10.00	10.00	10.00	10.43	8.54	8.54	8.54	8.90
Plant availability	%	n/a	91%	91%	94%	n/a	91%	91%	91%
Availability	**hours per year**	n/a	8,000	8,000	8,217	n/a	8,000	8,000	8,217
Thermal capacity (energy in waste fuel)	MW_{th}	n/a	187.51	198.92	98.07	n/a	160.07	169.81	83.72
Thermal efficiency	%	n/a	90%	90%	81%	n/a	90%	90%	80%
Energy converted to steam	MW_{th}	n/a	168.76	179.03	79.34	n/a	144.06	152.83	67.01
Steam for hot water (3bar/134°C)	MW_{th}	n/a	0.00	34.00	3.36	n/a	0.00	34.00	3.36
Steam for process use (8bar/170°C)	MW_{th}	n/a	0.00	0.00	0.00	n/a	0.00	0.00	0.00
Turbine/generator efficiency	%	n/a	21.67%	31.90%	29.75%	n/a	21.67%	31.88%	29.34%
Gross power output	**MW_e**	n/a	36.56	57.11	23.60	n/a	31.21	48.73	19.66
Gross power efficiency	%	n/a	19.50%	28.71%	24.07%	n/a	19.50%	28.70%	23.49%
Parasitic load	%	n/a	2.13%	3.00%	3.00%	n/a	2.13%	3.00%	3.00%
Parasitic load	MW_e	n/a	4.00	5.97	2.94	n/a	3.42	5.09	2.51
Net power output	**MW_e**	n/a	32.56	51.14	20.66	n/a	27.80	43.63	17.15
Net power output	kWh/tonne	n/a	482.39	714.20	610.16	n/a	411.80	609.34	506.45
Net power efficiency	**%**	n/a	17.37%	25.71%	21.07%	n/a	17.37%	25.70%	20.49%
NCV in WRATE	GJ/tonne	n/a	8.54	8.54	8.90	n/a	8.54	8.54	8.90
Correction factor	-	n/a	1.17	1.17	1.17	n/a	1.00	1.00	1.00
Corrected Net power efficiency	%	n/a	**20.34%**	**30.12%**	**24.68%**	**n/a**	**17.37%**	**25.70%**	**20.49%**
Z Ratio (hot water)	-	n/a	n/a	6.00	6.00	n/a	n/a	6.00	6.00
Overall net system efficiency	**%**	n/a	n/a	42.80%	24.50%	n/a	n/a	45.72%	24.50%
Heat efficiency	**%**	n/a	n/a	17.09%	3.43%	n/a	n/a	20.02%	4.02%
Correction factor for WRATE	-	n/a	n/a	1.17	1.17	n/a	n/a	1.00	1.00
Corrected Net heat efficiency	**%**	n/a	n/a	**20.02%**	**4.02%**	n/a	**n/a**	**20.02%**	**4.02%**
Total net energy recovered from waste at ERF/EfW	**MJ**	n/a	**937,764,000**	**2,452,041,318**	**710,698,921**	**n/a**	**800,544,745**	**2,235,776,102**	**606,810,374**
Total energy in waste	**MJ**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**	**4,890,322,729**	**4,609,839,600**	**4,890,322,729**	**2,476,383,793**
Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	3,364	n/a	n/a	n/a	3,364
Non-Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	4,819	n/a	n/a	n/a	4,819
LAC residual waste to Landfill	tonnes per year	572,856	32,856	0	286,428	572,856	32,856	0	286,428
Net IBA (minus Fe and Non-Fe)	tonnes per year	n/a	75,596	109,352	67,614	n/a	75,596	109,352	67,614
Fe within IBA to recycling	tonnes per year	n/a	9,085	10,708	492	n/a	9,085	10,708	492
Non-Fe within IBA to recycling	tonnes per year	n/a	3,135	7,102	323	n/a	3,135	7,102	323
APC residue	tonnes per year	n/a	18,187	23,003	11,311	n/a	18,187	23,003	11,311

Table 6.4: Modelling parameters and energy/mass balance for Sensitivity Analyses 2, 3 and 4

Modelling year: 2025		Sensitivity Analysis: Electricity Mix (2030)				Sensitivity Analysis: Electricity Mix (2035)				Sensitivity Analysis: Heat Generation (12 MWth)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.2	Scenario B.2	Scenario C.2	Scenario D.2	Scenario A.3	Scenario B.3	Scenario C.3	Scenario D.3	Scenario A.4	Scenario B.4	Scenario C.4	Scenario D.4
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Max capacity ERF/EfW													
Total Capacity	tonnes per year	n/a	540,000	700,000	700,000	n/a	540,000	700,000	700,000	n/a	540,000	700,000	700,000
WRATE Modelling Parameters													
Electricity Mix	year	2030	2030	2030	2030	2035	2035	2035	2035	2025	2025	2025	2025
Project Name	-	NLWA.2	NLWA.2	NLWA.2	NLWA.2	NLWA.3	NLWA.3	NLWA.3	NLWA.3	NLWA.4	NLWA.4	NLWA.4	NLWA.4
Waste compostion	-	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)
Total LAC waste managed	tonnes per year	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856
Energy and Mass Balance in WRATE													
Process Name	-	n/a	Current EfW	New ERF	AEB EfW	n/a	Current EfW	New ERF	AEB EfW	n/a	Current EfW	New ERF	AEB EfW
Pre-treatment		n/a	n/a	n/a	MRF (RDF production)	n/a	n/a	n/a	MRF (RDF production)	n/a	n/a	n/a	MRF (RDF production)
MRF process ID#		n/a	n/a	**n/a**	11388	n/a	n/a	**n/a**	11388	n/a	n/a	**n/a**	11388
EfW/ERF Process ID #	-	**n/a**	**11382**	**11371**	**11392**	**n/a**	**11382**	**11371**	**11392**	**n/a**	**11382**	**11391**	**11392**
LAC residual waste to EfW/ERF	%	n/a	94.26%	100.00%	48.57%	n/a	94.26%	100.00%	48.57%	n/a	94.26%	100.00%	48.57%
LAC residual waste to EfW/ERF	tonnes per year	n/a	540,000	572,856	278,245	n/a	540,000	572,856	278,245	n/a	540,000	572,856	278,245
Waste throughput	tonnes per hour	n/a	67.50	71.61	33.86	n/a	67.50	71.61	33.86	n/a	67.50	71.61	33.86
Net Calorific Value	GJ/tonne	10.00	10.00	10.00	10.43	10.00	10.00	10.00	10.43	10.00	10.00	10.00	10.43
Plant availability	%	n/a	91%	91%	94%	n/a	91%	91%	94%	n/a	91%	91%	94%
Availability	**hours per year**	n/a	8,000	8,000	8,217	n/a	8,000	8,000	8,217	n/a	8,000	8,000	8,217
Thermal capacity (energy in waste fuel)	MW_{th}	n/a	187.51	198.92	98.07	n/a	187.51	198.92	98.07	n/a	187.51	198.92	98.07
Thermal efficiency	%	n/a	90%	90%	81%	n/a	90%	90%	81%	n/a	90%	90%	81%
Energy converted to steam	MW_{th}	n/a	168.76	179.03	79.34	n/a	168.76	179.03	79.34	n/a	168.76	179.03	79.34
Steam for hot water (3bar/134°C)	MW_{th}	n/a	0.00	34.00	3.36	n/a	0.00	34.00	3.36	n/a	0.00	12.00	3.36
Steam for process use (8bar/170°C)	MW_{th}	n/a	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	0.00	0.00
Turbine/generator efficiency	%	n/a	21.67%	31.90%	29.75%	n/a	21.67%	31.90%	29.75%	n/a	21.67%	31.72%	29.75%
Gross power output	**MW_e**	n/a	36.56	57.11	23.60	n/a	36.56	57.11	23.60	n/a	36.56	56.79	23.60
Gross power efficiency	%	n/a	19.50%	28.71%	24.07%	n/a	19.50%	28.71%	24.07%	n/a	19.50%	28.55%	24.07%
Parasitic load	%	n/a	2.13%	3.00%	3.00%	n/a	2.13%	3.00%	3.00%	n/a	2.13%	3.00%	3.00%
Parasitic load	MW_e	n/a	4.00	5.97	2.94	n/a	4.00	5.97	2.94	n/a	4.00	5.97	2.94
Net power output	**MW_e**	n/a	32.56	51.14	20.66	n/a	32.56	51.14	20.66	n/a	32.56	50.82	20.66
Net power output	kWh/tonne	n/a	482.39	714.20	610.16	n/a	482.39	714.20	610.16	n/a	482.39	709.68	610.16
Net power efficiency	**%**	n/a	17.37%	25.71%	21.07%	n/a	17.37%	25.71%	21.07%	n/a	17.37%	25.55%	21.07%
NCV in WRATE	GJ/tonne	n/a	8.54	8.54	8.90	n/a	8.54	8.54	8.90	n/a	8.54	8.54	8.90
Correction factor	-	n/a	1.17	1.17	1.17	n/a	1.17	1.17	1.17	n/a	1.17	1.17	1.17
Corrected Net power efficiency	%	**n/a**	**20.34%**	**30.12%**	**24.68%**	**n/a**	**20.34%**	**30.12%**	**24.68%**	**n/a**	**20.34%**	**29.93%**	**24.68%**
Z Ratio (hot water)	-	n/a	n/a	6.00	6.00	n/a	n/a	6.00	6.00	n/a	n/a	6.00	6.00
Overall net system efficiency	**%**	n/a	n/a	42.80%	24.50%	n/a	n/a	42.80%	24.50%	n/a	n/a	31.58%	24.50%
Heat efficiency	**%**	n/a	n/a	17.09%	3.43%	n/a	n/a	17.09%	3.43%	n/a	n/a	6.03%	3.43%
Correction factor for WRATE	-	n/a	n/a	1.17	1.17	n/a	n/a	1.17	1.17	n/a	n/a	1.17	1.17
Corrected Net heat efficiency	**%**	n/a	**n/a**	**20.02%**	**4.02%**	n/a	**n/a**	**20.02%**	**4.02%**	n/a	**n/a**	**7.07%**	**4.02%**
Total net energy recovered from waste at ERF/EfW	**MJ**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**	**n/a**	**937,764,000**	**1,809,153,245**	**710,698,921**
Total energy in waste	**MJ**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**
Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	3,364	n/a	n/a	n/a	3,364	n/a	n/a	n/a	3,364
Non-Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	4,819	n/a	n/a	n/a	4,819	n/a	n/a	n/a	4,819
LAC residual waste to Landfill	tonnes per year	572,856	32,856	0	286,428	572,856	32,856	0	286,428	572,856	32,856	0	286,428
Net IBA (minus Fe and Non-Fe)	tonnes per year	n/a	75,596	109,352	67,614	n/a	75,596	109,352	67,614	n/a	75,596	109,352	67,614
Fe within IBA to recycling	tonnes per year	n/a	9,085	10,708	492	n/a	9,085	10,708	492	n/a	9,085	10,708	492
Non-Fe within IBA to recycling	tonnes per year	n/a	3,135	7,102	323	n/a	3,135	7,102	323	n/a	3,135	7,102	323
APC residue	tonnes per year	n/a	18,187	23,003	11,311	n/a	18,187	23,003	11,311	n/a	18,187	23,003	11,311

Table 6.5: Modelling parameters and energy/mass balance for Sensitivity Analyses 5, 6 and 7

Modelling year: 2025		Sensitivty Analysis: DECC electricity mix (2025)				Sensitivty Analysis: DECC electricity mix (2030)				Sensitivty Analysis: DECC electricity mix (2035)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.5	Scenario B.5	Scenario C.5	Scenario D.5	Scenario A.6	Scenario B.6	Scenario C.6	Scenario D.6	Scenario A.7	Scenario B.7	Scenario C.7	Scenario D.7
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Max capacity ERF/EfW													
Total Capacity	tonnes per year	n/a	540,000	700,000	1,400,000	n/a	540,000	700,000	1,400,000	n/a	540,000	700,000	1,400,000
WRATE Modelling Parameters													
Electricity Mix	year	DECC 2025	DECC 2025	DECC 2025	DECC 2025	DECC 2030	DECC 2030	DECC 2030	DECC 2030	DECC 2035	DECC 2035	DECC 2035	DECC 2035
Project Name	-	NLWA DECC	NLWA DECC	NLWA DECC	NLWA DECC	NLWA.2 DECC	NLWA.2 DECC	NLWA.2 DECC	NLWA.2 DECC	NLWA.3 DECC	NLWA.3 DECC	NLWA.3 DECC	NLWA.3 DECC
Waste compostion	-	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)
Total LAC waste managed	tonnes per year	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856
Energy and Mass Balance in WRATE													
Process Name	-	n/a	Current EfW	New ERF	AEB EfW	n/a	Current EfW	New ERF	AEB EfW	n/a	Current EfW	New ERF	AEB EfW
Pre-treatment		n/a	n/a	n/a	MRF (RDF production)	n/a	n/a	n/a	MRF (RDF production)	n/a	n/a	n/a	MRF (RDF production)
MRF process ID#		n/a	n/a	**n/a**	11388	n/a	n/a	**n/a**	11388	n/a	n/a	**n/a**	11388
EfW/ERF Process ID #	-	**n/a**	**11382**	**11371**	**11392**	**n/a**	**11382**	**11371**	**11392**	**n/a**	**11382**	**11371**	**11392**
LAC residual waste to EfW/ERF	%	n/a	94.26%	100.00%	48.57%	n/a	94.26%	100.00%	48.57%	n/a	94.26%	100.00%	48.57%
LAC residual waste to EfW/ERF	tonnes per year	n/a	540,000	572,856	278,245	n/a	540,000	572,856	278,245	n/a	540,000	572,856	278,245
Waste throughput	tonnes per hour	n/a	67.50	71.61	33.86	n/a	67.50	71.61	33.86	n/a	67.50	71.61	33.86
Net Calorific Value	GJ/tonne	10.00	10.00	10.00	10.43	10.00	10.00	10.00	10.43	10.00	10.00	10.00	10.43
Plant availability	%	n/a	91%	91%	94%	n/a	91%	91%	94%	n/a	91%	91%	94%
Availability	**hours per year**	n/a	8,000	8,000	8,217	n/a	8,000	8,000	8,217	n/a	8,000	8,000	8,217
Thermal capacity (energy in waste fuel)	MW_{th}	n/a	187.51	198.92	98.07	n/a	187.51	198.92	98.07	n/a	187.51	198.92	98.07
Thermal efficiency	%	n/a	90%	90%	81%	n/a	90%	90%	81%	n/a	90%	90%	81%
Energy converted to steam	MW_{th}	n/a	168.76	179.03	79.34	n/a	168.76	179.03	79.34	n/a	168.76	179.03	79.34
Steam for hot water (3bar/134°C)	MW_{th}	n/a	0.00	34.00	3.36	n/a	0.00	34.00	3.36	n/a	0.00	34.00	3.36
Steam for process use (8bar/170°C)	MW_{th}	n/a	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	0.00	0.00
Turbine/generator efficiency	%	n/a	21.67%	31.90%	29.75%	n/a	21.67%	31.90%	29.75%	n/a	21.67%	31.90%	29.75%
Gross power output	MW_e	n/a	36.56	57.11	23.60	n/a	36.56	57.11	23.60	n/a	36.56	57.11	23.60
Gross power efficiency	%	n/a	19.50%	28.71%	24.07%	n/a	19.50%	28.71%	24.07%	n/a	19.50%	28.71%	24.07%
Parasitic load	%	n/a	2.13%	3.00%	3.00%	n/a	2.13%	3.00%	3.00%	n/a	2.13%	3.00%	3.00%
Parasitic load	MW_e	n/a	4.00	5.97	2.94	n/a	4.00	5.97	2.94	n/a	4.00	5.97	2.94
Net power output	MW_e	n/a	32.56	51.14	20.66	n/a	32.56	51.14	20.66	n/a	32.56	51.14	20.66
Net power output	kWh/tonne	n/a	482.39	714.20	610.16	n/a	482.39	714.20	610.16	n/a	482.39	714.20	610.16
Net power efficiency	%	n/a	17.37%	25.71%	21.07%	n/a	17.37%	25.71%	21.07%	n/a	17.37%	25.71%	21.07%
NCV in WRATE	GJ/tonne	n/a	8.54	8.54	8.90	n/a	8.54	8.54	8.90	n/a	8.54	8.54	8.90
Correction factor	-	n/a	1.17	1.17	1.17	n/a	1.17	1.17	1.17	n/a	1.17	1.17	1.17
Corrected Net power efficiency	%	**n/a**	**20.34%**	**30.12%**	**24.68%**	**n/a**	**20.34%**	**30.12%**	**24.68%**	**n/a**	**20.34%**	**30.12%**	**24.68%**
Z Ratio (hot water)	-	n/a	n/a	6.00	6.00	n/a	n/a	6.00	6.00	n/a	n/a	6.00	6.00
Overall net system efficiency	%	n/a	n/a	42.80%	24.50%	n/a	n/a	42.80%	24.50%	n/a	n/a	42.80%	24.50%
Heat efficiency	%	n/a	n/a	17.09%	3.43%	n/a	n/a	17.09%	3.43%	n/a	n/a	17.09%	3.43%
Correction factor for WRATE	-	n/a	n/a	1.17	1.17	n/a	n/a	1.17	1.17	n/a	n/a	1.17	1.17
Corrected Net heat efficiency	%	n/a	**n/a**	**20.02%**	**4.02%**	n/a	**n/a**	**20.02%**	**4.02%**	n/a	**n/a**	**20.02%**	**4.02%**
Total net energy recovered from waste at ERF/EfW	**MJ**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**
Total energy in waste	**MJ**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**
Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	3,364	n/a	n/a	n/a	3,364	n/a	n/a	n/a	3,364
Non-Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	4,819	n/a	n/a	n/a	4,819	n/a	n/a	n/a	4,819
LAC residual waste to Landfill	tonnes per year	572,856	32,856	0	286,428	572,856	32,856	0	286,428	572,856	32,856	0	286,428
Net IBA (minus Fe and Non-Fe)	tonnes per year	n/a	75,596	109,352	67,614	n/a	75,596	109,352	67,614	n/a	75,596	109,352	67,614
Fe within IBA to recycling	tonnes per year	n/a	9,085	10,708	492	n/a	9,085	10,708	492	n/a	9,085	10,708	492
Non-Fe within IBA to recycling	tonnes per year	n/a	3,135	7,102	323	n/a	3,135	7,102	323	n/a	3,135	7,102	323
APC residue	tonnes per year	n/a	18,187	23,003	11,311	n/a	18,187	23,003	11,311	n/a	18,187	23,003	11,311

Table 6.6: Modelling parameters and energy/mass balance for Sensitivity Analyses 8, 9 and 10

Modelling year: 2025		Sensitivty Analysis: NG electricity mix (2025)				Sensitivty Analysis: NG electricity mix (2030)				Sensitivty Analysis: NG electricity mix (2035)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.8	Scenario B.8	Scenario C.8	Scenario D.8	Scenario A.9	Scenario B.9	Scenario C.9	Scenario D.9	Scenario A.10	Scenario B.10	Scenario C.10	Scenario D.10
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Max capacity ERF/EfW													
Total Capacity	tonnes per year	n/a	540,000	700,000	1,400,000	n/a	540,000	700,000	1,400,000	n/a	540,000	700,000	1,400,000
WRATE Modelling Parameters													
Electricity Mix	year	NG 2025	NG 2025	NG 2025	NG 2025	NG 2030	NG 2030	NG 2030	NG 2030	NG 2035	NG 2035	NG 2035	NG 2035
Project Name	-	NLWA NG	NLWA NG	NLWA NG	NLWA NG	NLWA.2 NG	NLWA.2 NG	NLWA.2 NG	NLWA.2 NG	NLWA.3 NG	NLWA.3 NG	NLWA.3 NG	NLWA.3 NG
Waste compostion	-	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)
Total LAC waste managed	tonnes per year	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856	572,856
Energy and Mass Balance in WRATE													
Process Name	-	n/a	Current EfW	New ERF	AEB EfW	n/a	Current EfW	New ERF	AEB EfW	n/a	Current EfW	New ERF	AEB EfW
Pre-treatment		n/a	n/a	n/a	MRF (RDF production)	n/a	n/a	n/a	MRF (RDF production)	n/a	n/a	n/a	MRF (RDF production)
MRF process ID#		n/a	n/a	**n/a**	11388	n/a	n/a	**n/a**	11388	n/a	n/a	**n/a**	11388
EfW/ERF Process ID #	-	**n/a**	**11382**	**11371**	**11392**	**n/a**	**11382**	**11371**	**11392**	**n/a**	**11382**	**11371**	**11392**
LAC residual waste to EfW/ERF	%	n/a	94.26%	100.00%	48.57%	n/a	94.26%	100.00%	48.57%	n/a	94.26%	100.00%	48.57%
LAC residual waste to EfW/ERF	tonnes per year	n/a	540,000	572,856	278,245	n/a	540,000	572,856	278,245	n/a	540,000	572,856	278,245
Waste throughput	tonnes per hour	n/a	67.50	71.61	33.86	n/a	67.50	71.61	33.86	n/a	67.50	71.61	33.86
Net Calorific Value	GJ/tonne	10.00	10.00	10.00	10.43	10.00	10.00	10.00	10.43	10.00	10.00	10.00	10.43
Plant availability	%	n/a	91%	91%	94%	n/a	91%	91%	94%	n/a	91%	91%	94%
Availability	**hours per year**	n/a	8,000	8,000	8,217	n/a	8,000	8,000	8,217	n/a	8,000	8,000	8,217
Thermal capacity (energy in waste fuel)	MW_{th}	n/a	187.51	198.92	98.07	n/a	187.51	198.92	98.07	n/a	187.51	198.92	98.07
Thermal efficiency	%	n/a	90%	90%	81%	n/a	90%	90%	81%	n/a	90%	90%	81%
Energy converted to steam	MW_{th}	n/a	168.76	179.03	79.34	n/a	168.76	179.03	79.34	n/a	168.76	179.03	79.34
Steam for hot water (3bar/134°C)	MW_{th}	n/a	0.00	34.00	3.36	n/a	0.00	34.00	3.36	n/a	0.00	34.00	3.36
Steam for process use (8bar/170°C)	MW_{th}	n/a	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	0.00	0.00
Turbine/generator efficiency	%	n/a	21.67%	31.90%	29.75%	n/a	21.67%	31.90%	29.75%	n/a	21.67%	31.90%	29.75%
Gross power output	**MW_e**	n/a	36.56	57.11	23.60	n/a	36.56	57.11	23.60	n/a	36.56	57.11	23.60
Gross power efficiency	%	n/a	19.50%	28.71%	24.07%	n/a	19.50%	28.71%	24.07%	n/a	19.50%	28.71%	24.07%
Parasitic load	%	n/a	2.13%	3.00%	3.00%	n/a	2.13%	3.00%	3.00%	n/a	2.13%	3.00%	3.00%
Parasitic load	MW_e	n/a	4.00	5.97	2.94	n/a	4.00	5.97	2.94	n/a	4.00	5.97	2.94
Net power output	**MW_e**	n/a	32.56	51.14	20.66	n/a	32.56	51.14	20.66	n/a	32.56	51.14	20.66
Net power output	kWh/tonne	n/a	482.39	714.20	610.16	n/a	482.39	714.20	610.16	n/a	482.39	714.20	610.16
Net power efficiency	**%**	n/a	17.37%	25.71%	21.07%	n/a	17.37%	25.71%	21.07%	n/a	17.37%	25.71%	21.07%
NCV in WRATE	GJ/tonne	n/a	8.54	8.54	8.90	n/a	8.54	8.54	8.90	n/a	8.54	8.54	8.90
Correction factor	-	n/a	1.17	1.17	1.17	n/a	1.17	1.17	1.17	n/a	1.17	1.17	1.17
Corrected Net power efficiency	%	**n/a**	**20.34%**	**30.12%**	**24.68%**	**n/a**	**20.34%**	**30.12%**	**24.68%**	**n/a**	**20.34%**	**30.12%**	**24.68%**
Z Ratio (hot water)	-	n/a	n/a	6.00	6.00	n/a	n/a	6.00	6.00	n/a	n/a	6.00	6.00
Overall net system efficiency	**%**	n/a	n/a	42.80%	24.50%	n/a	n/a	42.80%	24.50%	n/a	n/a	42.80%	24.50%
Heat efficiency	%	n/a	n/a	17.09%	3.43%	n/a	n/a	17.09%	3.43%	n/a	n/a	17.09%	3.43%
Correction factor for WRATE	-	n/a	n/a	1.17	1.17	n/a	n/a	1.17	1.17	n/a	n/a	1.17	1.17
Corrected Net heat efficiency	**%**	n/a	**n/a**	**20.02%**	**4.02%**	n/a	**n/a**	**20.02%**	**4.02%**	n/a	**n/a**	**20.02%**	**4.02%**
Total net energy recovered from waste at ERF/EfW	**MJ**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**
Total energy in waste	**MJ**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**
Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	3,364	n/a	n/a	n/a	3,364	n/a	n/a	n/a	3,364
Non-Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	4,819	n/a	n/a	n/a	4,819	n/a	n/a	n/a	4,819
LAC residual waste to Landfill	tonnes per year	572,856	32,856	0	286,428	572,856	32,856	0	286,428	572,856	32,856	0	286,428
Net IBA (minus Fe and Non-Fe)	tonnes per year	n/a	75,596	109,352	67,614	n/a	75,596	109,352	67,614	n/a	75,596	109,352	67,614
Fe within IBA to recycling	tonnes per year	n/a	9,085	10,708	492	n/a	9,085	10,708	492	n/a	9,085	10,708	492
Non-Fe within IBA to recycling	tonnes per year	n/a	3,135	7,102	323	n/a	3,135	7,102	323	n/a	3,135	7,102	323
APC residue	tonnes per year	n/a	18,187	23,003	11,311	n/a	18,187	23,003	11,311	n/a	18,187	23,003	11,311

Table 6.7: Modelling parameters and energy/mass balance for Sensitivity Analysis 11

Modelling year: 2025		Sensitivity Analysis: Netherlands electricity mix (2012)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.11	Scenario B.11	Scenario C.11	Scenario D.11
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Max capacity ERF/EfW					
Total Capacity	tonnes per year	n/a	540,000	700,000	1,400,000
WRATE Modelling Parameters					
Electricity Mix	year	NL 2012	NL 2012	NL 2012	NL 2012
Project Name	-	NLWA NL	NLWA NL	NLWA NL	NLWA NL
Waste compostion	-	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)	Amended NLWA (2009)
Total LAC waste managed	tonnes per year	572,856	572,856	572,856	572,856
Energy and Mass Balance in WRATE					
Process Name	-	n/a	Current EfW	New ERF	AEB EfW
Pre-treatment		n/a	n/a	n/a	MRF (RDF production)
MRF process ID#		n/a	n/a	**n/a**	11388
EfW/ERF Process ID #	-	**n/a**	**11382**	**11371**	**11392**
LAC residual waste to EfW/ERF	%	n/a	94.26%	100.00%	48.57%
LAC residual waste to EfW/ERF	tonnes per year	n/a	540,000	572,856	278,245
Waste throughput	tonnes per hour	n/a	67.50	71.61	33.86
Net Calorific Value	GJ/tonne	10.00	10.00	10.00	10.43
Plant availability	%	n/a	91%	91%	94%
Availability	**hours per year**	n/a	8,000	8,000	8,217
Thermal capacity (energy in waste fuel)	MW_{th}	n/a	187.51	198.92	98.07
Thermal efficiency	%	n/a	90%	90%	81%
Energy converted to steam	MW_{th}	n/a	168.76	179.03	79.34
Steam for hot water (3bar/134°C)	MW_{th}	n/a	0.00	34.00	3.36
Steam for process use (8bar/170°C)	MW_{th}	n/a	0.00	0.00	0.00
Turbine/generator efficiency	%	n/a	21.67%	31.90%	29.75%
Gross power output	**MW_e**	n/a	36.56	57.11	23.60
Gross power efficiency	%	n/a	19.50%	28.71%	24.07%
Parasitic load	%	n/a	2.13%	3.00%	3.00%
Parasitic load	MW_e	n/a	4.00	5.97	2.94
Net power output	**MW_e**	n/a	32.56	51.14	20.66
Net power output	kWh/tonne	n/a	482.39	714.20	610.16
Net power efficiency	**%**	n/a	17.37%	25.71%	21.07%
NCV in WRATE	GJ/tonne	n/a	8.54	8.54	8.90
Correction factor	-	n/a	1.17	1.17	1.17
Corrected Net power efficiency	%	**n/a**	**20.34%**	**30.12%**	**24.68%**
Z Ratio (hot water)	-	n/a	n/a	6.00	6.00
Overall net system efficiency	**%**	n/a	n/a	42.80%	24.50%
Heat efficiency	%	n/a	n/a	17.09%	3.43%
Correction factor for WRATE	-	n/a	n/a	1.17	1.17
Corrected Net heat efficiency	**%**	n/a	**n/a**	**20.02%**	**4.02%**
Total net energy recovered from waste at ERF/EfW	**MJ**	**n/a**	**937,764,000**	**2,452,041,318**	**710,698,921**
Total energy in waste	**MJ**	**5,728,560,000**	**5,400,000,000**	**5,728,560,000**	**2,900,854,182**
Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	3,364
Non-Fe metal extraction at MRF	tonnes per year	n/a	n/a	n/a	4,819
LAC residual waste to Landfill	tonnes per year	572,856	32,856	0	286,428
Net IBA (minus Fe and Non-Fe)	tonnes per year	n/a	75,596	109,352	67,614
Fe within IBA to recycling	tonnes per year	n/a	9,085	10,708	492
Non-Fe within IBA to recycling	tonnes per year	n/a	3,135	7,102	323
APC residue	tonnes per year	n/a	18,187	23,003	11,311

A4 Appendix 4: Default WRATE electricity mix (UK: 2025, 2030 and 2035, and the Netherlands: 2012)

A4.1.1 Note: Transmission losses are the same for all three UK electricity mixes:

a. high voltage, 1.81 per cent;
b. medium voltage, 4.74 per cent; and
c. low voltage, 7.68 per cent.

A4.1.2 For the Netherlands electricity mix, transmission losses are:

a. high voltage, 0.26 per cent;
b. medium voltage, 0.75 per cent; and
c. low voltage, 3.75 per cent.

Table 6.8: 2025 UK default electricity mix from WRATE

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	2.86	33.92	8.06
Oil	0.40	26.49	0.00
Gas	1.90	41.19	0.00
Gas CCGT	28.05	46.84	91.94
Nuclear	21.43	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.55	22.64	0.00
Renewables thermal	7.47	27.47	0.00
Solar PV	0.00	15.52	0.00
Wind	26.80	25.00	0.00
Tidal	7.03	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	2.21	82.00	0.00
Geothermal	0.00	82.00	0.00
Renewable other	1.29	82.00	0.00
Total	**100.00**	**N/A**	**100.00**

Table 6.9: 2030 UK default electricity mix from WRATE

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	4.43	33.92	14.15
Oil	0.31	26.49	0.00
Gas	1.56	41.19	0.00
Gas CCGT	22.92	46.84	85.85
Nuclear	28.85	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.49	22.64	0.00
Renewables thermal	6.59	27.47	0.00
Solar PV	0.00	15.52	0.00
Wind	24.97	25.00	0.00
Tidal	6.81	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	1.88	82.00	0.00
Geothermal	0.00	82.00	0.00
Renewable other	1.19	82.00	0.00
Total	**100.00**	**N/A**	**100.00**

Table 6.10: 2035 UK default electricity mix from WRATE

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	7.54	33.92	30.98
Oil	0.27	26.49	0.00
Gas	0.95	41.19	0.00
Gas CCGT	14.00	46.84	69.02
Nuclear	38.11	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.44	22.64	0.00
Renewables thermal	6.15	27.47	0.00
Solar PV	0.00	15.52	0.00
Wind	23.24	25.00	0.00
Tidal	6.47	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	1.74	82.00	0.00
Geothermal	0.00	82.00	0.00

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Renewable other	1.10	82.00	0.00
Total	**100.00**	**N/A**	**100.00**

Table 6.11: 2012 Netherlands default electricity mix from WRATE

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	26.64	29.10	27.70
Oil	1.07	27.60	1.11
Gas	54.38	34.90	56.54
Gas CCGT	0.00	46.84	0.00
Nuclear	3.82	27.70	0.00
Waste	3.89	25.30	4.05
Thermal other	0.14	22.64	0.15
Renewables thermal	4.85	18.10	5.04
Solar PV	0.25	15.50	0.26
Wind	4.86	25.00	5.05
Tidal	0.00	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	0.10	82.00	0.11
Geothermal	0.00	82.00	0.00
Renewable other	0.00	82.00	0.00
Total	**100.00**	**N/A**	**100.00**

A5 Appendix 5: DECC electricity mix (2025, 2030 and 2035)

A5.1.1 Based on the DECC ‘reference scenario’.

A5.1.2 Note: Transmission losses are as per the UK default mix and are the same for all three DECC electricity mixes:

a. high voltage, 1.81 per cent;

b. medium voltage, 4.74 per cent; and

c. low voltage, 7.68 per cent.

Table 6.12: 2025 DECC electricity mix

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	1.24	33.92	3.77
Oil	0.40	26.49	0.00
Gas	0.00	41.19	0.00
Gas CCGT	31.58	46.84	96.23
Nuclear	21.43	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.55	22.64	0.00
Renewables thermal	7.47	27.47	0.00
Solar PV	0.00	15.52	0.00
Wind	26.80	25.00	0.00
Tidal	7.03	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	2.21	82.00	0.00
Geothermal	0.00	82.00	0.00
Renewable other	1.29	82.00	0.00
Total	**100.00**	**N/A**	**100.00**

Table 6.13: 2030 DECC electricity mix

Energy Source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	0.00	33.92	0.00
Oil	0.31	26.49	0.00
Gas	0.00	41.19	0.00
Gas CCGT	28.91	46.84	100.00

Energy Source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Nuclear	28.85	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.49	22.64	0.00
Renewables thermal	6.59	27.47	0.00
Solar PV	0.00	15.52	0.00
Wind	24.97	25.00	0.00
Tidal	6.81	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	1.88	82.00	0.00
Geothermal	0.00	82.00	0.00
Renewable other	1.19	82.00	0.00
Total	**100.00**	**N/A**	**100.00**

Table 6.14: 2035 DECC electricity mix

Energy Source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	0.00	33.92	0.00
Oil	0.27	26.49	0.00
Gas	0.00	41.19	0.00
Gas CCGT	22.49	46.84	100.00
Nuclear	38.11	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.44	22.64	0.00
Renewables thermal	6.15	27.47	0.00
Solar PV	0.00	15.52	0.00
Wind	23.24	25.00	0.00
Tidal	6.47	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	1.74	82.00	0.00
Geothermal	0.00	82.00	0.00
Renewable other	1.10	82.00	0.00
Total	**100.00**	**N/A**	**100.00**

A6 Appendix 6: National Grid electricity mix (2025, 2030 and 2035)

A6.1.1 Based on the NG 'gone green' projection.

A6.1.2 Note: transmission losses are as per the UK default mix and are the same for all three National Grid electricity mixes:

a. high voltage, 1.81 per cent;
b. medium voltage, 4.74 per cent; and
c. low voltage, 7.68 per cent.

Table 6.15: 2025 National Grid electricity mix

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	3.86	33.92	0.00
Oil	0.02	26.49	0.00
Gas	0.00	41.19	0.00
Gas CCGT	30.18	46.84	0.00
Nuclear	12.16	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.00	22.64	0.00
Renewables thermal	7.17	27.47	13.33
Solar PV	2.55	15.52	4.74
Wind	38.87	25.00	72.26
Tidal	0.00	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	2.64	82.00	4.91
Geothermal	0.00	82.00	0.00
Renewable other	2.55	82.00	4.75
Total	**100.00**	**N/A**	**100.00**

Table 6.16: 2030 National Grid electricity mix

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	0.46	33.92	0.00
Oil	0.01	26.49	0.00
Gas	0.00	41.19	0.00
Gas CCGT	30.61	46.84	0.00

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Nuclear	14.70	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.00	22.64	0.00
Renewables thermal	6.18	27.47	11.39
Solar PV	3.00	15.52	5.54
Wind	38.94	25.00	71.83
Tidal	0.00	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	3.40	82.00	6.27
Geothermal	0.00	82.00	0.00
Renewable other	2.69	82.00	4.97
Total	**100.00**	**N/A**	**100.00**

Table 6.17: 2035 National Grid electricity mix

Energy source	Baseline fuel mix (%)	Generating efficiencies (%)	Marginal fuel mix (%)
Coal	0.44	33.92	0.00
Oil	0.01	26.49	0.00
Gas	0.00	41.19	0.00
Gas CCGT	26.86	46.84	0.00
Nuclear	16.52	35.71	0.00
Waste	0.00	19.38	0.00
Thermal other	0.00	22.64	0.00
Renewables thermal	5.69	27.47	10.13
Solar PV	3.69	15.52	6.57
Wind	40.20	25.00	71.56
Tidal	0.00	82.00	0.00
Wave	0.00	82.00	0.00
Hydro	3.56	82.00	6.33
Geothermal	0.00	82.00	0.00
Renewable other	3.04	82.00	5.41
Total	**100.00**	**N/A**	**100.00**

A7 Appendix 7: Modelling results

Table 6.18: Modelling results for the main analysis and Sensitivity Analysis 1

Modelling year: 2025		Main Analysis				Sensitivity Analysis: Calorific Value (default from WRATE calculation @ 8.64 GJ/tonne)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A	Scenario B	Scenario C	Scenario D	Scenario A.1	Scenario B.1	Scenario C.1	Scenario D.1
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Modelling results									
Approach 1: WRATE Model (database v3.0.1.8)									
Direct process burdens from EfW/ERF	**kgCO2e**	n/a	167,103,223	177,270,592	98,570,323	n/a	167,103,223	177,270,592	98,570,323
Net energy recovered from EfW/ERF	MJ	n/a	937,764,000	2,452,041,318	710,698,921	n/a	800,544,745	2,235,776,102	606,810,374
Net energy recovered from EfW/ERF	kWh	n/a	260,490,000	681,122,588	197,416,367	n/a	222,373,540	621,048,917	168,558,437
Gross energy recovered from EfW/ERF	**kWh**	n/a	292,500,000	728,860,588	221,590,152	n/a	249,699,645	661,801,607	189,194,969
Performance against the CIF	gCO2e/kWh	n/a	571.3	243.2	444.8	n/a	669.2	267.9	521.0
Environmental Indicators:									
Global Warming Potential	kgCO2e	302,770,144	26,313,579	-162,651,631	105,717,941	302,770,144	46,550,476	-130,757,467	121,045,731
Acidification Potential	kgSO2e	164,541	77,407	-312,683	-176,520	164,541	91,774	-290,042	-165,639
Eutrophication Potential	kgPO4e	203,388	59,559	-14,031	82,655	203,388	62,564	-9,296	84,931
Freshwater Aquatic Ecotoxicity	kg1,4-DCBe	1,239,185	-13,436,251	-30,007,256	-24,924,505	1,239,185	-12,823,201	-29,041,065	-24,460,170
Human Toxicity	kg1,4-DCBe	9,746,422	-139,955,603	-320,615,824	-289,528,324	9,746,422	-136,534,036	-315,223,297	-286,936,767
Abiotic Resource Depletion	kg antimony-eq	-129,472	-1,297,536	-2,686,365	-1,122,396	-129,472	-1,129,646	-2,421,763	-995,233
Normalised									
Global Warming Potential	Eur.Person.Eq	23,426	2,036	-12,585	8,180	23,426	3,602	-10,117	9,366
Acidification Potential	Eur.Person.Eq	2,300	1,082	-4,371	-2,467	2,300	1,283	-4,054	-2,315
Eutrophication Potential	Eur.Person.Eq	6,086	1,782	-420	2,473	6,086	1,872	-278	2,541
Freshwater Aquatic Ecotoxicity Potential	Eur.Person.Eq	940	-10,190	-22,758	-18,903	940	-9,725	-22,025	-18,551
Human Toxicity Potential	Eur.Person.Eq	493	-7,081	-16,221	-14,649	493	-6,908	-15,949	-14,517
Abiotic Resource Depletion Potential	Eur.Person.Eq	-3,351	-33,578	-69,519	-29,046	-3,351	-29,233	-62,671	-25,755
Approach 2: Mayor of London GHG calculator for MSW (v2.1)									
Direct combustion emissions	**kgCO2e**	n/a	207,293,095	219,905,728	109,952,864	n/a	207,293,095	219,905,728	109,952,864
Gross energy recovered	**kWh**	n/a	292,517,651	728,844,113	218,809,187	n/a	249,813,271	662,071,837	186,894,657
Performance against the CIF	**gCO2e/kWh**	n/a	708.7	301.7	502.5	n/a	829.8	332.1	588.3
			0.8062	0.8061	0.8852				
Power output equivalent (3,300 kWh / home / year)	# homes per year	n/a	88,642	220,862	66,306	n/a	75,701	200,628	56,635
Heat output equivalent (16,500 kWh / home / year)	# homes per year	n/a	17,728	44,172	13,261	n/a	15,140	40,126	11,327

Table 6.19: Modelling results for Sensitivity Analyses 2, 3 and 4

Modelling year: 2025		Sensitivity Analysis: Electricity Mix (2030)				Sensitivity Analysis: Electricity Mix (2035)				Sensitivity Analysis: Heat Generation (12 MWth)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.2	Scenario B.2	Scenario C.2	Scenario D.2	Scenario A.3	Scenario B.3	Scenario C.3	Scenario D.3	Scenario A.4	Scenario B.4	Scenario C.4	Scenario D.4
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Modelling results													
Approach 1: WRATE Model (database v3.0.1.8)													
Direct process burdens from EfW/ERF	**kgCO2e**	n/a	167,103,223	177,270,592	98,570,323	n/a	167,103,223	177,270,592	98,570,323	n/a	167,103,223	177,270,592	98,570,323
Net energy recovered from EfW/ERF	MJ	n/a	937,764,000	2,452,041,318	710,698,921	n/a	937,764,000	2,452,041,318	710,698,921	n/a	937,764,000	1,809,153,245	710,698,921
Net energy recovered from EfW/ERF	kWh	n/a	260,490,000	681,122,588	197,416,367	n/a	260,490,000	681,122,588	197,416,367	n/a	260,490,000	502,542,568	197,416,367
Gross energy recovered from EfW/ERF	**kWh**	n/a	292,500,000	728,860,588	221,590,152	n/a	292,500,000	728,860,588	221,590,152	n/a	292,500,000	550,280,568	221,590,152
Performance against the CIF	gCO2e/kWh	n/a	571.3	243.2	444.8	n/a	571.3	243.2	444.8	n/a	571.3	322.1	444.8
Environmental Indicators:													
Global Warming Potential	kgCO2e	300,621,567	14,345,949	-181,248,307	96,832,914	294,683,202	-18,645,917	-232,544,930	72,486,130	302,770,144	26,313,376	-115,708,284	105,717,941
Acidification Potential	kgSO2e	160,067	52,543	-351,341	-194,884	147,701	-15,971	-457,932	-245,118	164,541	77,407	-273,530	-176,520
Eutrophication Potential	kgPO4e	203,084	57,852	-16,677	81,361	202,245	53,183	-23,935	77,902	203,388	59,559	-10,278	82,655
Freshwater Aquatic Ecotoxicity	kg1,4-DCBe	1,241,317	-13,427,632	-29,992,735	-24,923,799	1,247,211	-13,399,393	-29,947,266	-24,910,852	1,239,185	-13,436,251	-29,260,081	-24,924,505
Human Toxicity	kg1,4-DCBe	9,728,898	-140,075,247	-320,794,113	-289,655,647	9,680,465	-140,370,837	-321,244,510	-289,920,219	9,746,422	-139,955,608	-313,751,211	-289,528,324
Abiotic Resource Depletion	kg antimony-eq	-145,773	-1,388,367	-2,827,498	-1,189,895	-190,827	-1,638,768	-3,216,795	-1,374,852	-129,472	-1,297,536	-2,301,275	-1,122,396
Normalised													
Global Warming Potential	Eur.Person.Eq	23,260	1,110	-14,024	7,492	22,801	-1,443	-17,993	5,609	23,426	2,036	-8,953	8,180
Acidification Potential	Eur.Person.Eq	2,237	734	-4,911	-2,724	2,065	-223	-6,401	-3,426	2,300	1,082	-3,823	-2,467
Eutrophication Potential	Eur.Person.Eq	6,077	1,731	-499	2,434	6,052	1,591	-716	2,331	6,086	1,782	-308	2,473
Freshwater Aquatic Ecotoxicity Potential	Eur.Person.Eq	941	-10,184	-22,747	-18,903	946	-10,162	-22,712	-18,893	940	-10,190	-22,191	-18,903
Human Toxicity Potential	Eur.Person.Eq	492	-7,087	-16,230	-14,655	490	-7,102	-16,253	-14,668	493	-7,081	-15,874	-14,649
Abiotic Resource Depletion Potential	Eur.Person.Eq	-3,772	-35,929	-73,171	-30,793	-4,938	-42,409	-83,245	-35,579	-3,351	-33,578	-59,553	-29,046
Approach 2: Mayor of London GHG calculator for MSW (v2.1)													
Direct combustion emissions	**kgCO2e**	n/a	207,293,095	219,905,728	109,952,864	n/a	207,293,095	219,905,728	109,952,864	n/a	207,293,095.0	219,905,728.0	109,952,864.0
Gross energy recovered	**kWh**	n/a	292,517,651	728,844,113	218,809,187	n/a	292,517,651	728,844,113	218,809,187	n/a	292,517,651.0	550,302,767.0	218,809,187.0
Performance against the CIF	**gCO2e/kWh**	n/a	708.7	301.7	502.5	n/a	708.7	301.7	502.5	n/a	708.7	399.6	502.5
Power output equivalent (3,300 kWh / home / year)	# homes per year	n/a	88,642	220,862	66,306	n/a	88,642	220,862	66,306	n/a	88,642	166,758	66,306
Heat output equivalent (16,500 kWh / home / year)	# homes per year	n/a	17,728	44,172	13,261	n/a	17,728	44,172	13,261	n/a	17,728	33,352	13,261

Table 6.20: Modelling results for Sensitivity Analyses 5, 6 and 7

Modelling year: 2025		Sensitivty Analysis: DECC electricity mix (2025)				Sensitivity Analysis: DECC electricity mix (2030)				Sensitivty Analysis: DECC electricity mix (2035)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.5	Scenario B.5	Scenario C.5	Scenario D.5	Scenario A.6	Scenario B.6	Scenario C.6	Scenario D.6	Scenario A.7	Scenario B.7	Scenario C.7	Scenario D.7
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Modelling results													
Approach 1: WRATE Model (database v3.0.1.8)													
Direct process burdens from EfW/ERF	**kgCO2e**	n/a	167,103,223	177,270,592	98,570,323	n/a	167,103,223	177,270,592	98,570,323	n/a	167,103,223	177,270,592	98,570,323
Net energy recovered from EfW/ERF	MJ	n/a	937,764,000	2,452,041,318	710,698,921	n/a	937,764,000	2,452,041,318	710,698,921	n/a	937,764,000	2,452,041,318	710,698,921
Net energy recovered from EfW/ERF	kWh	n/a	260,490,000	681,122,588	197,416,367	n/a	260,490,000	681,122,588	197,416,367	n/a	260,490,000	681,122,588	197,416,367
Gross energy recovered from EfW/ERF	**kWh**	n/a	292,500,000	728,860,588	221,590,152	n/a	292,500,000	728,860,588	221,590,152	n/a	292,500,000	728,860,588	221,590,152
Performance against the CIF	gCO2e/kWh	n/a	571.3	243.2	444.8	n/a	571.3	243.2	444.8	n/a	571.3	243.2	444.8
Environmental Indicators:													
Global Warming Potential	kgCO2e	304,282,461	34,643,747	-149,674,503	111,739,965	305,612,561	41,883,641	-138,365,779	116,820,386	305,612,561	41,738,245	-138,541,414	116,458,385
Acidification Potential	kgSO2e	167,690	94,761	-285,652	-163,961	170,459	109,889	-262,041	-153,253	170,459	109,774	-262,179	-153,539
Eutrophication Potential	kgPO4e	203,601	60,736	-12,198	83,505	203,789	61,743	-10,618	84,184	203,789	61,715	-10,652	84,115
Freshwater Aquatic Ecotoxicity	kg1,4-DCBe	1,237,684	-13,444,720	-30,020,379	-24,930,984	1,236,364	-13,455,142	-30,035,512	-24,944,084	1,236,364	-13,459,412	-30,040,669	-24,954,713
Human Toxicity	kg1,4-DCBe	9,758,756	-139,888,709	-320,511,243	-289,481,807	9,769,605	-139,851,584	-320,445,492	-289,494,955	9,769,605	-139,878,795	-320,478,362	-289,562,703
Abiotic Resource Depletion	kg antimony-eq	-117,999	-1,234,339	-2,587,915	-1,076,718	-107,908	-1,179,447	-2,502,160	-1,038,261	-107,908	-1,180,646	-2,503,609	-1,041,249
Normalised													
Global Warming Potential	Eur.Person.Eq	23,543	2,681	-11,581	8,646	23,646	3,241	-10,706	9,039	23,646	3,229	-10,719	9,011
Acidification Potential	Eur.Person.Eq	2,344	1,325	-3,993	-2,292	2,383	1,536	-3,663	-2,142	2,383	1,534	-3,665	-2,146
Eutrophication Potential	Eur.Person.Eq	6,092	1,817	-365	2,499	6,098	1,847	-318	2,519	6,098	1,847	-319	2,517
Freshwater Aquatic Ecotoxicity Potential	Eur.Person.Eq	939	-10,197	-22,768	-18,908	938	-10,205	-22,779	-18,918	938	-10,208	-22,783	-18,926
Human Toxicity Potential	Eur.Person.Eq	494	-7,078	-16,216	-14,646	494	-7,076	-16,213	-14,647	494	-7,077	-16,214	-14,650
Abiotic Resource Depletion Potential	Eur.Person.Eq	-3,054	-31,943	-66,971	-27,864	-2,792	-30,522	-64,752	-26,869	-2,792	-30,553	-64,789	-26,946
Approach 2: Mayor of London GHG calculator for MSW (v2.1)													
Direct combustion emissions	**kgCO2e**	n/a	207,293,095	219,905,728	109,952,864	n/a	207,293,095	219,905,728	109,952,864	n/a	207,293,095	219,905,728	109,952,864
Gross energy recovered	**kWh**	n/a	292,517,651	728,844,113	218,809,187	n/a	292,517,651	728,844,113	218,809,187	n/a	292,517,651	728,844,113	218,809,187
Performance against the CIF	**gCO2e/kWh**	n/a	708.7	301.7	502.5	n/a	708.7	301.7	502.5	n/a	708.7	301.7	502.5
Power output equivalent (3,300 kWh / home / year)	# homes per year	n/a	88,642	220,862	66,306	n/a	88,642	220,862	66,306	n/a	88,642	220,862	66,306
Heat output equivalent (16,500 kWh / home / year)	# homes per year	n/a	17,728	44,172	13,261	n/a	17,728	44,172	13,261	n/a	17,728	44,172	13,261

Table 6.21: Modelling results for Sensitivity Analyses 8, 9 and 10

Modelling year: 2025		Sensitivty Analysis: NG electricity mix (2025)				Sensitivty Analysis: NG electricity mix (2030)				Sensitivty Analysis: NG electricity mix (2035)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.8	Scenario B.8	Scenario C.8	Scenario D.8	Scenario A.9	Scenario B.9	Scenario C.9	Scenario D.9	Scenario A.10	Scenario B.10	Scenario C.10	Scenario D.10
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations	Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Modelling results													
Approach 1: WRATE Model (database v3.0.1.8)													
Direct process burdens from EfW/ERF	**kgCO2e**	n/a	167,103,223	177,270,592	98,570,323	n/a	167,103,223	177,270,592	98,570,323	n/a	167,103,223	177,270,592	98,570,323
Net energy recovered from EfW/ERF	MJ	n/a	937,764,000	2,452,041,318	710,698,921	n/a	937,764,000	2,452,041,318	710,698,921	n/a	937,764,000	2,452,041,318	710,698,921
Net energy recovered from EfW/ERF	kWh	n/a	260,490,000	681,122,588	197,416,367	n/a	260,490,000	681,122,588	197,416,367	n/a	260,490,000	681,122,588	197,416,367
Gross energy recovered from EfW/ERF	**kWh**	n/a	292,500,000	728,860,588	221,590,152	n/a	292,500,000	728,860,588	221,590,152	n/a	292,500,000	728,860,588	221,590,152
Performance against the CIF	gCO2e/kWh	n/a	571.3	243.2	444.8	n/a	571.3	243.2	444.8	n/a	571.3	243.2	444.8
Environmental Indicators:													
Global Warming Potential	kgCO2e	326,536,494	158,184,391	42,443,195	202,739,477	326,612,892	158,425,057	42,881,134	202,595,134	326,641,499	158,503,293	43,030,767	202,511,514
Acidification Potential	kgSO2e	173,375	126,170	-236,755	-141,095	174,082	129,782	-231,029	-138,983	174,437	131,704	-228,024	-137,646
Eutrophication Potential	kgPO4e	204,474	65,578	-4,667	87,065	204,783	67,254	-2,046	88,227	204,972	68,283	-439	88,954
Freshwater Aquatic Ecotoxicity	kg1,4-DCBe	1,595,110	-11,457,533	-26,931,144	-23,462,006	1,596,761	-11,449,978	-26,918,835	-23,459,265	1,593,969	-11,467,022	-26,944,805	-23,474,529
Human Toxicity	kg1,4-DCBe	10,819,888	-133,967,810	-311,314,136	-285,067,635	10,896,685	-133,555,634	-310,668,249	-284,788,845	10,909,149	-133,495,198	-310,571,226	-284,759,682
Abiotic Resource Depletion	kg antimony-eq	73,297	-172,401	-936,492	-294,524	73,260	-174,017	-938,516	-298,188	73,083	-175,656	-940,835	-300,556
Normalised													
Global Warming Potential	Eur.Person.Eq	25,265	12,239	3,284	15,687	25,271	12,258	3,318	15,676	25,273	12,264	3,329	15,669
Acidification Potential	Eur.Person.Eq	2,423	1,764	-3,309	-1,972	2,433	1,814	-3,229	-1,943	2,438	1,841	-3,187	-1,924
Eutrophication Potential	Eur.Person.Eq	6,118	1,962	-140	2,605	6,128	2,012	-61	2,640	6,133	2,043	-13	2,662
Freshwater Aquatic Ecotoxicity Potential	Eur.Person.Eq	1,210	-8,690	-20,425	-17,794	1,211	-8,684	-20,416	-17,792	1,209	-8,697	-20,435	-17,803
Human Toxicity Potential	Eur.Person.Eq	547	-6,778	-15,751	-14,423	551	-6,757	-15,718	-14,409	552	-6,754	-15,713	-14,407
Abiotic Resource Depletion Potential	Eur.Person.Eq	1,897	-4,461	-24,235	-7,622	1,896	-4,503	-24,287	-7,717	1,891	-4,546	-24,347	-7,778
Approach 2: Mayor of London GHG calculator for MSW (v2.1)													
Direct combustion emissions	**kgCO2e**	n/a	207,293,095	219,905,728	109,952,864	n/a	207,293,095	219,905,728	109,952,864	n/a	207,293,095	219,905,728	109,952,864
Gross energy recovered	**kWh**	n/a	292,517,651	728,844,113	218,809,187	n/a	292,517,651	728,844,113	218,809,187	n/a	292,517,651	728,844,113	218,809,187
Performance against the CIF	**gCO2e/kWh**	n/a	708.7	301.7	502.5	n/a	708.7	301.7	502.5	n/a	708.7	301.7	502.5
Power output equivalent (3,300 kWh / home / year)	# homes per year	n/a	88,642	220,862	66,306	n/a	88,642	220,862	66,306	n/a	88,642	220,862	66,306
Heat output equivalent (16,500 kWh / home / year)	# homes per year	n/a	17,728	44,172	13,261	n/a	17,728	44,172	13,261	n/a	17,728	44,172	13,261

Table 6.22: Modelling results for Sensitivity Analysis 11

Modelling year: 2025		Sensitivty Analysis: Netherlands electricity mix (2012)			
Modelling Parameters (high level estimates and assumptions)	Units	Scenario A.11	Scenario B.11	Scenario C.11	Scenario D.11
		Landfill Comparator	Current Operations in 2025/26	Future Operations	Alternative Future Operations
Modelling results					
Approach 1: WRATE Model (database v3.0.1.8)					
Direct process burdens from EfW/ERF	**kgCO2e**	n/a	167,103,223	177,270,592	98,570,323
Net energy recovered from EfW/ERF	MJ	n/a	937,764,000	2,452,041,318	710,698,921
Net energy recovered from EfW/ERF	kWh	n/a	260,490,000	681,122,588	197,416,367
Gross energy recovered from EfW/ERF	**kWh**	n/a	292,500,000	728,860,588	221,590,152
Performance against the CIF	gCO2e/kWh	n/a	571.3	243.2	444.8
Environmental Indicators:					
Global Warming Potential	kgCO2e	291,499,697	-33,779,868	-256,961,017	65,789,619
Acidification Potential	kgSO2e	134,062	-88,647	-572,006	-293,318
Eutrophication Potential	kgPO4e	199,128	36,391	-50,225	66,423
Freshwater Aquatic Ecotoxicity	kg1,4-DCBe	-2,069,502	-31,460,434	-58,155,885	-37,598,649
Human Toxicity	kg1,4-DCBe	7,989,429	-149,426,594	-335,442,278	-296,008,901
Abiotic Resource Depletion	kg antimony-eq	-204,383	-1,694,284	-3,309,979	-1,381,140
Normalised					
Global Warming Potential	Eur.Person.Eq	22,554	-2,614	-19,882	5,090
Acidification Potential	Eur.Person.Eq	1,874	-1,239	-7,996	-4,100
Eutrophication Potential	Eur.Person.Eq	5,958	1,089	-1,503	1,987
Freshwater Aquatic Ecotoxicity Potential	Eur.Person.Eq	-1,570	-23,860	-44,106	-28,515
Human Toxicity Potential	Eur.Person.Eq	404	-7,560	-16,972	-14,976
Abiotic Resource Depletion Potential	Eur.Person.Eq	-5,289	-43,845	-85,657	-35,742
Approach 2: Mayor of London GHG calculator for MSW (v2.1)					
Direct combustion emissions	**kgCO2e**	n/a	207,293,095	219,905,728	109,952,864
Gross energy recovered	**kWh**	n/a	292,517,651	728,844,113	218,809,187
Performance against the CIF	**gCO2e/kWh**	n/a	708.7	301.7	502.5
Power output equivalent (3,300 kWh / home / year)	# homes per year	n/a	88,642	220,862	66,306
Heat output equivalent (16,500 kWh / home / year)	# homes per year	n/a	17,728	44,172	13,261

Appendix D – District Heating Route Feasibility Study

North London Waste Authority

North London Heat and Power Project

District Heating Routing Feasibility Study

AD05.06 Appendix D

Issue | August 2015

Arup

Contents

Tables

Figures

1 Overview

1.1.1 Ove Arup and Partners Ltd (Arup) has been commissioned by the North London Waste Authority (NLWA) to review the likely route and engineering constraints for a District Heating (DH) connection at the Edmonton EcoPark. This report has been prepared to set out the findings of the study and where appropriate areas requiring further investigation at a later design stage have been highlighted. The study has been based on the heat supply between the proposed Lee Valley Heat Network (LVHN) District Heating Energy Centre (DHEC) connecting to the existing Energy from Waste (EfW) facility and subsequently the proposed Energy Recovery Facility (ERF) comprising flow and return pipework. The study is an assessment of the technical feasibility of the scheme and does not include an appraisal of the financial feasibility.

1.1.2 The district heating route feasibility study has been divided into the following sub-routes:

a. Phase 01 – route from the DHEC to the existing EfW facility, including:
   - connection to the existing EfW facility turbine hall; and
   - route for the LVHN pipework exiting the Edmonton EcoPark from the proposed LVHN DHEC.

b. Phase 02 – Extension of the district heating pipes to the proposed ERF, including:
   - possible connection to EcoPark House; and
   - possible connection to the RRF Offices.

c. Contingency Route – Route from the ERF north or west, including:
   - a route to Ardra Road via Deephams Farm Road; and
   - possible crossing of Salmons Brook to the Eley Estate.

1.1.3 This report has been divided into the following sections:

a. Section 2: Pipe route assumptions – provides a background of the pipe route assumptions which formed the basis of the design;

b. Section 3: The route – provides a summary and basis of the alignment for each of the district heating pipe sub-routes;

c. Section 4: Key engineering constraints – provides a summary of the possible engineering constraints identified for each sub-route; and

d. Section 5: Summary and next steps.

1.2 Baseline information

1.2.1 The following sources have been used to establish a baseline of existing infrastructure and to provide background information for consideration as part of the feasibility study:

a. Client Routing Notes – ‘LVHN Heat Pipe Requirements’;

b. ERF sketch drawings, produced by Ramboll;

c. LVHN markup plans;

d. Grimshaw sketch route plans, dated 06.03.15 , ref: ‘14047_GAL_00_0016’ and ‘14047_GAL_00_0402’;

e. Wayleave sketch drawing illustrating discussed wayleaves between LVHN & NLWA, dated August 2014;

f. NLWA ‘Southern Access Bridge – Optioneering Report’, produced by Amec Foster Wheeler, dated May 2015; and,

g. Amec existing and proposed services drawings, including:

   - 35180_LON_CVD_002_C;
   - 35180_LON_CVD_003_E;
   - 35180_LON_CVD_004_D;
   - 35180_LON_CVD_005_X;
   - 35180_LON_CVD_006_X;
   - 35180_LON_CVD_010_C;
   - 35180_LON_CVD_012_E;
   - 35180_LON_CVD_013_C; and
   - 35180_LON_CVD_014_B;

1.3 Core study area

1.3.1 The study area used for this assessment is illustrated on Figure 1. This study covers the extent of the Edmonton EcoPark and is therefore a smaller area than the DCO Application Site area boundary.

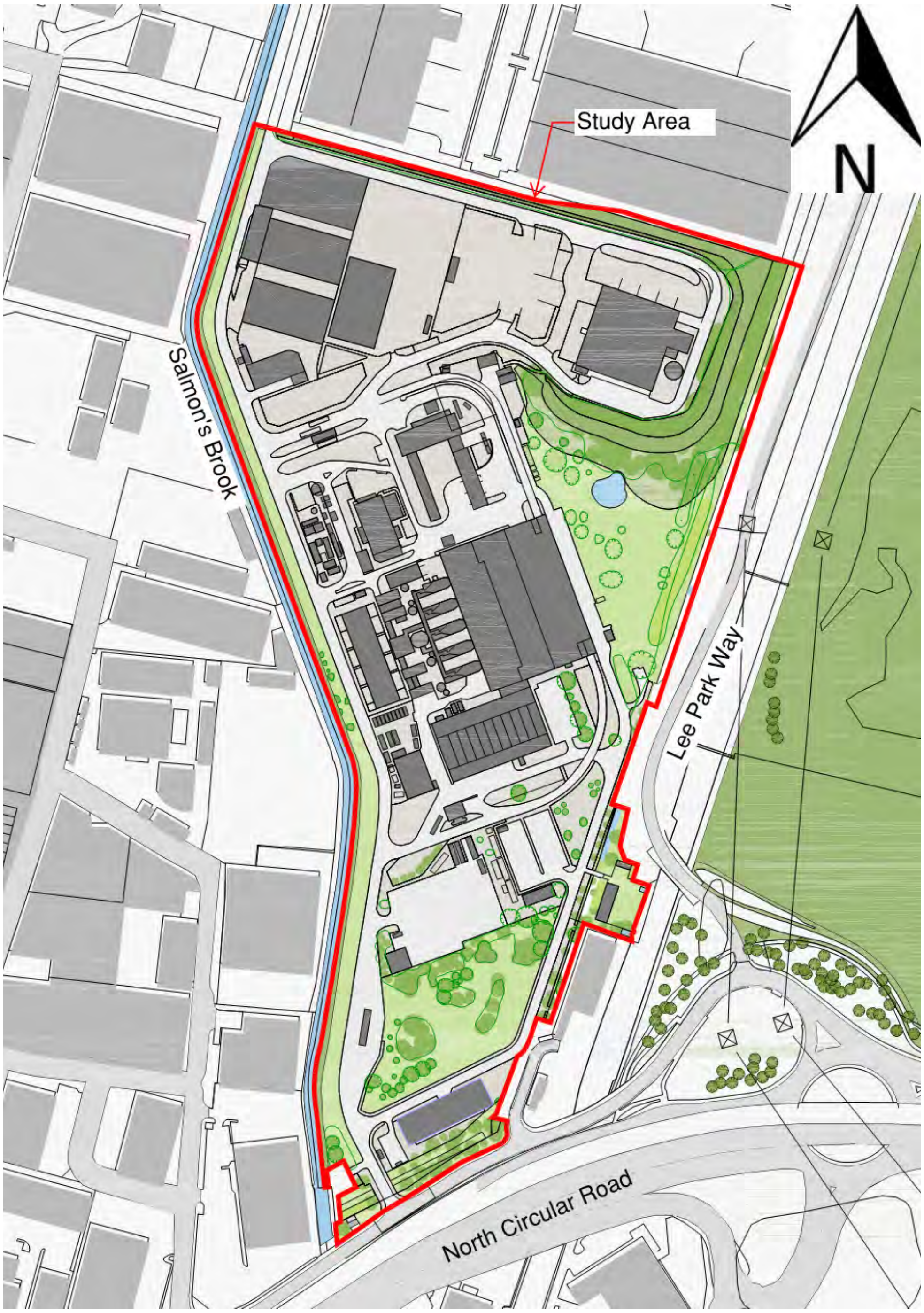


Figure 1: Edmonton EcoPark

2 Pipe route assumptions

2.1.1 The following key parameters have been adopted as part of this Routing Study, summarised by the bulleted points below, Table 1, and Figures 2 and 3:

a. flow and return pipework with same diameters;

b. the pipes require a minimum separation of 600mm from other utilities and ideally not adjacent to water or electricity, source: ‘Client Routing Notes – LVHN Heat Pipe Requirements’;

c. the pipes would have a general depth of 750mm from the top of the pipe to the finished road/surface, source: ‘Client Routing Notes – LVHN Heat Pipe Requirements’;

d. pipes are assumed to route below ground except where ditch crossings are required;

e. two pipe sizes have been identified for the primary pipe route. Case 1 (800mmID) represents the assumed pipe size required for a maximum heat export case, while Case 2 (500mmID) represents the assumed pipe size for the $35MW_{th}$ heat export connection to the DHEC. For the purposes of this study, the maximum heat scenario (Case 1) has been adopted;

f. a secondary pipe size is chosen for the connection of the EfW facility to supply $12MW_{th}$ in accordance with the Decentralised Energy Project Delivery Unit (DEPDU) heat-off take study;

g. pipe sizes were calculated based on heat export capacity for water filled pipes with a temperature differential of 40 Kelvin between flow and return pipework and linear pressure drops of below 250Pa/m. Pipe sizes would vary based on detailed design parameters or if steam pipes were adopted; and

h. the adopted wayleaves are illustrated on Figure 2. A 1.5m zone of influence is shown either side of the pipes which precludes any services being buried within that zone. An additional 3.5m clear zone is shown to one side which allows for a clear space above ground for mechanical plant to access the pipes. It is assumed that other buried services are permitted within the mechanical plant access zone.

Table 1: Table of design parameters

Pipe network	Primary (Case 1)	Primary (Case 2)	Secondary (EfW)
Pipe size (mm) (ID)	450	350	200
Pipe size (mm) (OD) - assumed	600	500	350
Pipe cover (mm)	750	750	750
Trench width (mm) - assumed	1750	1550	1250
Trench depth (mm) - assumed	1450	1350	1200
Easement width (mm) - assumed	8250	8050	7750
Heat export capacity	$80MW_{th}$	$35MW_{th}$	$12MW_{th}$

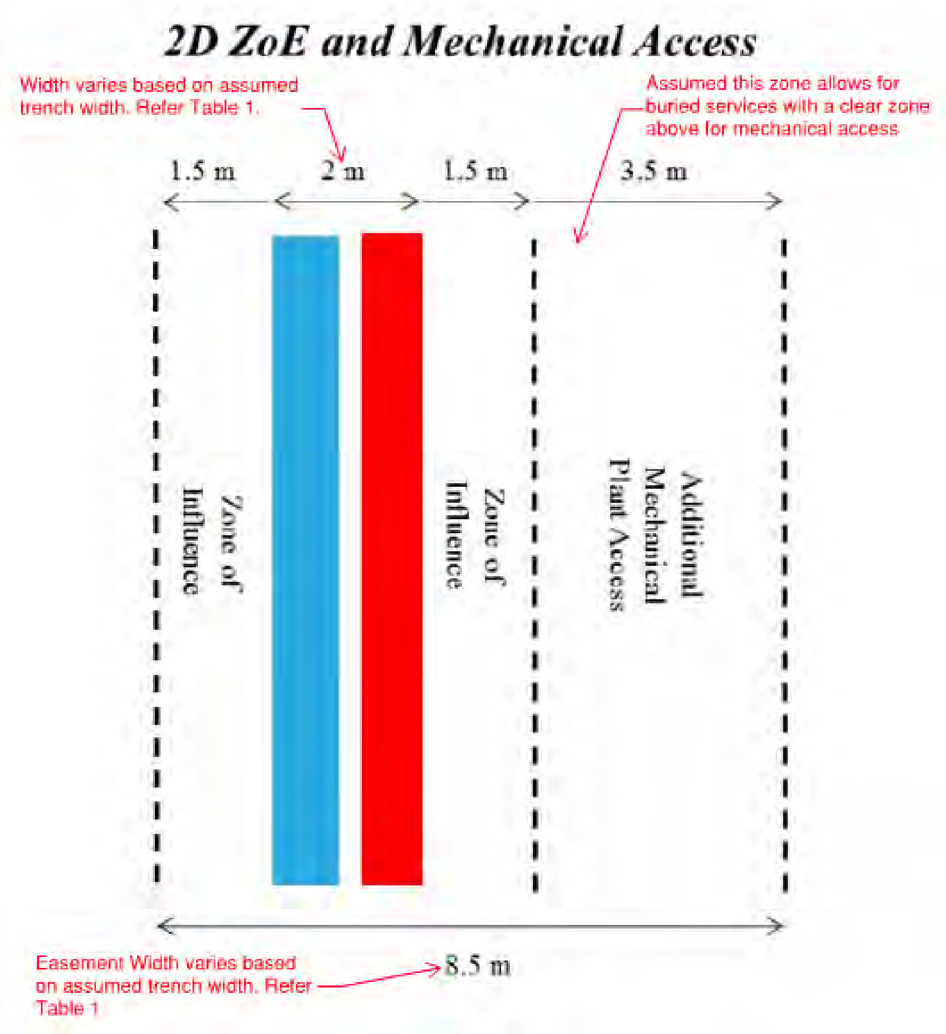


Figure 2: Discussed wayleaves between LVHN and NLWA, August 2014

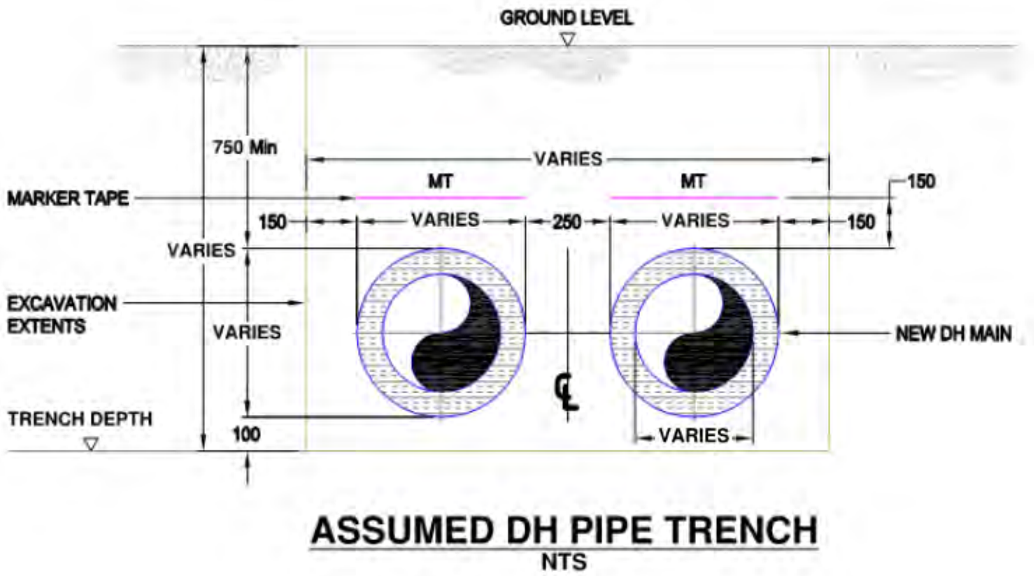


Figure 3: Assumed DH pipe trench. Source: Example Specification for DH Connection, Cofely, 2014

3 The Route

3.1 Phase 01 – Route from the DHEC to existing EfW facility

3.1.1 The first phase route forms the connection from the DHEC to the existing EfW facility. The pipes are proposed to exit the DHEC from the eastern extents of the building as indicated on Figure 4. It is then proposed to route the pipes below ground along the eastern boundary of the Edmonton EcoPark following the existing access road. Previous studies have indicated that the western boundary is heavily congested with utility connections, particularly along the bank of Salmons Brook, which limits any available space to route the DH pipes.

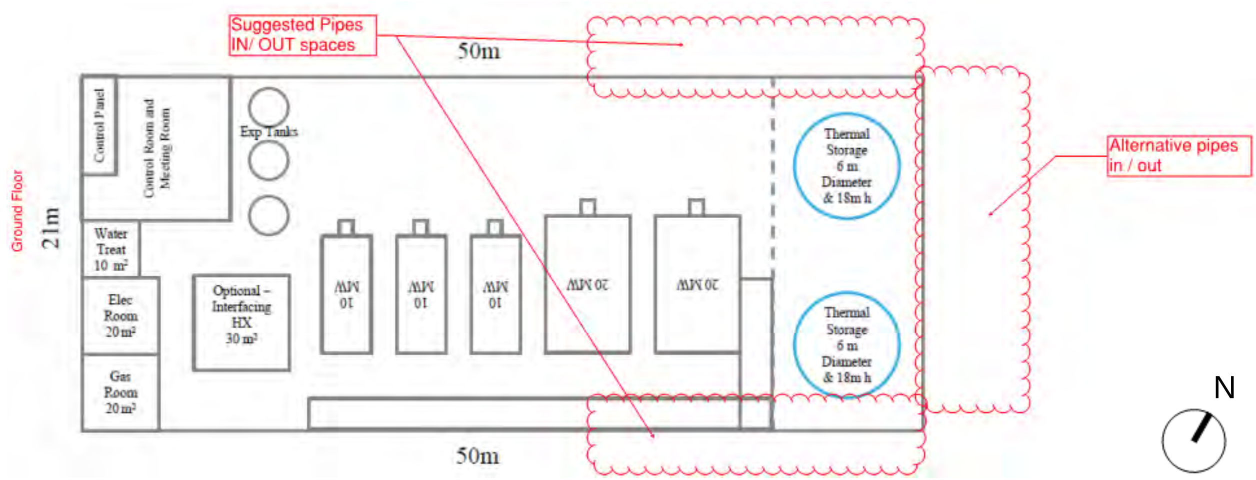


Figure 4: DHEC DH pipe in/out location

Source – LVHN – NLWA discussions 2014

Connection to EfW facility turbines

3.1.2 The DH pipes are proposed to connect to the turbine hall located within the EfW facility. Two options have been identified to make this connection:

- Option 1 – Enter the turbine hall via the eastern façade which may require a continuation of the DH pipes within the building to reach the south-west corner of the turbine hall. The feasibility of routing the DH pipes within the turbine hall requires confirmation; and
- Option 2 – Route the DH pipes below ground adjacent to the southern façade of the turbine hall and enter the building at the south-west corner.

3.1.3 An illustration of the abovementioned routes is shown on Figure 8.

Route for the proposed LVHN pipework leaving the Edmonton EcoPark from the DHEC

3.1.4 As part of the Phase 01 route, it is proposed the LVHN Main would route from the DHEC and exit the southern boundary of the Edmonton EcoPark where it would continue west along Angel Road. The Main would be required to cross Enfield Ditch which presents a number of options to make the crossing. These include:

a. incorporate the pipes internally in the southern access bridge;

b. attach the pipes to the outer southern access bridge structure which could consider a number of options including feeding the pipes in ducts which are attached to the bridge by hangers or attaching an I-beam to the bridge structure to support the pipes;

c. provide a standalone pipe bridge adjacent to the southern access bridge; or

d. immerse the pipes below Enfield Ditch river bed level.

3.1.5 For each option, a number of considerations are required to be made, which broadly include:

a. accessibility if the pipes are incorporated in the southern access bridge or immersed below Enfield Ditch river bed level;

b. spatial requirements of the pipes if they were incorporated in the southern access bridge and whether the bridge deck could accommodate the pipes cover requirements;

c. coordination against other utilities, including other existing pipe crossings located adjacent to the bridge;

d. approvals, e.g. Environmental Agency (EA) requirements for specified flood levels;

e. protection measures if the pipes are exposed; and

f. phasing for any future works planned in the area.

3.1.6 Reference to the NLWA 'Southern Access Bridge – Optioneering Report', produced by Amec Foster Wheeler, outlines proposals to widen the southern access bridge. This proposal could present opportunities to incorporate the LVHN Main within the widened bridge structure. Further to the above mentioned considerations, a key factor which could affect the feasibility of utilising the southern access bridge is the timing of the bridge widening which would need to coincide with the installation of the LVHN Main.

3.1.7 Figure 5 illustrates the subject area.

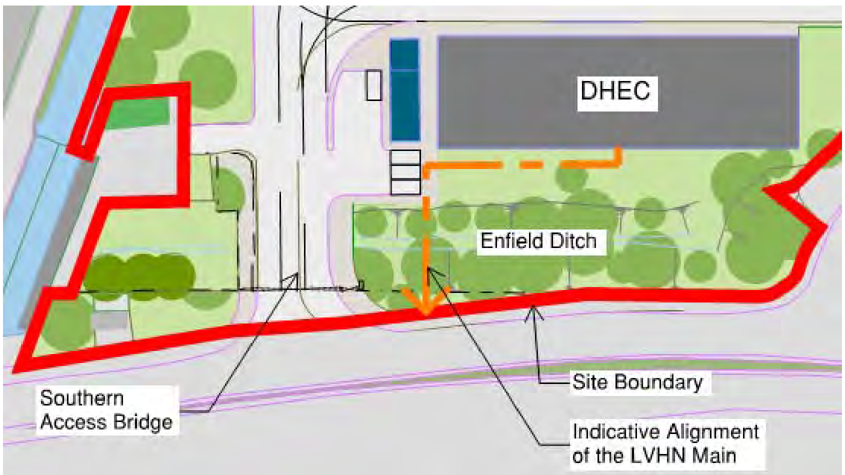


Figure 5: Route for the LVHN pipework leaving the Edmonton EcoPark from the DHEC

3.2 Phase 02 – Extension of the district heating pipes to the proposed ERF

3.2.1 The Phase 02 route forms the connection to the proposed ERF, which involves an extension of the Phase 01 DH pipe route. The proposed ERF would replace the EfW facility and therefore, any DH connection to the EfW facility would be decommissioned. It is envisaged that hydraulic valves would be supplied at the junction of the Phase 01 route (EfW connection) where a switchover would occur once the connection has been made to the ERF.

3.2.2 Two options have been identified to extend the Phase 01 route to the ERF as illustrated on Figure 10:

a. Option 1 – Route the DH pipes along the edge of the proposed embankment, following approximately the alignment of the eastern edge of the EfW facility; and

b. Option 2 – Route the DH pipes across the proposed embankment, into the external stores area and along the proposed access road.

3.2.3 Key engineering constraints associated with both options are discussed in Section 4.3.

3.2.4 The approximate location for the connection to the proposed ERF is illustrated in Figure 6.

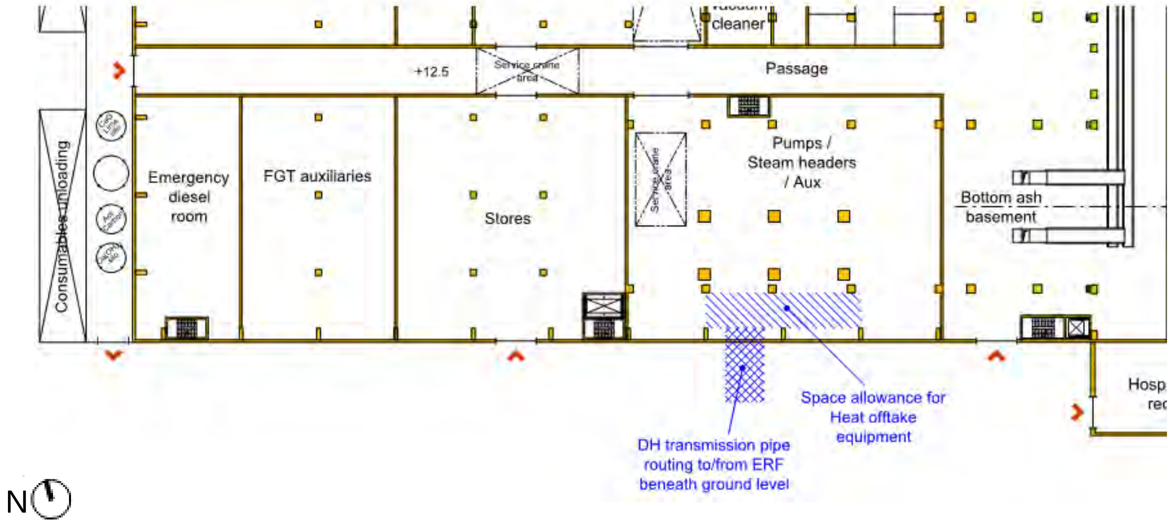


Figure 6: ERF DH pipe in/out location
Source – Ramboll

3.3 Contingency route – route from the ERF facility to Deephams Farm Road

3.3.1 A contingency route to enable supply in alternative directions is provided from the proposed ERF to Deephams Farm Road. The DH pipes are shown to exit the ERF at the location shown on Figure 6 and follow the access roads adjacent to the ERF and leading to Deephams Farm Road. In addition, a possible crossing over Salmons Brook is shown to connect to the Eley Estate. An illustration of the abovementioned routes are shown on Figure 10.

4 Key engineering constraints

4.1.1 A review of possible engineering constraints based on the completed Project for the abovementioned routes has been undertaken and are delineated with a number on Figure 8, Figure 9 and Figure 10:

a. Figure 8 shows the existing Edmonton EcoPark and engineering constraints associated with the Phase 01 DH pipe route;

b. Figure 9 shows the Phase 01 route with consideration to the developed Edmonton EcoPark; and

c. Figure 10 shows the redeveloped Edmonton EcoPark and engineering constraints associated with the Phase 02 DH pipe route.

4.1.2 Where DH pipe routes are shown, the lines relate to corridors to represent the assumed trench width +1.5m zone of influence, and 3.5m additional mechanical plant access zone as detailed in Table 2 and illustrated on Figure 2. The main thick line represents the total width of the trench and zone of influence where the outer dashed line represents the 3.5m additional mechanical plant access zone.

4.1.3 A description of the key engineering constraints corresponding to the numbered labels on the figures are as follows:

Phase 01

4.1.4 Refer to Figure 8 for the corresponding location of the numbered key engineering constraints listed in Table 2 below.

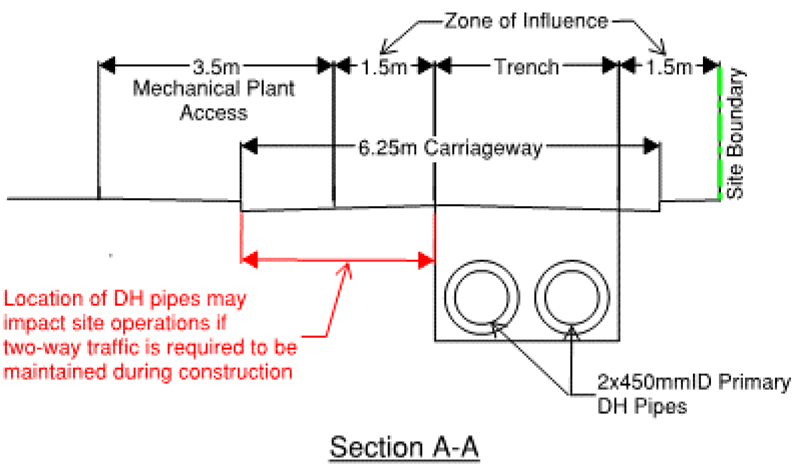


Figure 7: Coordination of DH pipes within access roads (indicative, not to scale)

Table 2: Phase 01 key engineering constraints (constraint numbers refer to Figure 8)

Constraint number	Constraint description
1	Existing utility service crossings: Utility crossings have been identified along both the route from the DHEC to the EfW facility and the LVHN Main exiting the Edmonton EcoPark to the south. These include crossings over a number of undefined services. A detailed assessment would be required to confirm the feasibility of these crossings, with an understanding of the utility type, size and depth.
2	Traffic management along access roads if full operational access is maintained. The positioning of the DH pipes within the access road may impact operations if two-way traffic is required to be maintained during construction, as illustrated on Figure 7. A temporary extension of the access road to the west may be required if operations are required to be maintained.
3	The Thames Water Utilities Ltd easement for Angel Sewer places a restriction on laying pipes without prior consent.
4	Utility congestion along the bank of Salmons Brook supports the preference for an eastern corridor.
5	Requirement to cross Enfield Ditch. Refer Section 3.1.2 for crossing options and considerations.
6	Construction phasing of internal access road upgrade. The location/depth of the DH pipes would need to consider the future access road upgrade. The placement of the DH pipes would need to ensure the pipes do not sterilise the potential for the future access road upgrade.
7	Construction phasing of Advent Way upgrade/replacement. The upgrade/replacement of the southern entrance as part of the North London Heat and Power Project may inhibit using the entrance as a potential crossing over Enfield Ditch as any future construction works would impact the DH pipes.

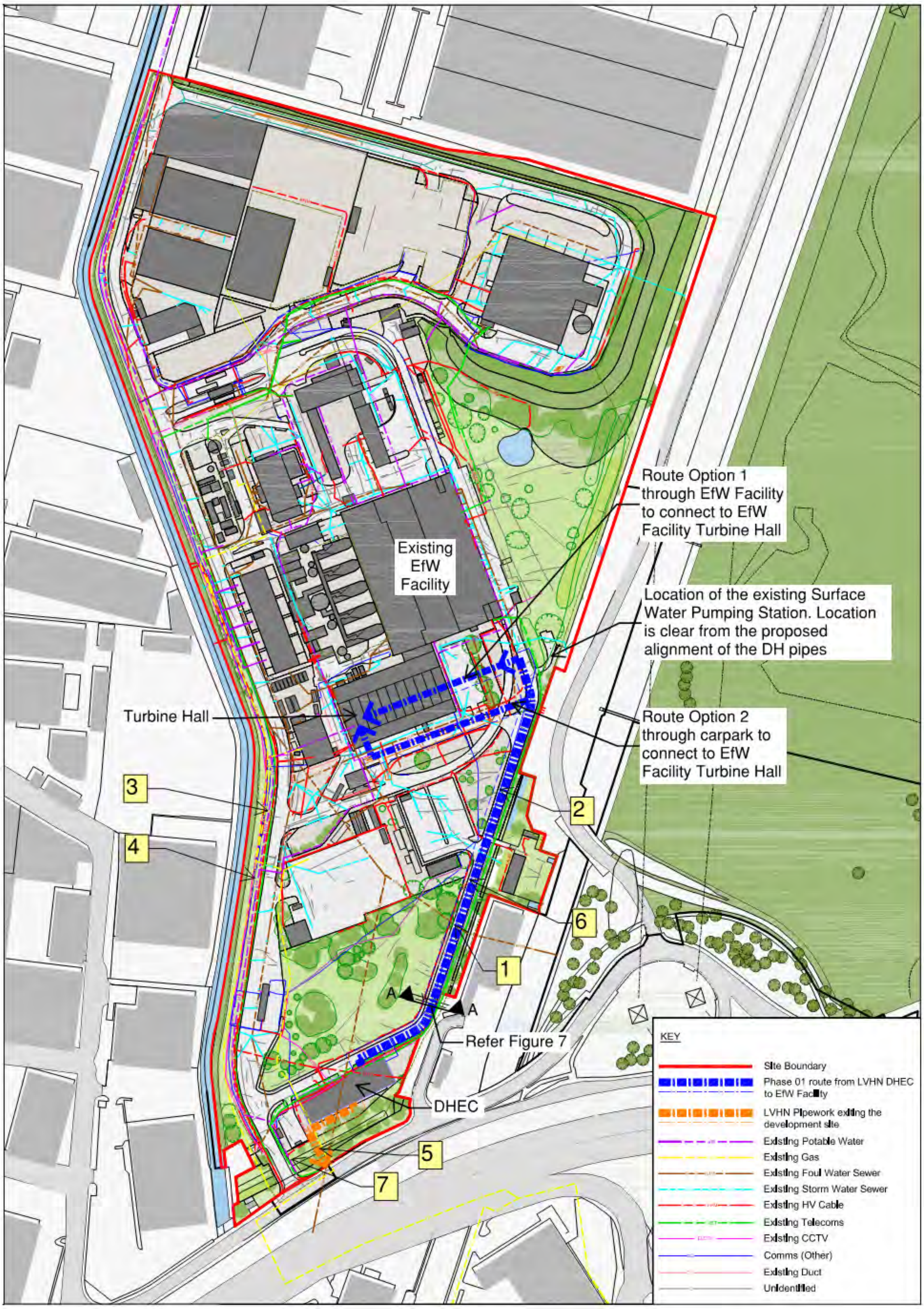


Figure 8: Phase 01 constraints plan (numbers as per Section 0)

5 Phase 01 route with consideration to the developed site

5.1.1 Refer to Figure 9 for the corresponding location of the numbered key engineering constraints listed in Table 3 below.

Table 3: Phase 01 key engineering constraints with consideration to the developed site (constraint numbers referring to Figure 9)

Constraint number	**Constraint description**
8	Construction coordination for internal access road upgrade and RRF foundation excavation. Temporary protection measures may be required to ensure the DH pipes are not impacted during the internal access road upgrade and RRF foundation excavation construction. Furthermore, the placement of the DH pipes would need to ensure the pipes do not sterilise the future construction of the RRF. The depths of the DH pipes are expected to be sufficient to not encroach on future pavement works, however, a temporary cover slab may be required to ensure construction traffic loadings do not impact the pipes.
9	Construction coordination for proposed car park. Similarly, temporary protection measures may be required to ensure the DH pipes are not impacted during the car park construction.
19	Consultation required with Thames Water Utilities Ltd to obtain a build over agreement for the DHEC building over Angel Sewer.
20	DHEC building to consider the diversion of Angel Sewer and associated wayleaves around the diversion area.
21	Proposed location of the new Angel Sewer access manhole. The proposed location would need to coordinate against the planned location of the LVHN pipework exiting the DHEC.

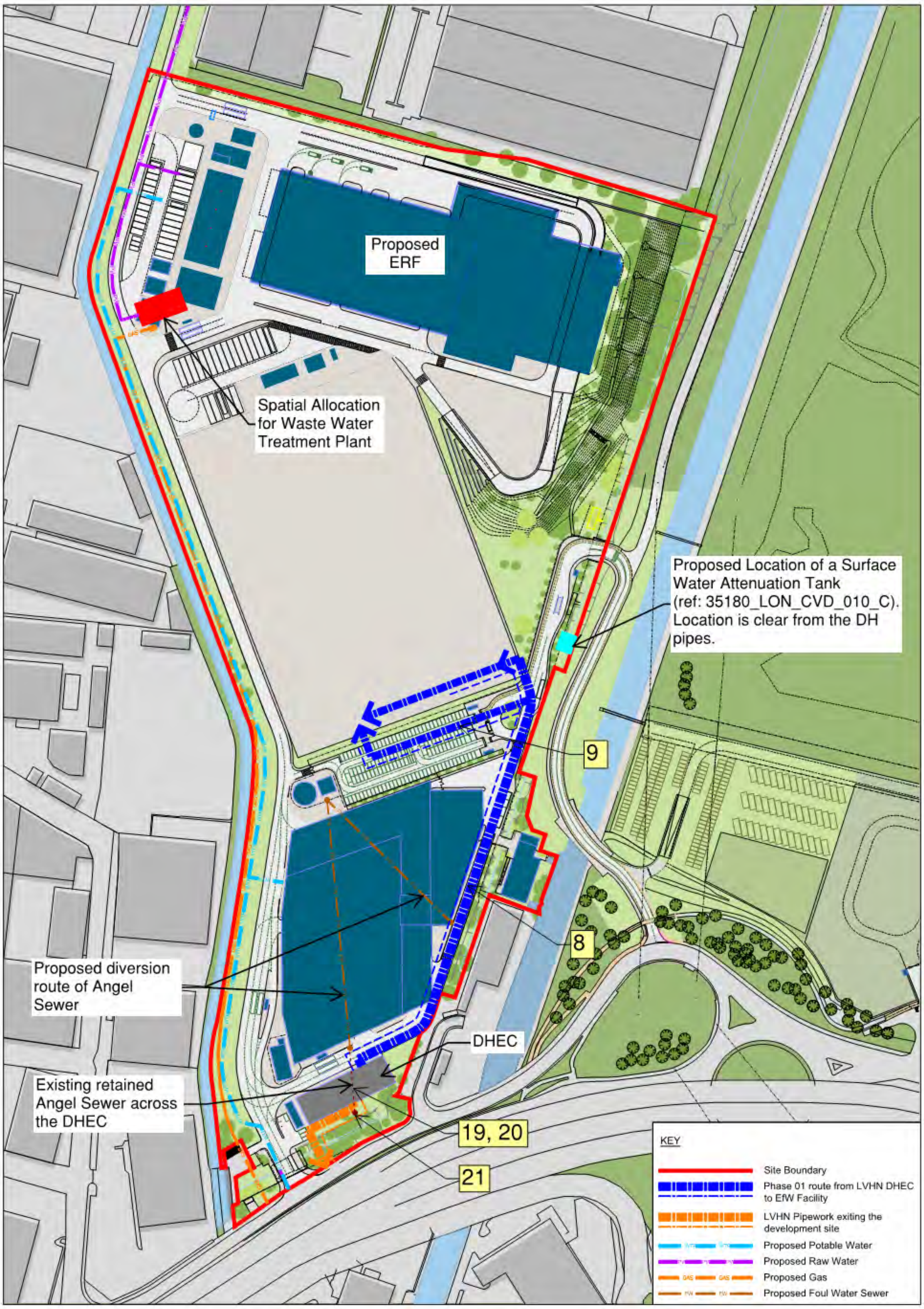


Figure 9: Phase 01 route with consideration to the developed site (numbers as per Section 5)

Phase 02

5.1.2 Refer to Figure 10 for the corresponding location of the numbered key engineering constraints listed in Table 4 below.

Table 4: Phase 02 key engineering constraints

Constraint number	Constraint description
10	Option 1 route along the edge of the embankment - Phasing issues with respect to the EfW demolition as the DH pipes are required to be installed at an earlier stage. The positioning of the DH pipes should be coordinated such that the subsequent demolition of the EfW facility does not impact the DH pipes.
11	Option 2 route through the embankment – Access and loading issues. The DH pipes would follow at grade from the toe of the embankment, passing below the out ramp retaining wall and into the external stores area. Along the length of the embankment, access to the DH pipes would not be achievable due to the depth of cover over the pipes which is proposed to be in excess of 5.0m at the top the embankment based on current masterplan levels. This also presents loading issues where the DH pipes may require some form of protection such as a pipe tunnel or cover slab. Access along the length of the external stores area is expected to be achievable as items stored would be of a semi-temporary nature, however, consideration is required for weight loading over the pipes if heavy structures (e.g. 2-storey portacabins) are placed.
12	Existing services to be retained are required to be confirmed along proposed routes. The extent of retained services is currently under development by Amec. Current proposed utilities are shown on the western boundary of the Edmonton EcoPark only. A detailed assessment would be required for any existing service crossings along the DH pipe route to confirm the feasibility of these crossings, with an understanding of the utility type, size and depth.
13	The Thames Water Utilities Ltd easement for Angel Sewer places a restriction on laying pipes without prior consent.
14	Utility congestion along the bank of Salmons Brook.
15	The need to construct a pipe bridge crossing over Salmons Brook for the possible connection to the Eley Estate. The level of the soffit of the pipe bridge would need to consider any clearance requirements for the waterway.
16	Pipe bridge crossing over Enfield Ditch for the possible connection of EcoPark House to the network. The level of the soffit of the pipe bridge would need to consider any clearance requirements for the waterway.
17	Utility coordination. The DH pipe route is shown to run parallel with the proposed raw water main and other existing retained utilities, i.e. Ø200mm Thames Water main and data cables. In addition, a cooling water main pipe may be proposed in the vicinity. The placement of the DH pipes should be coordinated such that minimum clearances and clear zones to the DH pipes are provided against other utilities.
18	Structural coordination for any foundations associated with the RRF Offices to avoid any clash with the possible district heating connection.

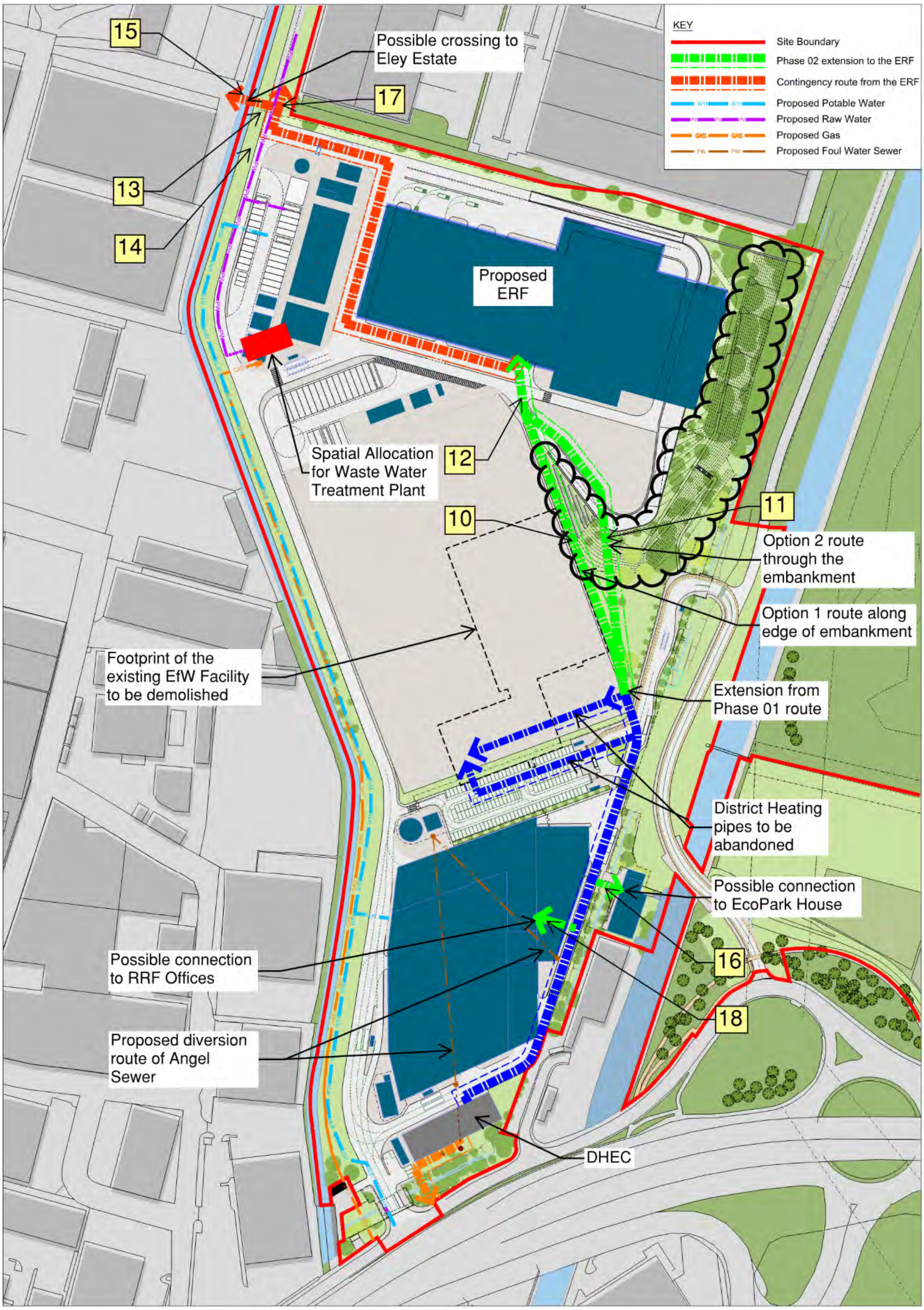


Figure 10: Phase 02 constraints plan (numbers as per Section 0)

6 Summary and next steps

6.1 Summary

6.1.1 A key engineering constraint associated with the Phase 01 route connecting from the DHEC to the existing EfW facility would be the coordination of existing services and confirmation of the feasibility of these crossings with an understanding of the utility type, size and depth. Additionally, the positioning of the DH pipes along the internal access road would need to consider traffic management during construction and whether two-way traffic is required to be maintained during construction.

6.1.2 Two options have been identified to make the connection to the turbine hall located within the EfW facility. The first proposes to enter the turbine hall via the eastern façade. The route to the eastern façade crosses various existing services where the feasibility of these crossings are required to be confirmed. The second option proposes to route the DH pipes adjacent to the southern façade entering the building at the south-west corner. Similarly, this involves a series of existing service crossings which may prove to be problematic as some of the services are shown to run parallel to the DH pipes which is likely to cause spatial issues for the required clear zone widths.

6.1.3 Phase 01 also includes a southern route for the LVHN Main from the DHEC. The Main is required to cross Enfield Ditch which could consider a number of options to make the crossing. The location of the pipe crossing would need to consider the future widening of the southern access bridge and in particular the timing of the bridge widening.

6.1.4 Phase 02 involves the extension of the DH pipes to connect to the proposed ERF. Two options have been identified to make the connection. The first proposes to route the DH pipes along the edge of the proposed embankment which requires coordination to ensure the subsequent demolition of the EfW facility does not impact the DH pipes. The second option proposes to route the DH pipes across the embankment which presents access and loading issues along the length of the embankment where the depth of cover over the pipes exceeds 5.0m at the top of the embankment.

6.1.5 A contingency route is shown leading from the ERF to Deephams Farm Road which also includes a possible crossing to Eley Estate. As the proposed utilities layout including existing services to be retained are under development, an assessment is required along the proposed routes to confirm the feasibility of any service crossings.

6.1.6 Implementation of the pipework routing outlined in this study is subject to further feasibility and cost benefit analysis. For instance, connections would only be made should an agreement be reached between the NLWA and a district heating provider, or other heat customer, for the supply of heat from the existing EfW facility initially and then from the proposed ERF. The intent of the NLWA is to safeguard a pipework route to enable heat export off-site.

6.2 Key next steps

a. Detailed design of the district heating pipes to confirm pipe sizes;

b. Agreement of the preferred route;

c. Constraints and challenges associated with the selected route to be reviewed in more detail, developing preliminary solutions to address these issues;

d. Site investigation to be undertaken along the preferred route including:

    a. Survey work along the extent of the preferred route including Ground Penetration Radar survey for existing service coordination and trial pits in targeted locations; and

    b. Geotechnical and contamination desk studies to be completed.

e. Detailed design development of the preferred route.

Series 05 Technical Documents

NORTH LONDON WASTE AUTHORITY
1b Berol House, 25 Ashley Road
Tottenham Hale
N17 9LJ

Telephone: 020 8489 5730
Fax: 020 8365 0254
Email: project@northlondonheatandpower.london