Rail Central
Northamptonshire

The Rail Central Rail Freight Interchange

Northampton Gateway Examination

Written Representation of Ashfield Land Management Limited and Gazeley GLP Northampton s.a.r.l.

Appendix 10 - Rail Central Environmental Statement Chapter 21. Climate Change Mitigation & Adaptation

Northampton Gateway PINS Reference Number
TR050006

6 November 2018

21. Climate Change Mitigation & Adaptation

Summary

21.1 The Assessment of effects on climate change as a result of the Proposed Development concluded that there would be a number of significant effects on the environment.

21.2 In relation to Climate Change Mitigation, aggregated in-combination (construction and operational phases) emissions are likely to result in a moderate beneficial reduction in GHG emissions, which is considered a significant beneficial effect of the Proposed Development.

21.3 In relation to Climate Change Adaptation, significant adverse effects on the Proposed Development as a result of changing climatic conditions have been identified; these will be mitigated through embedded and adaptive mitigation measures, reducing the level of adaptation risk to an acceptable level.

Climate Change Mitigation

21.4 The environmental receptor considered common to the Main SRFI Site, J15a Highway Works and Minor Highway Works was the climatic system.

21.5 Environmental effects on this receptor that could arise from construction included Greenhouse Gas (GHG) emissions arising from activities on-site, and upstream (emissions up to point of sale of a product) and downstream (emissions that occur after the point of sale of a product) of the Proposed Development, including those associated with the processing of materials used in construction.

21.6 Environmental effects on this receptor that could arise from operation included GHG emissions arising from activities on-site, and upstream and downstream of the Proposed Development, including those associated with the modal shift of freight from road to rail.

21.7 The Proposed Development has been designed to ensure adverse effects are avoided, reduced or offset by:

- Incorporating measures to monitor and assess the life-cycle GHG effects associated with materials used in construction
- Adopting best practice measures in relation to reducing waste generation
- Encouraging modal shift from road to rail
- Incorporating measures within buildings to reduce GHG emissions (e.g. using renewable energy and efficient building fabric and services).

21.8 Significant adverse environmental impacts have been prevented from arising at the Proposed Development through site design and procedures to be followed. Through the construction and operational phases in-combination, the Proposed Development will result in reduced GHG emissions compared to the baseline and a significant beneficial effect. Adaptive Mitigation measures been used to further reduce any significant adverse effects.

21.9 Monitoring of the effects of the Proposed Development on climate change will be carried out in accordance with the measures to be developed at design stage to ensure GHG emissions are reduced.

Climate Change Adaptation

21.10 The environmental receptors considered common to the Main SRFI Site, J15a Highway Works and Minor Highway Works included:

- Buildings, infrastructure and equipment
- Construction employees
- Habitats and species
- Climatic system
- Building occupants and site users
- Building operations

21.11 Climatic effects on these receptors that could arise during construction included changes in temperature and rainfall which are anticipated between 2010 and 2039 (2020s).

21.12 Climatic effects on these receptors that could arise during operation included changes in temperature and rainfall which are anticipated between 2070 and 2099 (2080s); this was considered the worst-case assessment.

21.13 The Proposed Development has been designed to ensure adverse effects are avoided, reduced or offset by:

- Adopting best practice design approach in relation to the design of foundations, considering climatic effects on future ground conditions.
- Carrying out a dynamic assessment of overheating in buildings and adopting the cooling hierarchy, with a preference for passive design measures.
- Incorporating SUDs to reduce the risk of surface water flooding.
- Providing measures to reduce water use in buildings.

21.14 Significant adverse environmental impacts have been avoided through site design and requirement to follow certain procedures. Adaptive Mitigation will further reduce the level of effects so that they are no longer considered significant.

21.15 Monitoring of the effects of climate change on the Proposed Development will be carried out in accordance with measures to be agreed and carried out during detailed design and those outlined in the Construction Environmental Management Plan.

Purpose of the Assessment

21.16 This Chapter has been prepared by Turley Sustainability and its purpose is to assess the likely significant climate change effects on, and as a result of, the Proposed Development during the construction and operation phases. The requirement to address climate change has been introduced by the EIA (2017) Regulations (Ref 21.1) with a specific requirement to consider the following:

- The impact of the project on climate (for example the nature and magnitude of greenhouse gas (GHG) emissions) ("Climate Change Mitigation").
- The vulnerability of the project to climate change ("Climate Change Adaption").

21.17 The assessment has been undertaken in accordance with guidance documents developed by the Institute of Environmental Management Assessment (IEMA) and through the application of professional judgement.

21.18 Following this introductory section which sets out the outcome of scoping and consultation applicable to both Climate Change Mitigation and Climate Change Adaptation, this Chapter is split into two sections:

- **Section 1: Climate Change Mitigation** – Provides an assessment of the likely significant climate change effects resulting from the Proposed Development and their mitigation (including an estimation of the quantum, scale and significance of GHG emissions).
- **Section 2: Climate Change Adaptation** - Provides an assessment of the likely significant effects of climate change on the Proposed Development (including the need for any adaptation measures and the resulting resilience to climate change).

21.19 This Chapter is supported by three technical appendices which are located in Volume 3 of this ES:

- Appendix 21.1: Climate Change Mitigation - Rail Central GHG Assessment
- Appendix 21.2: Climate Change Mitigation - Rail Central Road and Rail Freight Emission Factors

- Appendix 21.3: Climate Change Adaptation - Rail Central Climate Change Risk Assessment

Scoping and Consultation

21.20 This section provides a summary of the adopted Scoping Opinion, consultation with SNC and relevant responses from the Section 42 consultation.

Scoping Opinion

21.21 An Environmental Statement Scoping Report was issued to the Secretary of State in December 2015; Table 21.1 sets out the responses within the Scoping Opinion, received in January 2016, that relate to climate change.

21.22 Relevant responses to the Scoping Opinion are set out in Table 21.1. Whilst no specific issues were raised with the proposed approach to assessment set out in the Scoping Opinion, the inclusion of climate change considerations was welcomed by the Secretary of State. Climate related issues were referenced by a single respondent to the consultation (Blisworth Parish Council).

Table .22.1.1.a.i.1: Summary of Scoping Opinion

Scoping Opinion Section/Paragraph	Summary of Issues Raised	Where in the ES is this Addressed?
Paragraph 3.13	The Scoping Opinion states that *"The Secretary of State welcomes the consideration of climate change within the ES".*	Addressed with the Climate Change Mitigation and Adaptation sections of this ES Chapter.
Appendix 3 - Response from Natural England (Annex A to letter, Section 7)	The Scoping Opinion includes a request from Natural England that the ES should reflect the principles of the England Biodiversity Strategy published by Department for Environment Food & Rural Affairs (DEFRA)*: "The ES should reflect these principles and identify how the development's effects on the natural environment will be influenced by climate change and how ecological networks will be maintained."*	Addressed with the Climate Change Adaptation section of this ES Chapter and specifically the assessment of effects.
Appendix 3 – Response from Blisworth Parish Council	The Scoping Opinion includes a request from Blisworth Parish Council that the development carry out a *"carbon impact assessment for the development taking into account all embodied carbon (including*	Addressed in the Climate Change Mitigation section of this Chapter and within Volume 3, Appendix

	construction transport, raw materials production etc.) and all operational carbon over a range of time periods'….and *'an assessment of the time it will take to offset this carbon through the anticipated reduction in road transport using low, medium and high range forecasts of the potential switch from road to rail freight"..*	21.1.
Appendix 3 – Response from The Environment Agency	The response from the Environment Agency notes that their interests aim to promote sustainable development. As such, the ES should demonstrate the environmental sustainability of the project, potential implications for the water and natural environment, and that best practice is followed in relation to waste generation and fluvial flood risk issues.	Assessed in the Climate Change Adaptation section of this Chapter. Water issues are addressed within Chapter 14, Hydrology, Drainage and Flood Risk. Waste Issues are addressed within Chapter 20, Waste and Natural Resources.

21.23 In response to the comments by Blisworth Parish Council, the Secretary of State and in accordance with the NPS NN, EIA Regulations (2017) and the associated IEMA guidance, an assessment of the effects of the Proposed Development on climate change as a result of GHG emissions is set out in the Climate Change Mitigation section of this Chapter. This is informed by a robust assessment of direct and indirect GHG emissions on-site, and upstream and downstream of the Proposed Development, including those emission sources outlined by Blisworth Parish Council.

Consultation with SNC

21.24 Table 21.2 sets out the relevant consultation undertaken with the Local Authority with regards to the identification and application of local sustainability policy.

Table .24.1.1.a.i.1: Consultation Summary

Consultation and Date	Summary of Consultation	Where in the ES is this Addressed?
South Northamptonshire Council (SNC) - January 2017.	The policy team from SNC have been consulted in relation to policies pertaining to sustainable design and construction, and therefore the reduction of GHG emissions	Addressed within the Climate Change Mitigation section of this Chapter in the form of Embedded and Adaptive Mitigation.

	from new development. The Council referred the Applicant to the adopted Joint Core Strategy and the policies therein.

Section 42 Consultation

21.25 No issues were raised relating to climate change effects following the March 2018 Section 42 consultation.

Section 1: Climate Change Mitigation

Methodology

21.26 This section considers the anticipated GHG emissions resulting from the Proposed Development as a contributor to future climate change and the measures taken to mitigate any adverse effects during construction and operation.

21.27 Determining the significance of effect is a complex issue as climate change is a consequence of numerous GHG emission releases from activities and developments across the globe, the vast majority of which are outside the control of the Applicant. In this context, the approach taken is to assess the GHG emissions as a result of the Proposed Development and to assess the potential effect of these GHG emissions on climate change in the context of national carbon budgets.

21.28 There is not currently a single approved methodology to assess and evaluate the significance of GHG emissions; nor are there established criteria or a defined significance threshold for GHG assessments (Ref 21.2).

21.29 The Greenhouse Gas Protocol (Ref 21.3) suite of standards provides the basis for the majority of emissions assessments, and although the Corporate Standard (21.4) and Scope 3 Standards (Ref 21.5) are designed for organisations reporting on emissions that have occurred in the past, the general approach can be applied to anticipated future emissions. The GHG Protocol is one of the standards identified in the EIA Guidance (Ref 21.2) and has been applied to the assessment of emissions in this assessment.

21.30 There is inherent uncertainty in the assessment of GHG emissions, as they can only be truly measured at source as they occur; a predictive assessment can only estimate the quantity of emissions through assumptions.

21.31 To this end, activity data is multiplied by an appropriate emission factor to result in an estimated emission total over a given period.

21.32 Paragraphs 5.17-5.19 of the NPS NN state the following with regard to GHG emissions:

- Paragraph 5.17 – The applicant is required to submit a carbon[1] assessment of the proposals and whilst it is unlikely that the impacts of a single project will affect the Government's ability to meet its carbon plan, the applicant should present an assessment of GHG emissions against the Governments carbon budgets.

- Paragraph 5.18 – States that any increase in carbon *(GHG)* emissions is not a reason to warrant a refusal unless the scale of GHG emissions would have a material impact on the ability to meet the carbon budgets.

- Paragraph 5.19 – States the importance of including proportionate mitigation measures within the application to reduce GHG emissions where reasonable.

21.33 The methodology for calculating GHG emissions for the Proposed Development is consistent with Paragraphs 5.17-5.19 of the NPS NN given that it will allow a comparison of the calculated GHG emissions from different phases of the Proposed Development against UK Government carbon budgets.

21.34 The method of assessment adopted in this section comprises the following components, with those measures specifically identified which relate to the IEMA GHG guidance:

- An establishment of the Scope and Boundaries of the GHG assessment as per Section 4 and 5 of the IEMA GHG guidance.

- An assessment of the GHG emissions arising from existing use of the site to establish the baseline as per Section 4 of the IEMA GHG guidance.

- An assessment of the GHG emissions arising during the construction and operation phases of the Proposed Development.

- An assessment of additionality and resulting net emissions considering comparator scenarios such as existing freight movements, commuter journeys and warehouse space that will be displaced from elsewhere as a result of the SRFI.

- An assessment of the GHG emissions of the Proposed Development in the context of UK Government carbon budgets to establish context and magnitude of GHG emission impact.

- A wider assessment of the impacts of GHG emissions on the baseline environment before and after mitigation in accordance with the EIA hierarchy for managing project related GHG emissions.

[1] Note that references to carbon throughout the NPS NN relate to carbon dioxide equivalent (CO_2e).

21.35 For the purpose of this assessment, and consistent with national accounting methodologies, GHG emissions are measured in units of carbon dioxide equivalent (CO_2e) over a 100-year timeframe. This takes into account the Global Warming Potential (GWP) of all GHGs compared with the GWP of carbon dioxide (CO_2).

Emission Factors

21.36 Consistent with the Methodology for Baseline, Methodology for Assessment, and Assessment of Effects, are the use of emission factors. Emission factor sources are described in full detail in Volume 3: Appendix 21.1; in summary they include:

- 2018 UK Government GHG Conversion Factors for Company Reporting (Ref 21.6), termed "BEIS Emission Factors" throughout this document, these are the basis for all emission factors used in this assessment.
- Adjustments to the BEIS Emission Factors are made to take into account future decarbonisation of supplies and other effects considered likely to occur over the various assessment phases.
- A separate assessment of future adjustments relating to road and rail freight emissions factors is provided in Appendix 21.2.
- A full breakdown of emission factors applied in this assessment can be found in Volume 3: Appendix 21.1 and Volume 3: Appendix 21.2 (specific to freight).

Identification of Study Area

21.37 For the purpose of quantifying the GHG effects as a result of the Proposed Development, all works within Order Limits are considered. However, in some instances, due to the upstream and downstream nature of emissions, the boundary extends beyond this area. This includes emissions associated with electricity consumption, which relate to use on site, but are generated at power stations; and emissions associated with transport to and from the site, where gases are combusted in transit.

21.38 An assessment boundary has been identified that applies the principles of the operational control approach set out within the GHG Protocol (Ref 21.3) to the Proposed Development site. The GHG assessment boundary therefore includes all relevant on-site, upstream and downstream emissions associated with the Main SRFI, J15a Highway Works and Minor Highway Works. These are categorised as follows:

- Scope 1 Emissions: Direct emissions from the combustion of fuels and/ or gases within the Proposed Development boundary, during construction and operation.
- Scope 2 Emissions: Indirect emissions associated with the use of purchased electricity consumed within the Proposed Development boundary, during

construction and operation. Note that emissions associated with the generation of purchased electricity occur upstream of the development.

- Scope 3 Emissions: Indirect emissions emitted as a consequence of the Proposed Development, upstream or downstream of the Proposed Development.
  - Upstream emissions occur in order to facilitate the construction and operation of the Proposed Development and include the combustion of fuels to transport people and goods to the site; emissions associated with goods and services purchased; and emissions associated with fuel and energy related activities in the course of generating and distributing electricity and fuels; and waste generated during operations.
  - Downstream emissions occur as a result of the construction and operation of the development and include the transportation and distribution of goods.

21.39 Further, to ensure that all emission sources are considered, the following categories are applied to facilitate their identification:

- Stationary combustion: the use of fuels or purchased electricity to generate heat, steam or electricity in stationary equipment (e.g. boilers, heat pumps and generators)
- Mobile combustion: the use of fuel or purchased electricity to generate heat, steam or electricity in mobile equipment (e.g. vehicles and construction plant)
- Process emissions: the use of fuel or purchased electricity in a process (e.g. the manufacture of materials used in construction)
- Fugitive emissions: the controlled or un-controlled release of gases (e.g. leakage of refrigerant gases or the release of agricultural methane)

21.40 The GHG assessment (Volume 3, Appendix 21.1) assesses the GHG emissions for the existing site (Ex), construction phase (C) and operational phase (O) of the Proposed Development. Table 21.3 sets out the relevant emission sources within each scope and the stages at which they are relevant. Some emission sources may be relevant, but the assessment of those emissions may be disproportionate to this assessment; in those instances, emission sources have been scoped out (SO). Where emissions have been scoped out, a full justification is provided within Volume 3 Appendix 21.1.

Table .40.1.1.a.i.1: GHG Emission Scopes and Sources

GHG Emission Scope	Emission Sources within Scope	Relevance
Scope 1	**Stationary combustion**	
	Production of electricity, heat or steam.	Ex, C, O
	Mobile combustion	
	Use of fuels in mobile plant and equipment	Ex, C, O (SO)
	Fugitive emissions	
	Agricultural emissions	Ex (SO)
	HFC emissions arising from the use of refrigeration and air-conditioning equipment.	O (SO)
Scope 2	**Stationary combustion**	
	Use of purchased electricity, heat or steam.	Ex, C, O
Scope 3	**Mobile combustion**	
	Transportation of freight	Ex, C, O
	Transportation of waste	Ex (SO), C, O
	Transportation of materials	Ex (SO), C, O (SO)
	Employee business travel	SO
	Employee commuting	Ex (SO), C, O
	Process Emissions	
	Agrochemical production and use	Ex
	Fuel and energy related emissions	Ex (SO), C, O
	Production of purchased materials	Ex (SO), C, O (SO)

Methodology for Baseline

Activity Data

21.41 At the existing site, GHG emissions occur as a result of the current use of the site and include: direct emissions as a result of the combustion of fuel; indirect emissions through the use of purchased electricity in farm- and industrial-related activity; and indirect upstream emissions as a result of agriculture use (e.g. the manufacture and use of agrochemicals).

21.42 As outlined in Para 21.48, for the purpose of the GHG assessment, only emissions relating to displaced freight are assessed. These are assessed as a saving during the operational phase of the Proposed Development and are therefore excluded from the baseline.

Aggregated Baseline

21.43 In order to assess emissions as a result of the Proposed Development net of those that would have otherwise occurred (i.e. the 'do nothing' scenario), an 'aggregated baseline'

must also be developed that corresponds to the same timeframes as those being assessed. This takes into account decarbonisation effects that are expected to occur in order to meet the carbon budgets (i.e. grid decarbonisation).

Methodology for Assessment

Activity Data

21.44 Activity data is obtained from various sources as set out in Volume 3 Appendix 21.1, within the relevant emission scope and category depending on the emission type being assessed.

21.45 Activity data is dependent on the information available at the time of the assessment. At this stage, design details are only available in outline, so assumptions regarding aspects such as the design of buildings, quantities of materials and the precise quantities of freight that will be handled over time must be made. Assumptions related to each category of emissions are detailed in Volume 3, Appendix 21.1 and Volume 3, Appendix 21.2.

21.46 During construction, GHG emissions will be directly released due to the combustion of fuels in construction plant and vehicles, and indirectly through the consumption of electricity. Upstream emissions will result from the combustion of fuels and consumption of electricity, heat or steam in the processing of materials and manufacture of products, and the subsequent combustion of fuels in the transportation of materials and resources to the Proposed Development. Downstream emissions will occur as a result of the transportation of waste and treatment of water consumed in site activities.

21.47 During operation, GHG emissions will be directly released due to the combustion of fuels and from fugitive releases of refrigerant gases where refrigeration and air-conditioning equipment are present. Indirect releases will occur as a result of the consumption of electricity in buildings. Upstream emissions will be released from the combustion of fuel in vehicles used to transport employees to the Proposed Development, and to transport goods to the SRFI. Downstream emissions will occur as a result of fuel combustion in the onward movement of goods from the SRFI.

21.48 The movement of freight is a significant component of the Proposed Development and it is anticipated that the construction of the SRFI will result in significant modal shift from road to rail.

21.49 MDS Transmodal have estimated the mode shift benefits at Rail Central in their paper *'Estimated Mode Shift Benefits at Rail Central'* (Ref 21.7). This sets out that the movement of freight is demand-led and as such, is not driven by increases in warehouse area such as that included within the Proposed Development. It also notes that:

> *"The south Midlands region is a key location for large warehousing serving a national hinterland, but at the same time has attracted significant units serving the regional market.*

Given this and the continual process of warehouse renewal as described, this implies that in the event Rail Central SRFI is not developed, there will still be an ongoing requirement to develop new-build warehousing in the south Midlands region. The freight concerned would therefore continue to flow into and out of the region, but most likely at sites (existing expanded and new sites) which are not rail-served.

21.50 It is therefore assumed that any changes in the quantum of freight are not as a result of the Proposed Development and would occur without the SRFI; an assessment of emissions as a result of mode shift from road to rail are instead calculated based on the anticipated displacement effects set out by MDS Transmodal.

21.51 This includes the development of a counterfactual comparator scenario, described as follows:

This subsequently suggests a comparator scenario involving the same quantum of warehousing floor space that is planned for Rail Central, but instead being constructed on non-rail-linked sites within the same sub-regional market. This could include distributing that floor space across several established B8 sites in the wider Northampton area. This assumption of equivalent supply provision within the south Midlands region is purely made for the purposes of devising the comparator scenario, with no assessment of the likeliness of this occurring. However, the comparator scenario has therefore been taken to be a road-only based scheme at the same location i.e. the same quantum of floor space. This is the simplest comparator to explain and model… and it allows a direct comparison to be made between road-only and rail-served schemes at the same location. The same volume of cargo that can be expected to pass through the warehousing will also be assumed, albeit that it will all arrive or depart by road. Mode shift will be generated when the Rail Central SRFI can be shown to result in a significant reduction in HGV-km compared with this road only comparator."

Assessing Significance of Effect

21.52 IEMA's Climate Change Mitigation and EIA Principles published in 2010 (Ref 21.8) and reinforced within the 2017 Guidance (Ref 21.2) suggests that:

'*GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant; and the EIA process should, at an early stage influence the*

location and design of projects to optimise GHG performance and limit likely contribution to GHG emissions.'

21.53 This Chapter has qualitatively assessed the scale and significance of effect by calculating the net GHG emissions for the Proposed Development and considering the predicted deviation from the existing baseline site condition and UK Government carbon budgets, both before and after Adaptive Mitigation.

Magnitude of Effect

21.54 Current emission levels are already having an impact on the climatic system and to avoid catastrophic climate change, the level of global warming must remain within a two-degree limit, which will be exceeded if global emission reductions are not achieved; however, even by limiting warming to two degrees, there will still be some irreversible climatic impacts.

21.55 This means that maintaining current emission levels, with no change in emissions as a result of the Proposed Development, will still have a climatic impact.

21.56 Based on the fact that national carbon budgets reflect the requirement to remain within global emission limits and that this will be reflected in baseline emissions over time (e.g. through decarbonisation of grid supplies), emission reductions related to the emission intensity applied to activity data are taken into account through the use of an aggregated baseline.

21.57 However, activity reductions are also required to remain within emission limits, so for example, a low increase or decrease in emissions relative to the current baseline would still have a low adverse or beneficial effect on the receptor (climatic system).

21.58 In the absence of any defined criteria for assessing magnitude of effect, a qualitative assessment utilising professional judgement and the criteria set out in Table 21.4, has been undertaken.

21.59 Paragraphs 5.17-5.18 of the NPS NN states that the scale of GHG emissions from the Proposed Development should be compared to the UK Government carbon budgets to assist in quantifying impact of GHG emissions. Therefore, to assist with determining the magnitude and significance of impact and to provide context, a comparison of the GHG emissions against carbon budgets will be undertaken for both the Proposed Development and the relevant aggregated baseline. This approach is in accordance with Section 6.2 of the IEMA Guidance.

Table .59.1.1.a.i.1: Climate Change Mitigation - Defining Magnitude of Effect

Magnitude of Effect	Description
High	High decrease (beneficial)/ increase (adverse) in GHG emissions relative to the baseline and UK Government

	carbon budgets
Medium	Moderate decrease (beneficial)/ increase (adverse) in in GHG emissions relative to the baseline and UK Government carbon budgets
Low	Low decrease (beneficial)/ increase (adverse) in in GHG emissions relative to the existing baseline and UK Government carbon budgets
Negligible	Negligible decrease (beneficial)/ increase (adverse) in GHG emissions relative to the existing baseline and UK Government carbon budgets

Sensitivity of Receptor

21.60 In the case of GHG emissions, the receptor is the climatic system and as per IEMA principles, this receptor is considered to be sensitive to any increase in GHG emissions.

Significance of Effect

21.61 Given that it is established that the climatic system is sensitive to any increase in GHG emissions, the level of sensitivity of the receptor does not vary and is considered high; the scale applied in this assessment is set out in Table 21.5.

21.62 The effect can either be adverse (i.e. increase in GHG emissions) or beneficial (i.e. decrease in GHG emissions). A negligible effect is also possible if the magnitude of GHG emission change is marginal.

Table .62.1.1.a.i.1: Climate Change Mitigation - Defining Significance of Effect

Magnitude of Effect	Sensitivity of Receptor				
	High	**Medium**	**Low**	**Very Low**	**Negligible**
High	Major	N/A	N/A	N/A	N/A
Medium	Moderate	N/A	N/A	N/A	N/A
Low	Minor	N/A	N/A	N/A	N/A
Negligible	Negligible	N/A	N/A	N/A	N/A

21.63 Based on professional judgement, it is considered that any effect of moderate or high significance is considered significant in EIA terms.

Duration of Effect

21.64 The duration of effect of GHG gases depends on their radiative efficiency and lifetime. The lifetime of GHGs vary from 0.7 years for methyl bromide (CH_3Br) to 50,000 years for PFC-14 (CF_4); to take into account differences in potency and lifetime, GHGs are assessed based on

their impact over a set period of time relative to carbon dioxide. The most common assessment period is 100 years, and the quantity of carbon dioxide equivalent (CO_2e) calculated in this assessment relates to the 100-year impact of all GHGs relative to CO_2.

21.65 The Intergovernmental Panel on Climate Change (IPCC) publish 20-year and 100-year figures for Global Warming Potentials (GWPs) of different gases; the Framework Convention on Climate Change requires the use of 100-year figures in Government emissions reporting and the UK Greenhouse Gas Inventory and associated emission factors are based on this data.

21.66 Although temporary in nature, emissions associated with the construction and operation of the development can therefore be assumed to have a long-term effect.

Baseline Conditions

Regional Baseline

21.67 BEIS estimate that UK GHG emissions were 496.0 million tonnes CO_2e in 2016 (Ref 21.9), 4% lower than the previous 2015 estimate. Carbon dioxide accounts for 81% of GHG emissions and is estimated at 386.5 million tonnes CO_2 for 2016.

21.68 The Climate Change Act 2008 set a target to ensure that the net carbon account for the year 2050 is at least 80% lower than the 1990 baseline. The 1990 baseline is the aggregate of net UK emissions of carbon dioxide and other targeted greenhouse gases for that year (i.e. CO_2e).

21.69 It is the duty of the Secretary of State to set for each succeeding period of five years (beginning with the period 2008 to 2012) an amount for the net UK carbon account (the 'carbon budget') and to ensure that the net quantity of emissions do not exceed the carbon budget.

21.70 Carbon budgets have been set up to 2032, and Government has noted that from this point forward (2018), an annual reduction in emissions of circa 3% is required to meet the 2050 target. On this basis, we have estimated the level of carbon budgets likely to be required post-2032 to meet the 2050 target. Table 21.6 sets out the carbon budgets, with those estimated in italics.

Table .70.1.1.a.i.1: Summary of Aggregated UK Baseline GHG Emissions

Period	GHG Emissions [million tonnes CO_2e]
1st carbon budget (2008 – 2012)	3,018
2nd carbon budget (2013 – 2017)	2,782
3rd carbon budget (2018 – 2022)	2,544
4th carbon budget (2023 – 2027)	1,950

5th carbon budget (2028 – 2032)	1,725
6th carbon budget (2033 – 2037)	*1,491*
7th carbon budget (2038 – 2042)	*1.255*
8th carbon budget (2043 – 2047)	*1,019*
9th carbon budget (2048 – 2050)	*468*

21.71 2018 is currently within the 3rd carbon budget period, with an annual budget of 509 million tonnes CO_2e; in accordance with Paragraph 5.17-5.18 of the NPSNN, this assessment will compare the GHG emissions of the Proposed Development against the carbon budgets presented in Table 21.6.

Main SRFI Site

21.72 Baseline emissions occur as a result of activities already taking place on the existing site, and upstream/downstream of the site.

Current Baseline (2018)

21.73 Emissions associated with the current use of the site (excluding freight movements) provide a benchmark for determining GHG emissions without development, and net emissions during operation.

21.74 The existing site consists mainly of farmland and some limited industrial activity; emissions associated with these uses are assessed in Volume 3: Appendix 21.1 and resulting emissions are set out in Table 21.7.

Future Baseline (2019)

21.75 The future site baseline in 2019 assesses the emissions associated with the use of the site immediately prior to construction; this factors in any changes in emission factors for various fuels over the period between the current site baseline and the commencement of construction.

21.76 A detailed assessment of current and future baseline GHG emissions is provided in Volume 3, Appendix 21.1 and Volume 3, Appendix 21.2. Table 21.7 sets out the total estimated emissions for each emission source in 2019.

Table .76.1.1.a.i.1: Summary of Current and Future Baseline GHG Emissions (tonnes CO_2e)

	Current (2018)	Future (2019)
Stationary combustion: Production of heat and electricity	1	1

Mobile combustion: Fuel use in mobile plant & equipment	1,070	1,070
Stationary combustion: Use of purchased electricity	63	60
Total Site Emissions	**1,134**	**1,131**
Process emissions: Agrochemical production and use	1,602	1,602
Process Emissions: Fuel & energy related emissions	21	291
Total Upstream & Downstream Emissions	**1,631**	**1,623**
TOTAL EXISTING BASELINE EMISSIONS	**2,757**	**2,754**

Future Baseline (aggregated)

21.77 To compare the predicted construction phase (2019 – 2028) and operational phase emissions with baseline emissions, baseline emissions must be aggregated to cover the same periods of time, and the same assumptions applied regarding emission factors over those periods. Table 21.8 sets out the aggregated baseline emissions for the three assessment periods.

Table .77.1.1.a.i.1: Summary of Aggregated Existing Site Baseline GHG Emissions

	2019 - 2028	2029 - 2038	2039 - 2050	2039 - 2088
Stationary combustion: Production of heat and electricity	8	8	9	39
Mobile combustion: Fuel use in mobile plant & equipment	10,702	10,702	12,842	53,509
Stationary combustion: Use of purchased electricity	452	221	140	434
Total Site (Scope 1 & 2) Emissions	**11,162**	**10,931**	**12,992**	**53,982**
Process emissions: Agrochemical production and use	16,018	16,018	19,221	80,089
Process emissions: Fuel and energy related	214	214	257	1,071
Total Upstream & Downstream (Scope 3) Emissions	**16,232**	**16,232**	**19,478**	**81,160**
Total Existing Site Baseline Emissions	**27,394**	**27,163**	**32,470**	**135,142**

21.78 In the absence of any development, GHG emissions as a result of current activity on site are estimated at circa. 1,134 tCO_2e per annum. GHG emissions as a result of activity upstream and downstream of the site are estimated at circa 1,631 tCO_2e per annum. These emissions will reduce over time as a result of external actions to reduce the emissions associated with the fuels consumed and electricity purchased.

21.79 2018 baseline emissions at the existing site account for 0.00054% of the 2018 carbon budget. By 2028 (end of the construction period), with no emission reductions other than those as a result of external factors, annual baseline emissions would contribute 0.00070%; by 2038, this increases to 0.00108% and by 2050 to 0.00173%.

Junction 15a Highway Works

21.80 There are no baseline emissions associated with the J15a Highway Works.

Minor Highways Works

21.81 There are no baseline emissions associated with the Minor Highways Works.

All Development Within the Order Limits

21.82 As the Main SRFI Site.

Embedded Mitigation

21.83 For the purpose of this assessment, Embedded Mitigation relating to Climate Change Mitigation includes:

- Principles set out in the Outline Construction Environmental Management Plan (CEMP).
- Commitments made by the Applicant in the Sustainability Statement submitted with the Planning Application.

21.84 Also assumed as Embedded Mitigation are Government projected emission factor reductions in line with national carbon budgets, associated with fuels and electricity consumed in the construction and operation of the Proposed Development.

Main SRFI Site

21.85 Specific to the Main SRFI Site are measures related to the design of buildings which include:

A 20% reduction in **regulated emissions via Building Regulations Part L2a, demonstrated through calculations provided by the Applicant for the Applicant's standard building specification.**

J15a Highway Works

21.86 There are no specific measures relevant to the J15a Highway Works beyond those identified relevant to All Development within the Order Limits.

Minor Highway Works

21.87 There are no specific measures relevant to the Minor Highway Works beyond those identified relevant to All Development within the Order Limits.

All Development within the Order Limits

21.88 Relevant to All Development within the Order Limits are those measures that relate to general construction practices and the treatment of transport. This includes:

- **CEMP:** The CEMP will include measures such as the implementation of a Site Waste Management Plan (SWMP) and the adoption of an Environmental Management System (EMS) which would reduce emissions through the requirement to monitor and manage waste and energy during construction.

Assessment of Construction Phase Effects

21.89 Construction phase effects are the GHG emissions that will occur as a result of the construction process. They include the on-site emissions associated with mobile construction plant and equipment and the purchase of electricity during construction; and more significantly, the upstream and downstream emissions associated with the transport of materials, waste and employees, and the production of energy and materials used on site.

21.90 For the purpose of assessing the effects of the Proposed Development on climate change mitigation, all GHG emissions and any savings over the project life-cycle from modal shift are combined to produce an assessment of effect of All Development within the Order Limits. There are however specific emission sources that relate only to certain elements of the proposals; where this is the case, they have been identified separately below.

Main SRFI Site

21.91 The transportation of waste is based on assumptions set out in Chapter 20 Waste relating to quantities of waste generated during the construction of the Proposed Development. This assumes benchmark figures relating to the quantum of building area under development, so although will include some aspects of external works, is predominantly related to the construction of buildings within the Main SRFI Site.

21.92 Estimates of construction material quantities have been provided by RPS (Ref 21.10) based on assumptions regarding the build-up of buildings and roads; this information is used to estimate the GHG emissions associated with processing and transportation of construction materials. This assessment relates to the Main SRFI Site and is broken down into materials for:

- Estate Roads & Temporary Construction Access
- Bridges on A43 Road & to Northampton Road

- Buildings
- Landscaping
- Intermodal
- Express Freight Platform

J15a Highway Works

21.93 Activity data relating to the materials required for the J15a Highway Works are estimated based on a total area of 84,000m^2, and a worst-case assumption that the entire area is carriageway construction.

21.94 This activity data is used to assess the emissions associated with the processing of materials used in the construction of the Proposed Development and the transportation of those materials from factory gate to the site of the J15a Highway Works.

Minor Highways Works

21.95 Activity data relating to the materials required for Minor Highways Works was provided by TPA (Ref 21.11) covering:

- Junction Four –A5076/ Upton Way
- Junction Six – A5076/ Hunsbury Hill
- Junction Seven – Towcester Road/ Tesco
- Junction Fourteen – Tove
- Junction Fifteen – Abthorpe
- Junction Nineteen – Upton Way/ Telford Way
- Junction Twenty – Upton Way/ High Street

21.96 This activity data is used to assess the emissions associated with the processing of materials used in the construction of the Proposed Development and the transportation of those materials from factory gate to the site of the Minor Highway Works.

All Development within the Order Limits

21.97 An estimate of Scope 1 and Scope 2 on-site emissions is made based on proxy data per £m construction spend, and as such is assessed for the scheme as a whole rather than the component parts.

21.98 A profile of construction spend has been developed based on the completion of circa 20% floorspace, J15a Highway Works and other Minor Highway Works by 2021, with the remaining floorspace delivered between 2022 and 2028 at an equal rate. It should be noted that the time taken to complete a section of works is not necessarily an accurate indicator of the profile of spend; however, in lieu of any further detail, it is considered proportionate and appropriate for this assessment.

21.99 Given that the total spend is not allocated to specific components of the development, figures provided for on-site emissions relate to All Development within the Order Limits.

21.100 Fuel and energy related emissions relate to the upstream well-to-tank and transport and distribution impacts associated with fuels and electricity consumed and therefore relate to All Development within the Order Limits.

21.101 Emissions related to construction employee commuting are based on the Framework Construction Traffic Management Plan produced by TPA, which estimates the number of vehicles that will travel to the site on a daily basis, based on outline construction phasing and delivery timescales.

21.102 Table 21.9 sets out the construction-related emissions that occur during the construction phase (2019 – 2020) for All Development within the Order Limits.

Table .102.1.1.a.i.1: Construction Phase Emissions (2019 – 2028) for All Development within the Order Limits

Construction Emission Sources	GHG Emissions [tCO_2e]	Direct/ Indirect
Mobile combustion: Fuel use in mobile plant & equipment	11,052	Direct
Stationary combustion: Use of purchased electricity in buildings & infrastructure	694	Indirect
Total Site (Scope 1 & Scope 2) Emissions	**11,746**	-
Mobile combustion: Transportation of materials	4,253	Indirect
Mobile combustion: Transportation of waste	124	Indirect
Mobile combustion: Employee commuting	3,856	Indirect
Process emissions: Production of construction materials	200,778	Indirect
Process Emissions: Fuel and energy related emissions	344	Indirect
Total Upstream & Downstream (Scope 3) Emissions	**209,355**	-
Total Construction Phase Construction Emissions	**221,101**	-

21.103 All GHG emissions are considered **temporary** as they occur at a single point in time and last for a known period of time, depending on their radiative efficiency; however, for the purposes of GHG emission assessments they may result in potentially irreversible and permanent climate change impacts.

21.104 As the assessment considers the quantity of CO_2e over a 100-year lifespan, all construction emissions are therefore considered to have long-term effects despite the fact that they are emitted from temporary activities.

21.105 Construction emissions represent 0.00555% of the aggregated UK carbon budget over the corresponding period (2019 – 2028), compared with the 0.00063% contribution made by the aggregated existing baseline.

21.106 As there is a net increase in emissions over the current site baseline as a result of construction activity, there is deemed to be an adverse effect. Through professional judgement, the quantum of increase relative to the UK carbon budget and aggregated existing baseline is considered to be of medium magnitude, resulting in a **moderate adverse** effect on climate change, resulting in a **significant** effect.

21.107 However as stated previously in this chapter and in relevant IEMA guidance, the effect upon climate change must be considered based upon the net GHG emissions impact on the basis that construction of any building or physical development will result in GHG emissions.

Impact of Timing of Construction Phasing

21.108 Over time, the decarbonisation of power supplies will reduce the climate change effect of activities that generate emissions. If the construction phase is reduced, a greater proportion of activity will occur when the GHG content of fuels and electricity are higher. These higher emissions will occur over a shorter timeframe, resulting in increased emissions as a percentage of the carbon budgets. Conversely, if the construction phase is extended, a greater proportion of activity will occur when the GHG content is lower, reducing total GHG emissions, spread over a longer period of time, thus reducing the emissions as a percentage of carbon budgets. It is likely that in either scenario, the magnitude of emissions would be similar, and the level of significance would not alter.

Assessment of Operational Phase Effects

21.109 Operational effects are the GHG emissions that will occur as a result of the operation of the Proposed Development. They include the on-site emissions associated with energy use in buildings and site infrastructure; and the upstream and downstream emissions associated with the transport of freight, waste and employees, and the production of energy used on site.

21.110 For the purpose of assessing the effects of the Proposed Development on climate change, all GHG emissions are combined so an assessment of All Development within the Order Limits

has been undertaken. There are however specific emission sources that relate only to certain elements of the proposals; where this is the case, they have been identified separately below.

Main SRFI Site

21.111 An estimate of Scope 1 and Scope 2 on-site emissions is made based on the anticipated energy consumption of buildings and on-site infrastructure and long-term emission factor profiles. This includes an estimate for the consumption of external lighting and other site-wide infrastructure but is predominantly related to the operation of buildings within the Main SRFI Site.

21.112 The transportation of waste is based on assumptions set out in Chapter 20 Waste relating to quantities of waste generated during the operation of the scheme. This assumes benchmark figures relating to the quantum of building area developed, and so is related to the operation of buildings within the Main SRFI Site.

21.113 Emissions related to employee commuting are based on the Transport Assessment produced by TPA, which estimates the number of vehicles that will travel to the site on a daily basis, based on benchmark data per sqm of industrial employment space and similar schemes elsewhere. This relates to the operation of the Main SRFI site only, as the highway elements are not considered a destination.

21.114 Fuel and energy related emissions relate to the upstream well-to-tank and transport and distribution impacts associated with fuels and electricity consumed and therefore relate to the activity assessed under the Main SRFI Site.

21.115 The displacement of freight through modal shift is considered to occur as a result of the rail-connected warehouse provision and intermodal facility within the Main SRFI site. The shift from road to rail is assumed to begin during the construction phase on completion of rail-connected warehouse units; linear interpolation is applied to estimate the quantity of modal shift between partial and full completion based on the areas of these units.

21.116 The reduction in emissions compared with the comparator (baseline) scenario are presented, resulting in a saving in both mobile combustion and process emissions associated with fuels used in freight transportation.

J15a Works

21.117 All transport emissions are assumed to occur as a result of the Main SRFI site, so whilst this may increase local traffic, any changes in traffic emissions are reported in relation to the Main SRFI Site.

Minor Highways Works

21.118 All transport emissions are assumed to occur as a result of the Main SRFI site, so whilst this may increase local traffic, any changes in traffic emissions are reported in relation to the Main SRFI Site.

All Development within the Order Limits

21.119 For the purpose of assessing the effects of the Proposed Development on climate change, all operational phase GHG emissions have been combined and are considered across three periods:

- During construction (2019 - 2028)
- Short-term operation (2029 - 2038)
- Long-term operation (2039 - 2089)

Construction Phase (2019 – 2028)

21.120 During the construction phase, components of the Proposed Development will be completed, and operation of those components will commence. This will result in an annual increase in building- and site-related emissions as buildings within the Main SRFI Site are completed, and reductions in freight emissions as road freight begins to switch to rail. Table 21.10 sets out the total aggregated operational emissions that are anticipated to occur during the construction phase, taking into account Embedded Mitigation measures previously identified.

Table .120.1.1.a.i.1: Construction Phase Operational Emissions (2019 – 2028)

Operational Emission Sources (2019 – 2028)	GHG emissions [tCO_2e]	Direct/ indirect
Stationary combustion: Production of heat & electricity	3,447	Direct
Stationary combustion: Use of purchased electricity in buildings & infrastructure	30,808	Indirect
Total Site (Scope 1 & Scope 2) Emissions	**42,254**	-
Mobile combustion: Transportation of freight	-122,188	Indirect
Mobile combustion: Transportation of waste	755	Indirect
Mobile combustion: Employee commuting	32,369	Indirect
Process Emissions: Fuel and energy related emissions	-7,924	Indirect
Total Upstream & Downstream (Scope 3) Emissions	**-96,988**	-
Total Construction Phase Operational Emissions	**-54,734**	-

21.121 All GHG emissions are considered **temporary** as they occur at a single point in time and last for a known period of time, depending on their radiative efficiency; however, GHG emissions may result in potentially irreversible and permanent climate change impacts.

21.122 As the assessment considers the quantity of CO_2e over a 100-year lifespan, all operational emissions are considered to have long-term effects.

21.123 The total construction phase operational emissions are equivalent to 0.00050% of the aggregated carbon budget for the comparable period, compared with 0.00063% for the aggregated existing site baseline.

21.124 As there is a net reduction in emissions over the aggregated existing site baseline, construction phase operational emissions are deemed to have a **minor beneficial** effect on climate change in the short-term operational phase. In effect the operation of a number of SRFI buildings during the construction phase have already begun to offset some of the construction phase emissions.

Short-term Operational Phase (2029 – 2038)

21.125 During short-term operation, all elements of the Proposed Development are assumed to be complete and fully operational. Table 21.11 sets out the total aggregated emissions over the short-term operational period, taking into account Embedded Mitigation measures.

Table .125.1.1.a.i.1: Short-term Operational Emissions (2029 – 2038)

Operational Emission Sources (2029 – 2038)	GHG emissions [tCO_2e]	Direct/ indirect
Stationary combustion: Production of heat & electricity	6,627	Direct
Stationary combustion: Use of purchased electricity in buildings & infrastructure	45,880	Indirect
Total Site (Scope 1 & Scope 2) Emissions	**52,508**	-
Mobile combustion: Transportation of freight	-224,397	Indirect
Mobile combustion: Transportation of waste	2,406	Indirect
Mobile combustion: Employee commuting	50,577	Indirect
Process Emissions: Fuel and energy related emissions	-2,372	Indirect
Total Upstream & Downstream (Scope 3) Emissions	**-173,786**	-
Total Short-term Operational Phase Emissions	**-121,278**	-

21.126 Were the existing site to continue in its current use, and the SRFI not go ahead, with no road freight displacement to rail, total operational emissions over the period 2019 -2028 are

estimated to be circa 27,394 tonnes CO_2e; this compares with 54,734 tonnes CO_2e that would be saved as a result of the operation of the SRFI over the same period.

21.127 During the short-term operational phase of development, the Proposed Development will result in a reduction in GHG emissions equivalent to a 0.00391% of the aggregated carbon budget for the period. This compares with an increase in GHG emissions equivalent to 0.00087% of the aggregated carbon budget for the period that the aggregated existing site baseline would have otherwise contributed.

21.128 As there is a net reduction in emissions over the aggregated existing site baseline, short-term operational emissions are deemed to have a **minor beneficial** effect on climate change in the short-term operational phase.

Long-term Operational Phase (2039 – 2088)

21.129 A quantitative assessment of emissions beyond 2038 has not been made as there is considerable uncertainty and an absence of reliable data around future operational trends, technologies and innovations, energy supplies and emission factors.

21.130 Qualitatively, it is our professional judgement that emissions post-2038 will reduce significantly; indeed, this will be necessary to meet the UK's legally binding targets set for GHG emission reductions by 2050. This qualitative assessment is based upon the following assumptions derived from a number of Government reports, research papers and industry publications:

- By 2050 it is expected that emissions related to the use of electricity will reduce by almost 88% compared with current grid emissions; no further savings are anticipated beyond this point (Ref 21.12).
- There is significant research currently being undertaken into the development of alternative fuels for HGVs and rail uses, which could have a significant impact on both road and rail freight emissions.
- Innovations and cost reductions in battery storage are likely to make the use of renewable energy and electric vehicles more viable in the medium- to long-term, resulting in a market-driven shift (as opposed to policy driven) in the commercial and transportation sectors to renewable fuels and low/ zero emission vehicles.
- Many European cities and member states have made commitments relating to the types of vehicles that can be sold in the future, and this is supported by a growing number of manufacturer commitments to produce more vehicles to support cleaner fuels.
- Behaviour changes and the 'sharing economy', supported by disruptive IT infrastructure could reduce the number of private vehicles with the greatest potential for reductions relating to commuting. Greater collaboration and consolidation of freight could reduce the requirement for shorter-distance

freight movements, typically carried out by road; rail legs of such journeys would likely remain.

- Demand-side response and energy efficiency measures, particularly at replacement intervals, are likely to reduce the energy demand from buildings further.

21.131 Although a full quantitative assessment of emissions during the long-term operational phase has not been carried out, if we assume there are no further emission reductions post-2038 other than those anticipated for grid electricity, the aggregated emissions presented in Table 21.12 are observed.

Table .131.1.1.a.i.1: Long-term Operational Emissions

Operational Emission Sources (2039 – 2088)	2039 -2050	2051 -2088
Stationary combustion: Production of heat & electricity	7,770	32,374
Stationary combustion: Use of purchased electricity in buildings & infrastructure	29,044	90,056
Total Site (Scope 1 & Scope 2) Emissions	**36,814**	**122,43**
Mobile combustion: Transportation of freight	-313,538	-1,227,994
Mobile combustion: Transportation of waste	2,780	11,585
Mobile combustion: Employee commuting	46,524	178,615
Process Emissions: Fuel and energy related emissions	-41,836	-259,478
Total Upstream & Downstream (Scope 3) Emissions	**-306,070**	**-1,297,272**
Total Long-term Operational Phase Emissions	**-233,995**	**-972,586**

21.132 Between 2038 and 2050, this represents a GHG emissions reduction equivalent to 00643% of the aggregated UK carbon budget for the period, compared with 0.00130% that the aggregated existing site baseline otherwise would have contributed.

21.133 The aggregated significance of effect into the long-term operational phase will continue to reduce and has the potential to deliver a **moderate beneficial** effect over time.

21.134 The combination of construction and operational phase emissions over the construction, short-term operational and long-term operational phases, net of existing site baseline emissions and compared with UK carbon budget (CB) emissions over the same periods are shown in Table 21.13.

Table .134.1.1.a.i.1: In-combination Emissions compared with Carbon Budgets

Aggregated Emissions	2019 - 2028	2019 -2038	2019 - 2050	2019 - 2088
Carbon budget [million	4,378	7,500	9,991	15,919

tCO_2e]				
Baseline Emissions [tCO_2e]	27,394	54,556	87,026	189,698
Proposed Development Emissions [tCO_2e]	242,986	121,707	-38,444	-777,035
Net Proposed Development Emissions [tCO_2e]	215,592	67,151	-147,609	-966,733
Baseline emissions as % of CB	0.00063%	0.00073%	0.00087%	0.00119%
Proposed Development emissions as % of CB	0.00555%	0.00162%	-0.00038%	-0.00488%
Net emissions as % of CB	0.00049%	0.00009%	-0.00013%	-0.00061%

21.135 By the end of the construction phase (2028), aggregated in-combination emissions from the Proposed Development equate to 0.00505% of the UK carbon budget, reducing to 0.00044% when existing site baseline emissions are displaced.

21.136 By the end of the short-term operational phase (2038), in-combination emissions from the construction and operational phases of the Proposed Development equate to 0.00133% of the UK carbon budget, reducing to 0.00022% when baseline emissions are displaced. This is still a net increase in emissions compared with the 'do nothing' scenario, but by an increasingly reduced quantity as the impact of GHG emissions from the construction phase become proportionally less.

21.137 It is significant that at 2050, and the point at which the UK is legally required to have reached an 80% reduction in emissions compared with the 1990 baseline, aggregated emissions from the Proposed Development are estimated to generate a saving over the aggregated existing site baseline of 125,470 tCO_2e, thereby contributing to a reduction against the UK Government carbon budgets.

21.138 By the end of the long-term operational phase (2088), in-combination emissions from the construction and operational phases of the Proposed Development could potentially result in a reduction of circa 966,733 tCO_2e compared with the existing site baseline; this would deliver a **moderate beneficial** effect.

21.139 For comparative purposes, i GHG emission reductions are typically only procured through renewable energy projects which demonstrates the significant contribution that Rail Central is expected to make to a low carbon economy.

Adaptive Mitigation

21.140 IEMA guidance recommends the use of the IEMA GHG Mitigation Hierarchy which presents a structure for mitigating GHG emissions and which has been adopted at Rail Central.

21.141 During the construction phase, GHG emissions as a result of the construction of the Proposed Development result in a significant adverse effect which requires Adaptive Mitigation in order to reduce the level of effect.

21.142 Despite the assessment of the operational effects on climate change as a result of the Proposed Development revealing a minor to moderate beneficial effect, additional Adaptive Mitigation measures have been considered on the basis that any further reductions in GHG emissions can only be beneficial. Paragraph 5.19 of the NPS NN also requires appropriate mitigation to ensure the carbon footprint is not '*unnecessarily high*'.

21.143 It is acknowledged however that the Adaptive Mitigation measures proposed will only apply during the detailed design phase of the Proposed Development and that legislation (such as Building Regulations) and technology may change, which could result in further reductions in GHG emissions. It is therefore considered more appropriate to ensure the mechanisms and procedures are in place to seek GHG emission reductions as opposed to defining specific targets or technologies at this stage.

Table .143.1.1.a.i.1: EIA Hierarchy for Managing Project Related GHG Emissions

Hierarchy	Description
Avoid	Investigate and deploy options to eliminate GHG emissions
Reduce	Ensure that construction and operational activities will deliver efficient use of energy and resources.
Substitute	Commit to deploying renewables and low carbon materials, methods and technologies in place of more carbon intensive sources.
Compensate	Develop a strategy to compensate for residual or unavoidable emissions.

21.144 Identified Adaptive Mitigation measures are outlined in Table 21.15 below:

Table .144.1.1.a.i.1: Climate Change Mitigation - Proposed Adaptive Mitigation Measures

Potential Effect	Proposed Mitigation	Means of Implementation	Mechanism for Securing Mitigation
Construction Phase			
GHG emissions arising from the operation of the construction site beyond best practice levels	Emissions reductions to be sought in CEMP to manage and reduce GHG emissions where possible.	Implementation of CEMP	Requirement in the DCO

assumed.			
GHG emissions arising from the production of materials used in construction.	Development of a life-cycle assessment for all principal materials quantified in this assessment to target a reduction in assessed emissions.	Assessment of Whole-life Carbon in accordance with RICS Guidance (or similar)	Requirement in the DCO for Sustainability Statement
Operational Phase			
N/A	N/A	N/A	N/A

21.145 Table 21.16 sets out estimated construction emissions assuming the Adaptive Mitigation measures set out in Table 21.15 are applied.

21.146 At this stage, it is not possible to estimate the potential savings through the development of a life-cycle assessment to allow the targeting of the use of materials with lower GHG emissions in production, however a reduction of 20% will be targeted.

Table .146.1.1.a.i.1: Climate Change Mitigation - Construction Phase Construction Emissions after Adaptive Mitigation

Construction Emission Sources	GHG Emissions [tCO_2e]
Mobile combustion: Fuel use in mobile plant & equipment	11,052
Stationary combustion: Use of purchased electricity in buildings & infrastructure	694
Total Site (Scope 1 & Scope 2) Emissions	**11,746**
Mobile combustion: Transportation of materials	4,253
Mobile combustion: Transportation of waste	124
Mobile combustion: Employee commuting	3,856
Process emissions: Production of construction materials	160,622
Process Emissions: Fuel and energy related emissions	344
Total Upstream & Downstream (Scope 3) Emissions	**169,199**
Total Construction Phase Emissions	**180,945**

21.147 It is estimated that a 15% reduction in construction emissions could be achieved following the Adaptive Mitigation measures identified in Table 21.15. Total construction emissions following mitigation are estimated to be 180,945 tCO_2e.

Residual Effects

21.148 Given the absence of any significant criteria or thresholds, professional judgement is used to determine the scale and significance of any mitigation measures in the context of residual effects.

Table .148.1.1.a.i.1: Climate Change Mitigation - Summary of Residual Effects

Description of Effect	Level of Effect	Adaptive Mitigation Measures	Residual Effect
Construction Phase			
Quantity of GHG emissions	Moderate Adverse	Identified in Table 21.15	Moderate Adverse
Operational Phase			
N/A			
In-combination (Construction & Operation)			
Quantity of GHG emissions	Moderate Beneficial	Identified in Table 21.15	Moderate Beneficial

21.149 Whilst the measures proposed will not reduce the overall significance of effects, they are applied in accordance with the IEMA Hierarchy for Managing Project Related GHG Emissions and any reduction is considered beneficial.

Cumulative Effects

Cumulative Assessment: Intra-Project Effects

21.150 All relevant GHG emissions associated with other ES topics have been considered within this Chapter and no additional intra-project effects are considered likely. The impact of GHG emissions on the Proposed Development is considered in the context of a changing climate and is considered in the Climate Change Adaptation section of this Chapter.

21.151 For the reasons set out above there is no requirement for a separate assessment of intra-project cumulative effects.

Cumulative Assessment: Inter-Project Effects

21.152 The GHG emissions presented in this Chapter are based on circumstances specific to the Proposed Development; whilst external factors could have an impact on the quantity of estimated emissions, reasonable endeavours have been taken to ensure that likely scenarios are accounted for (for example in projections of future emission factors).

21.153 GHG emissions arise as a result of activities that take place every day across the world, and their effects cumulatively result in the climatic effects that are considered in the Climate

Change Adaptation section of this Chapter. As such, inter-project effects are significant, but are quantified at a global level, and an assessment of the emissions of projects locally significant to the Proposed Development would serve no purpose.

21.154 It should be noted that IEMA's overarching principles on climate change and EIA state that the GHG emissions from all projects will contribute to climate change, the largest inter-related cumulative environmental effect. Central estimates of the effects of climate change are presented as part of the Climate Change Adaptation section of this Chapter, and no further assessment of cumulative effects is considered necessary.

Monitoring

21.155 During the detailed design phase of the Proposed Development we commit to undertake a Life Cycle Assessment for each phase of development in order to facilitate GHG reductions through the use of materials with lower process emissions.

Limitations and Assumptions

21.156 As this is a predictive assessment, there is inherent uncertainty in the results. As far as practicable, data specific to the Proposed Development has been used to develop the activity and emissions profiles, but in some cases, this is not possible and other external sources of data are used. In accordance with the principles of the GHG Protocol, all assumptions and data uncertainties are disclosed in Volume 3, Appendix 21.1 and Appendix 21.2.

Activity Data

21.157 Information pertaining to the detailed design of the scheme is not yet available, so where necessary, proxy data has been used to provide an estimate of activity for both baseline and estimated actual emissions. Assumptions made have been fully disclosed in the Data Sources sub-section for each category of emissions; any uncertainty around those assumptions has been assessed in the relevant Data Quality and Uncertainty sub-sections of Volume 3, Appendix 21.1.

Emission Factors

21.158 The primary source for current emission factors used in this report are the BEIS Emission Factors; these are produced annually and current factors (2018) are provided for use by UK based organisations reporting on UK operations that occurred during the period 1st April 2017 to 31st March 2018. However, it should be noted that this data is two years out of date and relates to the period 1st April 2015 to 31st March 2016.

21.159 BEIS Emission Factors are based on various sources that are reviewed at different frequencies, some of which may not be annual. Where annual averages are provided, they may not be reflective of the actual supply that will be procured.

21.160 Assessments have been made of likely future emission factors based on data published by various sources relating to the decarbonisation of energy supplies.

21.161 For electricity, this includes Green Book Supplementary Guidance: Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal, *Table 1*.

21.162 For gas, this includes:

- *Next steps for UK heat policy* (Ref 21.13), and the assumption that in order to meet the fifth carbon budget (central scenario), a reduction in heating emissions of 22% to 2030 relative to 2015 is required.
- *Decarbonising the Gas Network* (Ref 21.14), which references the above and sets out that the most likely transition to a lower carbon network up to 2030 would include a bio methane injection of up to 4%. Post 2030, a range of measures, including hydrogen, could achieve larger savings. Urgent research is required to understand the costs of and technical issues posed by a hydrogen gas gird, but Government and industry stakeholders advocate one of two broad strategies: hydrogen blending where up to 20% hydrogen could enter the grid, increasing as technologies mature and the supply chain develops; or 100% hydrogen switch which would rapidly achieve major carbon savings, but would require the conversion of all appliances (e.g. boilers) from natural gas to pure hydrogen.

21.163 It is therefore assumed that a linear reduction in emissions is achieved to 2030 by annual increases in the supply of bio methane to the gas grid. Beyond 2030, it is assumed that 20% hydrogen enters the grid, and that it is produced by electrolysis.

21.164 This reduces emissions in use but increases upstream well-to-tank (WTT) and transport and distribution (T&D) emissions.

21.165 Assumptions relating to other fuels are made and explained in full in Volume 3, Appendix 21.1 along with a full table of emission factors applied in this assessment.

Section 2: Climate Change Adaptation

Methodology

21.166 This section considers the anticipated effects of climate change on the Proposed Development, and what measures, if any, are needed to adapt to likely future climate effects and improve climate resilience.

21.167 Climate change is anticipated to have a significant impact on the UK climate leading to more frequent periods of weather extremes including higher peak and average temperatures and increased rainfall events.

21.168 The magnitude, sensitivity and significance criteria adopted for this assessment have been developed based on available IEMA guidance and through the application of professional judgement. The tables in this section provide a summary of how significance of effect has been determined for the assessment of Climate Change Adaptation.

21.169 The Method of Assessment adopted in this section to assess Climate Change Adaptation comprises the following principal components:

- Identification of the existing baseline climatic conditions utilising data from the Met Office.
- Identification of the relevant UKCP09 future climate change scenario and baseline data.
- A qualitative assessment of the potential effects and impacts of the selected future climate change scenario during the construction and operational phases of the development.
- Identification of any mitigation measures as necessary and a review of the residual impacts.

21.170 The potential effects of climate change may also be addressed by other Chapters within this ES in accordance with policy and legislation specific to that environmental topic. This Chapter will not duplicate such work but will reference such assessments where necessary in order to provide a holistic overview of how the effects of climate change have been assessed for the Proposed Development.

21.171 Disciplines which may separately assess the effects of climate change in the context of the Proposed Development include hydrology, ecology, and transport. A full list of Chapters and details of Adaptive Mitigation measures relating to Climate Change Adaptation are considered in this assessment and are included as part of Cumulative Assessment: Intra-Project Effects further on in this section.

Identification of Study Area

21.172 The study area for the Climate Change Adaptation assessment comprises the Proposed Development which includes All Development within the Order Limits.

21.173 Due to the nature of climate change, the impacts and implications of the identified effects may be outside of the Study Area and may be affected by the Proposed Development or have an impact on the Proposed Development. For example, the risk of surface water flooding, likely to increase due to climate change, can both impact on the Proposed Development (with surface water from the surrounding area impacting on the site), or on other developments (with surface water from the site travelling across the site boundary to the wider area).

Methodology for Baseline

21.174 The current and future climatic baselines for the Proposed Development are based on available data from the UK Met Office and UK Climate Change Projections published in 2009; this does not vary depending on the component of the site being assessed, and a single baseline is provided relevant to All Development within the Order Limits.

Current Baseline

21.175 The current climatic baseline is based on long-term average data from the UK Met Office (Ref 21.15) for Northampton Moulton Park, which is located approximately 12km to the north east of the Proposed Development Site and is considered representative of the climate at the Proposed Development; these climatic conditions are outlined in Table 21.26.

Future Baseline

21.176 The Climate Change Adaptation assessment is based on future climatic baseline predictions sourced from the UKCP09 website which is the source of climate projection data for the UK. The UKCP09 website (Ref 21.16) is managed by the Environment Agency, working with the Met Office.

21.177 The UKCP09 website allows users to access information on plausible changes in 21st century climate; it provides probabilistic climate projections for land and marine regions as well as observed (past) climate data for the UK.

21.178 UKCP09 was produced in 2009, funded by a number of agencies led by DEFRA. It is based on sophisticated scientific methods provided by the Met Office, with input from over 30 contributing organisations. UKCP09 can be used to help organisations assess potential effects of the projected future climate and to explore adaptation options to address those effects.

21.179 UKCP09 provides climate projections for the UK for three different future GHG emission scenarios: a Low emission scenario; a Medium emission scenario; and a High emission scenario, all of which are based on the scenarios presented by the Intergovernmental Panel on Climate Change [IPCC] Emissions Scenarios Report (Ref 21.17).

21.180 The three scenarios all assume very rapid economic growth, global population that peaks mid-century and then declines, and the rapid introduction of new and more efficient technologies. The High scenario assumes a high use of fossil fuels, the Low scenario assumes a high use of non-fossil energy sources and the Medium Scenario assumes an intermediate case. UKCP09 treats all three emission scenarios as equally plausible, however for the purposes of this assessment, the Government's NN NPS includes guidance on the assessment of climate change and states:

"Where transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the UKCP09 high emissions scenario against the 2080 projections at the 50% probability level."

21.181 In this context and given the nature of the Proposed Development on the national rail network and its anticipated life of 60 years, it is considered appropriate to follow Government guidance and apply the High emissions scenario.

21.182 The projections are averaged over each of seven future overlapping 30-year time periods, stepped forward by a decade, starting with 2010 – 2039. These future time periods are referred to by their middle decade, starting from the 2020s (2010 – 2039) and ending with the 2080s (2070 – 2099); all changes are expressed relative to a modelled 30-year baseline period of 1961 – 1990.

21.183 Central estimates are used in this assessment. The central estimate is not the most likely outcome, it simply shows that half of the climate scenarios used to inform the probability distribution fell below that figure and half fell above it. If, for example, the central estimate for temperature rise for 2050 was 3ºC then the evidence suggests that temperatures are as likely to increase by less than 3ºC as they are to increase by more.

21.184 The consideration of potential climate change effects is undertaken in accordance with defined and agreed timeframes for construction and operation. Table 21.18 details the anticipated project construction and operational timescales associated with the Proposed Development.

Table .184.1.1.a.i.1: Proposed Development and UKCPO9 timeframes

Timeframe	Construction	First Operation	Short-term Operation[2]	Long-term Operation
Proposed Development Timeframe	2019-2029	2021	2029-2039	2039-2089
Corresponding UKCPO9 Timeframe	2020	2020	2020	2080

21.185 In this context, to identify the key effects of climate change on the Proposed Development, data will be sourced from UKCP09 covering the 2020s and 2080s under the High emissions scenario to determine the change in local climate and effects faced by the Proposed Development.

[2] Note that in accordance with NPS NN, a worst-case scenario assuming the effects identified for the 2080s are applied to all operational phases.

21.186 It should also be noted that the government has recently provided funding to update the UKCP09 datasets in line with recent scientific findings and trends in global GHG emissions and will be available from November 2018.

Methodology for Assessment

21.187 Determining the magnitude and significance of climate change on the Proposed Development is a complex issue given the uncertainty in the magnitude of the future changes to the climate and the frequency of 'climate change' related events.

21.188 The magnitude, sensitivity and significance criteria adopted for this assessment have been developed based on available IEMA guidance (Ref 21.18) and through the application of professional judgement. The tables in this section provide a summary of how the level of effect has been determined for the Climate Change Adaptation assessment.

Climate Change Risk Assessment

21.189 A review of the UK Climate Change Risk Assessment (Ref 21.19), relevant guidance and the anticipated future climate within the East Midlands has been undertaken, and along with an assessment of existing and future baseline conditions, is used to develop the Rail Central Climate Change Risk Assessment appended in Volume 3, Appendix 21.3.

21.190 This Rail Central Climate Change Risk Assessment reviews the scale of climatic variation and effects anticipated over the construction and operational phases of the Proposed Development as a result of climate change. This is used to determine the climatic effects that will be considered in the Assessment of Effects later in this section.

21.191 Table 21.19 summarises the climatic effects, risks, severity and nature of impact and overall assessment of risk relevant to the Proposed Development, as determined in the Rail Central Climate Change Risk Assessment.

Table .191.1.1.a.i.1: Climate Change Risk Assessment Summary

Climatic Effect	Risk	Severity of Impact	Nature of Impact	Risk Assessment
Increase in Winter Mean Temperature	Risk to landscape and mitigation for species and habitats from changing climate space	Medium: Potential for the loss of species through climate space changes	Continual: Linked to a rise in summer temperature this risk is considered to be continual	High
Increased summer mean and daily maximum	Risk to landscape and mitigation for species and	Medium: Potential for the loss of species through climate	Continual: Linked to a rise in summer temperature this	High

temperature	habitats from changing climate space	space changes	risk is considered to be continual	
	Increase in energy demand from additional cooling required in buildings	Low: Likely to have minor change to operational energy	Frequent/ Seasonal: Linked to periods of extreme temperature, likely to be short lived	Moderate
	Damage to electrical infrastructure, i.e. substation overheating	High: Potential damage to electrical equipment likely to be a severe impact	Frequent/ Seasonal: Linked to periods of extreme temperature, likely to be short lived	High
	Risk of overheating impacting health and wellbeing	Medium: Likely to have minor impact on wellbeing	Frequent/Seasonal: Linked to periods of extreme temperature, likely to be short lived	High
	Risk of damage to rail infrastructure including rail and electrical equipment	High: Potential damage to electrical equipment likely to be a severe impact	Frequent/ Seasonal: Linked to periods of extreme temperature, likely to be short lived	High
Decrease in summer rainfall	Risk to landscape and mitigation for species and habitats from water availability	Medium: Potential for the loss of biodiversity /severe impact on habitats and species	Seasonal: Linked to increased summer rainfall and a decrease in rainfall over the same period	High
	Risk to fresh water supplies	Low: Likely to have minor impact on operation	Seasonal: Linked to increased summer rainfall and a decrease in rainfall over the same period	Moderate

	Risk to building and infrastructure foundations from ground movement	High: Potential damage to infrastructure with severe impact	Seasonal: Linked to periods of extreme temperature and reduction in summer rainfall	High
Increase in winter rainfall	Risk of increase in flooding (fluvial and surface water) due to increased rainfall	High: Potential damage to infrastructure with severe impact	Seasonal: Increase in winter rainfall also linked to an increase in winter temperature	High
	Risk to building and infrastructure foundations from ground movement	High: Potential damage to infrastructure with severe impact	Seasonal: Linked to an increase in winter temperature and saturated ground	High

21.192 In addition to the risks identified in Table 21.20, a number of opportunities were also identified that have the potential to provide benefits to the Proposed Development and also require consideration in the Assessment of Effects in Table 21.21.

Table .192.1.1.a.i.1: Climate Change Opportunities

Climatic Effect	Opportunity
Increase in winter mean temperature	Opportunity for new species colonisation and increase in climate space
	Opportunity for improvement in health and wellbeing
	Opportunity for reduced energy use and therefore reduced GHG emissions
	Reduced risks from cold weather on construction and operational phases
Increased summer mean and daily maximum temperature	Opportunity for new species colonisation and increase in climate space

Magnitude of Effect

21.193 Table 21.21 sets out the definition for the magnitude of the effects associated with climate change, which have the potential to impact on the construction and operational phases of the different Proposed Development components.

21.194 The effects of climate change can be either beneficial or adverse, for example an increase in winter temperature could improve working conditions, whereas an increase in summer mean and daily maximum temperature could lead to overheating in buildings.

21.195 Potential adverse effects could be seasonal or on-going; have structural impacts on elements such as the rail lines, buildings and roads; or have an operational effect (e.g. the overheating of buildings could lead to reduced working hours).

Table .195.1.1.a.i.1: Climate Change Adaptation – Defining Magnitude of Effect

Magnitude of Effect	Description
High	On-going annual effect with the potential for extreme events to cause operational or structural damage. For example, higher temperatures causing a major failure in structures or buildings with the potential for injury.
Medium	Seasonal effect with the potential for climatic events to cause operational or structural damage. For example, increased summer maximum temperatures can affect structures through the movement of materials, foundations etc.
Low	Seasonal effect with the potential for minor operational loss. For example, higher summer temperatures can cause overheating which can lead to a loss in operational hours.
Very low	Increased maintenance required to mitigate annual operational impacts as a result of the effect. For example, increased winter rainfall can cause damage to drainage systems, requiring maintenance.
Negligible	Minimal effect, neither positive or negative and likely to be mitigated through resilience measures included through regulatory or best practice.

Sensitivity of Receptors

21.196 An understanding of the sensitivity of identified receptors is required in order to determine the need for Adaptive Mitigation. In the case of the Proposed Development, the most sensitive receptors are considered to be those whereby any effect may lead to a risk of injury to humans or that may compromise safety critical infrastructure; Table 21.22 therefore sets out criteria for determining the sensitivity of a receptor which will be determined through the application of professional judgement.

Table .196.1.1.a.i.1: Climate Change Adaptation – Sensitivity of Receptors

Sensitivity of Identified receptor	Description

High	Receptor is particularly sensitive to the climatic effect and potential impacts, and/or, receptor includes safety critical infrastructure which if damaged could result in significant risks to people and/or property.
Medium	Receptor is sensitive to the climatic effect and potential impacts
Low	Receptor has low sensitivity to the potential climatic effect
Very Low	Receptor has very low sensitivity to the potential climatic effect
Negligible	Receptor is not sensitive to the climatic effect

Duration of Effect

21.197 The effects of climate change are on-going and, in this context, climatic effects are relative to the phase of the Proposed Development being assessed.

21.198 Given the nature of the Proposed Development it is anticipated that the effects of climate change on the construction phase will mostly be short term.

Nature of Impact

21.199 Any resulting impacts could be beneficial or adverse and will be identified utilising professional judgement; for the purpose of this assessment, impacts are categorised as follows:

- An adverse impact will result in the potential for harm to the environment, buildings, infrastructure or humans as a result of the climatic effect.
- A beneficial impact will result in an improvement to the environment, buildings, infrastructure or humans as a result of a climatic effect.

Level of Effect

21.200 The level of effect for each potential climatic effect has been assessed using Table 21.23, which has been developed based on IEMA guidance (Ref 21.18) and professional judgement. This defines the level of effect from Negligible to Major. Depending on the type of effect, the level of effect may be either beneficial or adverse.

Table .200.1.1.a.i.1: Climate Change Adaptation - Level of Effect

Magnitude of Effect	Sensitivity of Receptor				
	High	**Medium**	**Low**	**Very Low**	**Negligible**
High	Major	Major	Moderate	Moderate	Minor
Medium	Major	Moderate	Minor	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible	Negligible

Very Low	Moderate	Minor	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

21.201 At this stage it is considered that any effects with a moderate or major adverse or beneficial effect are considered significant.

Identifying Climate Resilience and Mitigation

21.202 Once the level of effect has been determined, the resilience of the Proposed Development to the effect of the climatic variable will be assessed using Table 21.24 below, which has been developed through professional judgement.

Table .202.1.1.a.i.1: Climate Change Resilience

Climate resilience level	Definition
High	A low level of climate vulnerability to specific climate risk. Further action or adaptation not considered necessary.
Medium	A medium level of vulnerability remains. Further action or adaptation could improve resilience, however appropriate resilience is considered to have been provided.
Low	A significant level of vulnerability to specific climate risk remains. Mitigating action or adaptation is required.
Very Low	A very significant level of vulnerability to specific climate risk remains. Mitigating action or adaptation is required.

Baseline Conditions

21.203 This section sets out the existing and future baseline conditions, setting out how the UK and East Midlands climate is anticipated to change over time, relevant to the construction and operational phase timeframes of the Proposed Development.

21.204 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that the ES present an outline of the likely evolution of baseline conditions without implementation of the Proposed Development (i.e. the 'do nothing scenario'), as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge.

21.205 With regards to Climate Change Adaptation, as noted in the Methodology for Baseline section, the future baseline scenario at 2080 is considered to be the worst-case future climate scenario for the purposes of the assessment based on the anticipated long-term operation of the site.

Existing and Future Climatic Conditions

21.206 The existing and future climatic scenarios based on the UKCP09 projections are set out below to aid the qualitative assessment of the predicted climatic effects as a result of climate change on the Proposed Development.

Existing Climatic Conditions (

21.207 The existing climate for the Proposed Development, covering All Development within the Order Limits, is set out in Table 21.25; this sets out average climate data for Northampton Moulton Park climate station (Ref 21.20) from 1981 to 2010.

Table .207.1.1.a.i.1: Baseline Climate Data

Month	Max. temp (°C) (°C)	Min. temp(°C) (°C)	Days of air frost (days)	Sunshine (hours)	Rainfall (mm)	Days of rainfall >= 1 mm (days)
Jan	6.8	1.1	10.9	55.7	54	11.4
Feb	7.1	0.9	11.1	77.9	41.1	9.4
Mar	10	2.7	6.3	108.2	44.1	9.8
Apr	12.8	4	3	151.4	49.4	10
May	16.2	6.8	0.2	189.9	54.4	9.6
Jun	19.2	9.7	0	233.8	54.9	9.4
Jul	21.7	11.9	0	199.3	49.2	8.1
Aug	21.5	11.8	0	185.2	54.5	8.5
Sep	18.4	9.8	0	134	57.6	8.9
Oct	14.1	7	0.8	109.6	63.9	10.2
Nov	9.7	3.7	4.5	64.4	60	10.8
Dec	7	1.5	10.6	49.5	55.3	10.8
Annual	13.7	5.9	47.3	1498.9	638.1	116.9

Future Climatic Conditions

21.208 Table 21.26 summarises the UKCP09 dataset for East Midlands for the 2020s (Ref 21.21) and 2080s (Ref 21.22), for the High emissions scenario, in line with the construction phase, short-term operational phase and long-term operational phase of the Proposed Development.

21.209 The future baseline climatic conditions are relevant to All Development within the Order Limits.

Table .209.1.1.a.i.1: Summary of UKCP09 East Midlands Climate Change Projections (High Emissions Scenario, Central Estimate)

	Timeframe	
Effect	2020s	2080s
Temperature	Increase in winter mean temperature of 1.3C	Increase in winter mean temperature of 3.6C
	Increase in summer mean temperature of 1.4C	Increase in summer mean temperature of 4.4C
	Increase in summer mean daily maximum temperature of 1.8C	Increase in summer mean daily maximum temperature of 6C
	Increase in summer mean daily minimum temperature of 1.5C	Increase in summer mean daily minimum temperature of 4.9C
Rainfall	Change in annual mean precipitation of 0%	Change in annual mean precipitation of 1%
	Increase in winter mean precipitation of 6%	Increase in winter mean precipitation of 25%
	Reduction in summer mean precipitation of 4%	Reduction in summer mean precipitation of 25%

21.210 In addition to the summary of climatic variables set out in Table 21.26, Table 21.27 presents the UKCP09 predictions of potential climatic changes relating to wind, storms, lightning, snow and fog, where possible for the period up to 2080, which corresponds to the worst-case long-term operation of the Proposed Development.

21.211 For some variables, data is unavailable for certain periods. Where this is the case, the timeframe for which the closest data is available is included, this is noted in Table 21.27 and applied to this assessment on the basis that it is considered the worst-case scenario for that variable.

Table .211.1.1.a.i.1: Changes in Wind, Storms, Lightning, Snow and Fog in the East Midlands

Climatic Variable	Estimated Changes at 2080
Wind (Ref 21.23)	Minor decrease in wind speed of between -0.1m/s in winter and -0.2 in summer under the High emissions scenario. Data is available up to 2050.
Storms (Ref 21.24)	There is no consistent signal of change in either storms or blocking near the UK. Such changes as are seen are relatively modest, and the potential for substantial change appears to be small. Data is not time specific.

Lightning (Ref 21.25)	Increase in lighting projected for all four seasons across the UK through to 2080.
Snow (Ref 21.26)	Reduced snowfall; snow days projected to reduce by 80-90% in winter and 60-80% in spring due to a shift from snow to rain for the period up to 2080.
Fog (Ref 21.27)	Reduced fog predicted across the UK between 10-40% through to 2080.

Summary of Climate Change Effects

21.212 Qualitatively the future climatic effects at the location of the Proposed Development in 2020, and with increasing variability up to 2080 over the existing baseline will likely include:

- an increase in mean average temperature of between 3.6C (2020s) and 1.3C (2080s) in winter and 1.4C (2020s) and 4.4C (2080s) in summer;
- more very hot days, particularly throughout the long-term operational phase, with an increase in daily maximum temperature of between 1.8C (2020s) and 6C (2080s) and daily minimum temperature of between 1.5C (2020s) and 4.9C (2080s);
- more intense downpours of rain, with an increase in winter rainfall of between 6% (2020s) and 25% (2080s), with reduced snowfall;
- an increase in dry spells, particularly in summer months, with summer rainfall dropping by between 4% (2020s) and 25% (2080s);
- minimal changes in wind speed;
- no consistent change in storm frequency;
- an Increase in lightning events; and
- reduced fog.

Baseline conditions in the 'do nothing' scenario

21.213 Whilst the Proposed Development will both generate and save GHG emissions, and will therefore have an impact on future climate change (the assessment of which is undertaken in the Climate Change Mitigation section of this Chapter), the climatic scenarios described, particularly in the short- to medium-term are as a result of historic emissions and it is therefore likely that the climatic effects identified in the baseline scenarios will occur in the absence of the Proposed Development under the 'do nothing' scenario.

Embedded Mitigation

21.214 Embedded Mitigation for the Proposed Development is outlined within Chapter 5: The Proposed Development and in particular is shown onthe following documents:

- Parameters Plan (Main SRFI Site and J15a Works)
- The Green Infrastructure Plan (Main SRFI Site and J15a Works)
- Code of Construction Practice (COCP)
- Construction Environmental Management Plan (CEMP) – Part 1

21.215 In addition to mitigation measures that are embedded in the design of the Proposed Development, there are a number of relevant tertiary mitigation measures which are also considered to be embedded through compliance with existing legislative requirements; these include:

- **Flood risk legislation –** Central to the planning for new development are the Flood and Water Management Act 2010 (Ref 21.28) and Flood Risk Regulations 2009 (Ref 21.29) which require lead local flood authorities to prepare a flood risk assessment and management plan to be reviewed by the Environment Agency. They are supported by a number of policy and guidance document at a local and national level including:
  - **NPPF** sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow. Where these tests are not met, national policy is clear that new development should not be permitted.
  - **PPG Flood risk and coastal change** (Ref 21.30) sets out specific guidance for how flood risk should be considered in accordance with the NPPF. This includes:
    - requirements to assess flood risk in areas at risk of flooding, or for sites of 1 hectare or more, a requirement for a site-specific flood risk assessment to accompany applications for planning permission;
    - requirements to avoid flood risk to steer development to areas with the lowest probability of flooding; and
    - where development needs to be in locations where there is a risk of flooding, requirements to manage and mitigate flood risk so that development is appropriately flood resilient and resistant, safe for uses for the lifetime of the development, and will not increase flood risk overall; this includes the identification of flood risk management

opportunities to reduce the causes and impacts of flooding (e.g. through the use of sustainable drainage systems)

- **Non-statutory technical standards for sustainable drainage systems** (Ref 21.31) contains technical standards for the design, maintenance and operation of sustainable drainage systems.

- **Flood risk assessments: climate change allowances** (Ref 21.32) provides advice on allowances that should be applied when producing flood risk assessments for the purposes described above. Climate change allowances include prediction of anticipated change for peak river flow by river basin district; peak rainfall intensities; sea level rise; and offshore wind speed and extreme wave height. As a statutory consultee, the Environment Agency benchmarks against these changes in the advice it provides to applicants.

- **Health and safety legislation –** The Health and Safety Executive [HSE] sets out UK legislation and guidance (Ref 21.33) to ensure the safety of construction and operational workforce. This includes guidance on thermal comfort, outdoor working and heat stress, setting out measures which can be applied to reduce the impact of temperature effects.

- **Building Regulations –** The Building Regulations are statutory instruments that seek to ensure that the policies set out in relevant legislation are carried out and include a number of Approved Documents [ADs] which guide the design of new development; relevant ADs include:

  - **ADA - Structure** (Ref 21.34) includes a requirement to ensure that new buildings are constructed so that the risk of ground movement caused by the swelling, shrinkage, or subsidence is minimised.

  - **ADL2A - Conservation of fuel and power in new buildings other than dwellings** (Ref 21.35) includes an assessment of internal temperature in summer based on assumptions of air change rates and historic weather data specific to the region the building is located in. This assessment is, however, widely recognized as being insufficient in identifying the current and future risk of overheating due to the type of modelling adopted (static as opposed to dynamic, which is more accurate) and the external temperature data used (which is average historic data and does not include any future climate projections).

  - **ADH – Drainage and waste disposal** (Ref 21.36) includes design provisions to ensure that new drainage systems in buildings do not increase the vulnerability of buildings to flooding and that where development is in areas prone to flooding, design measures are included to reduce the risk of damage to property in the event of a flood.

21.216 The following elements of Embedded Mitigation are noted in reference to Climate Change Adaptation and the identified climatic effects. Prior to the assessment of climatic effects on the Proposed Development, consultation with the design team and EIA practitioners has identified a number of specific measures contained within the identified supporting documents and these are described below where relevant.

Main SRFI Site

Parameters Plan

21.217 The Parameters Plan sets out the development parameters including the proposed transport connections, areas for development and key features such as the proposed rail infrastructure attenuation basins and bunds. Key elements of Embedded Mitigation relating to Climate Change Adaptation include:

- **Surface Water Drainage** – The Parameters Plan includes areas of surface water attenuation incorporated within the Main SRFI Site. These have been sized to take into account the anticipated surface water run-off for a 1 in 200-year storm with a 40% allowance for climate change as set out in Chapter 13 – Hydrology, Drainage and Flood Risk

Green Infrastructure Plan (Main SRFI Site)

21.218 The Green Infrastructure Plan for the Main SRFI Site shows an outline of the proposed green spaces within the development. At this stage it does not show any detail in relation to the landscaping, habitats or species proposed, and therefore does not detail the impact on the site biodiversity. This detail is included as part of Chapter 14 Biodiversity and therefore forms part of Adaptive Mitigation measures.

Code of Construction Practice (COCP)

21.219 The COCP includes general 'good practice' methodologies. Sitting underneath the overarching COCP document are the Outline Construction Environment Management Plan (CEMP), outline Pollution Prevention Method Statement (PPMS), Outline Site Waste Management Plan (SWMP) and Outline Materials Management Plan (MMP).

COCP – Project Sustainability

21.220 Included within the COCP is a section on Project Sustainability which details key elements of embedded mitigation incorporated into the design of the Proposed Development. This includes:

- All appropriate UK legislation including Construction (Design and Management) Regulations 2015, Building Regulations 2013, Health and Safety at Work Act 1974, and Environmental Permitting (England and Wales) Regulations 2016.

- A commitment to develop the site to BREEAM Excellent 2014 standard to help minimise operational GHG emissions, energy use and waste generation and a commitment to sustainable buildings.

- Details included within the Construction Environmental Management Plan (CEMP) including Site Waste Management Plan, Materials Management Plan (appropriate management of excavated soils), Construction Traffic Management Plan and Travel Plan, Air Quality Management Plan and Pollution Prevention Method Statement.

Construction Environment Management Plan (CEMP)

21.221 The CEMP is a live document which will be updated during the application and detailed design process. It includes a number of sections which relate to construction best practice and climate change, including:

- **Air Quality and Dust**: The CEMP states that a Dust Management Plan (DMP) will be prepared to include measures to control dust emissions. This includes the need to take into account a potential increase in dust due to a warmer, dryer summer climate during construction.

- **Construction Compound**: The Construction compound will be designed in line with best practice and with provision for surface water drainage which includes silt traps and oil separators to prevent pollution run-off. This will include an allowance for increased winter rainfall due to climate change.

- **Construction Site Drainage**: During construction, run-off from the site will be treated appropriately to reduce silt loads and any potential pollution. The drainage system put in place will include an allowance for increased rainfall due to climate change.

- **Health and Wellbeing:** During construction, provision will be made to include suitable facilities to protect the health and wellbeing of employees, including the provision of water supplies, sun protection and shaded areas to reduce the risk of overheating and sun exposure.

- **Protection of Controlled Waters:** The protection of controlled waters (and specifically the design of storage) and pollution control systems will include allowance for future climate change due to increased winter rainfall.

- **Water Efficiency**: To minimise water use during construction, measures will be put in place, for example, measures to be considered include the monitoring and recording of water use and the capture and re-use of rainwater.

- **Design of Watercourse Realignment and Surface Water Drainage**: confirms the drainage strategy for the Main SRFI site includes attenuation measures to

provide for up to the 1 in 200-year event plus a 40% allowance for climate change.

J15A Works

Green Infrastructure Plan – Junction 15a

21.222 The Green Infrastructure Plan shows an outline of the Junction 15a Works and associated ecological mitigation. At this stage it is not considered to include any climate change adaptation mitigation with regards to climate tolerant species.

COCP (incorporating the CEMP)

21.223 As per Main SRFI Site and including the following specific measures.

- **Design of Watercourse Realignment and Surface Water Drainage**: confirms the drainage strategy for the Main SRFI site includes attenuation measures to provide for up to the 1 in 200-year event plus a 40% allowance for climate change.

Other Minor Highway Works

COCP (incorporating the CEMP)

21.224 As per Main SRFI Site.

All Development within the Order Limits

COCP (incorporating the CEMP)

21.225 As per Main SRFI Site.

Assessment of Construction Stage Effects

21.226 The Rail Central Climate Change Risk Assessment appended in Volume 3: Appendix 21.3 sets out the potential climatic effects and associated areas of risk considered in this Assessment of Effects.

21.227 The following sections and tables set out the initial assessment of effects with Embedded Mitigation proposed and the level of climate change resilience incorporated into the Proposed Development.

21.228 Due to the nature of the climatic effects identified, effects are applicable to All Development within the Order Limits; however, given the nature of each individual component, the sensitivity of the receptor may be slightly different in each development component. Where this is the case, the different sensitivities and resulting Level of Effect are identified.

21.229 Given the construction timeframe proposed the impacts have been considered under the climate change projections for 2020 which have a lower impact than those stretching out to 2080.

21.230 As the construction phase is relatively short the effects of climate change over this period are considered to be predominantly temporary in nature.

All Development within the Order Limits

21.231 During the construction phase, there are no effects for which the Sensitivity of Receptor and Level of Effect differ across the development components differ and Table 21.28 sets out the Assessment of Construction Phase Effects related to All Development within the Order Limits.

21.232 At this stage it is anticipated that given the short-term nature of the construction stage, and limited climate change impacts during the 2020s the significant environmental effects which would require Adaptive Mitigation beyond the Embedded Mitigation already included in the proposals are limited.

All Development within the Order Limits

21.233 At this stage, no effects are deemed to have a moderate or higher Level of Effect and no Adaptive Mitigation measures have been identified to improve resilience to climate change.

Table .233.1.1.a.i.1: Assessment of Construction Stage Effects – All Development within the Order Limits

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
Increase in winter mean temperature	Construction employees and equipment	Direct - Higher average winter temperatures are likely to result in lower instances of disruption from ice and snow and provide for a warmer working environment, improving health and wellbeing.	No Embedded Mitigation proposed.	Low Beneficial: Temporary effect associated with construction.	Low: Sensitivity of construction equipment, employees and is considered to be low.	Minor Beneficial	High
Increase in summer mean and maximum temperatures	Construction employees	Direct - Higher average mean summer temperatures and daily maximum temperatures may pose a health and safety risk.	The COCP sets out a requirement for construction to be carried out in accordance with UK legislation on Health and Safety which includes details on Heat Stress and how it can be	Low Adverse: Temporary impact associated with construction.	Low: Sensitivity of employees reduced through measures identified in the COCP	Minor Adverse	High

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
			tackled.Welfare facilities are also to be provided for workers during construction.				
Increase in winter rainfall	Buildings, infrastructure and equipment	Direct - An increase in winter rainfall may increase the potential for construction site flooding, causing damage to materials and disruption to construction processes.	The COCP and CEMP set out construction compound details confirming how surface water will be managed and the drainage strategy sets out how surface water will be managed across the wider site during construction.	Low Adverse: Temporary impact associated with construction.	Very Low: The provision of measures in the COCP and CEMP to safely and securely store materials and equipment reduces the potential sensitivity to this effect.	Negligible	High
Increase in winter rainfall	Habitats and species	Indirect - An increase in winter rainfall may increase the potential for contamination to	The COCP and CEMP sets out measures to ensure the cleaning of site roads and storage of materials, a drainage plan and	Very Low Adverse: This is a temporary impact associated with construction and Embedded Mitigation will	Very Low: The provision of measures within the CEMP and COCP reduce the potential sensitivity to this	Negligible	High

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
		nearby water courses and/or groundwater through increased run-off washing contaminants from the site.	groundwater management plan which include measures to reduce the risk of pollution from surface water runoff.	reduce potential Magnitude of Impact.	effect		
Decrease in summer rainfall	Buildings and infrastructure (operational)	Direct - A decrease in summer rainfall may restrict water supply disrupting construction.	The COCP states development will include measures to improve water efficiency during construction.	Very Low Adverse: Lack of water availability has the potential for minor seasonal operational loss	Very Low: Absence of water is unlikely however mitigation will improve water availability	Negligible	High
Decrease in summer rainfall	Habitats and species	Indirect - A decrease in summer rainfall may lead to an increase in dust generation from construction due to dry land conditions impacting on existing habitats.	The COCP and CEMP set out measures to mitigate the risk of air quality and dust pollution.	Very Low Adverse: This is a temporary impact associated with construction	Very Low: Low sensitivity of receptors to dust considered appropriate	Negligible	High

Assessment of Operational Phase Effects

21.234 Table 21.29 sets out the Assessment of Operational Phase Effects related to All Development within the Order Limits; however, where there are differences in the sensitivity of receptor and Level of Effect due to the nature of a specific project component, these are identified in the table.

21.235 Given the operational timeframe proposed, climatic effects have been considered under the climate change projections for 2080 to cover the long-term operation and worst-case scenario.

21.236 Where appropriate in each section, significant impacts are identified where Adaptive Mitigation is required, and also where Adaptive Mitigation could be provided to improve the climate change resilience of the Proposed Development.

Main SRFI Site

21.237 The following effect(s) are deemed to have a moderate or higher significance and require further Adaptive Mitigation to reduce the effect and improve resilience to climate change:

.237.1 **Increase in summer and winter temperatures and changes in rainfall**: An increase in temperatures and changes in rainfall are anticipated to lead to greater swings in ground conditions through summer and winter which can lead to ground movement impacting on infrastructure and foundations within the Main SRFI Site. Given the potential for structural damage this is therefore considered to have a **moderate adverse** effect. In this context, best practice measures, taking into account the effects of climate change, are required in the design of foundations to mitigate this effect.

.237.2 **Increase in summer mean and daily maximum temperature**: An increase in summer mean and daily maximum temperature may result in an increased need for cooling which could increase energy use and therefore GHG emissions. Building Regulations (Part L) include consideration of overheating; however, this does not consider future climatic scenarios and the Committee for Climate Change has reported to Government that the limited measures contained with the regulations are insufficient to mitigate overheating risk. This has the potential to negatively impact on the comfort and operation of buildings and human health and is therefore considered to have a **moderate adverse** effect. Detailed thermal dynamic modelling is required to detail potential overheating effects and guide appropriate mitigation in accordance with the cooling hierarchy.

21.238 At this stage, Embedded Mitigation is considered to be suitable to provide the development with an adequate level of resilience from specific environmental effects, however further Adaptive Mitigation could improve the resilience of the development for the following:

.238.1 **Reduced Summer Rainfall**: A reduction in summer rainfall may have a **minor adverse** effect on site habitats through a lack of rainfall or water irrigation supplies. Provision of on-going habitat management and use of onsite irrigation utilising water from the surface water attenuation areas could help minimise this impact.

.238.2 **Reduced summer rainfall:** A reduction in summer rainfall may affect local and national water supplies. As the East Midlands is in an area of moderate water stress (Ref 21.37) this could impact on the operation of the site and is considered to have a **minor adverse** effect, further water efficiency measures should be incorporated to reduce consumption and the risk of water supply shortages.

Junction 15a Works and Minor Highway Works

21.239 The following effect(s) are deemed to have a moderate or higher significance and require further Adaptive Mitigation to reduce the effect and improve resilience to climate change:

.239.1 **Increase in summer and winter temperatures and changes in rainfall**: The increase in temperatures and changes in rainfall are anticipated to lead to greater swings in ground conditions through summer and winter which can lead to ground movement impacting on the J15a Works for the road and infrastructure foundations. Given the potential for structural damage this is therefore considered to have a **moderate adverse** effect. In this context ensuring best practice design measures taking into account the impacts of climate change are incorporated prior to construction is key to mitigating this effect.

Table .239.1.1.a.i.1: Assessment of Operational Stage Effects – All Development within the Order Limits

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
Increase in winter mean temperature	Habitats and species	Direct - Higher winter mean temperatures are anticipated to have different effects on the species present at the completed development providing a number of benefits and disadvantages for site biodiversity proposed as part of the Green Infrastructure Plan.	No Embedded Mitigation is proposed.	Negligible: Discussions with the project ecologist confirm that the likely species selection will be able to adapt to climate change. This is in accordance with the guidance set out in the England Biodiversity 2020 Strategy published by Department for Environment Food & Rural Affairs (DEFRA) (Ref 21.38)	Very Low: While susceptible to climate change, the overall balance of beneficial and adverse effects limitLimit the risk to the overall biodiversity.	Negligible Beneficial/ Adverse	High
Increase in winter mean temperature	Buildings and climatic system	**Main SRFI Site Only –** Indirect - Higher winter mean temperatures will reduce heating requirement and therefore energy use	**Main SRFI Site Only -** No Embedded Mitigation is proposed or considered necessary.	**Main SRFI Site Only -** Low: A reduction in energy use in buildings has the potential to be a	**Main SRFI Site Only -** Low: Heating requirements for buildings makes up a relatively small	**Main SRFI Site Only -** Minor Beneficial	**Main SRFI Site Only -** High

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
		and GHG emissions.		long-term benefit in reduced GHG emissions.	portion of the energy use from the entire development.		
Increase in summer mean and daily maximum temperature	Buildings and infrastructure	Direct - Higher average mean summer temperatures and daily maximum temperatures may increase the potential for impacts on the foundations of infrastructure and buildings as a result of shrinkage.	No Embedded Mitigation proposed beyond that inherent in legislation	Medium: Ground movement has the potential to cause structural defects across the Proposed Development.	Medium: Building, road and rail infrastructure is sensitive to ground movement and foundation damage.	Moderate Adverse	Medium
	Main SRFI Site Only - Buildings, infrastructure and equipment	**Main SRFI Site Only –** Direct - Higher average mean summer temperatures and daily maximum temperatures could impact on site electrical equipment and infrastructure.	**Main SRFI Site Only -** No Embedded Mitigation proposed	**Main SRFI Site Only -** Medium: Damage to electrical equipment could cause major operational disruption	**Main SRFI Site Only -** Low: Electrical systems are regularly checked and would be subject to maintenance anticipated to forestall any issues.	**Main SRFI Site Only -** Minor Adverse	**Main SRFI Site Only -** High

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
	Main SRFI Site Only - Building occupants	**Main SRFI Site Only** Direct - Higher average mean summer temperatures and daily maximum temperatures may lead to building overheating, affecting the comfort and operation of the buildings, potentially impacting the health and wellbeing of occupants.	**Main SRFI Site Only** No specific mitigation by design proposed – Building Regulations include an assessment of overheating based on climatic conditions; however this is not always sufficiently robust to identify overheating issues with the latest building design and construction techniques.	**Main SRFI Site Only -** Medium(adverse): An increase in maximum temperatures would likely be mitigated through systems put in place as a result of required energy modelling.	**Main SRFI Site Only -** Medium: Receptors are considered to be moderately sensitive to the potential effects of overheating given the adverse health and wellbeing impacts possible.	**Main SRFI Site Only** Moderate Adverse	**Main SRFI Site Only** Low
	Main SRFI Site Only - Climatic system	**Main SRFI Site Only** Indirect - Higher average mean summer temperatures and an increase in daily maximum temperatures may lead to an increase in cooling	**Main SRFI Site Only** No specific mitigation by design proposed – – Building Regulations include an assessment of overheating based on climatic conditions and	**Main SRFI Site Only** Low: An increase in GHG emissions is considered a negative impact, however this is anticipated to be an infrequent	**Main SRFI Site Only** Low: Low: Potential GHG increase considered small.	**Main SRFI Site Only** Minor Adverse	**Main SRFI Site Only** Moderate

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
		requirements, increasing energy use and GHG emissions.	where cooling is required guidance includes the use of the cooling hierarchy to prioritise passive design to reduce energy use.	occurrence			
	Habitats and species	Direct - Higher summer mean and daily maximum temperatures are anticipated to have a mixed impact providing benefits and disadvantages for the on-site biodiversity.	No Embedded Mitigation is proposed	Negligible: Discussions with the project ecologist confirm that the likely species selection will be able to adapt to climate change.	Very Low: While susceptible to climate change, the overall balance of beneficial and adverse effects limit the risk to the overall biodiversity.	Negligible	High
Increase in winter rainfall	Buildings, infrastructure and site users	**Main SRFI Site Only** Direct - An increase in winter rainfall is likely to lead to an increase in surface water run-off	**Main SRFI Site Only** The Parameters Plan includes provision for Sustainable Drainage Systems (SuDS) to manage surface water run-off. The Hydrology	**Main SRFI Site Only** Very Low: Seasonal impact with potential for some operational loss, however embedded mitigation anticipated to reduce	**Main SRFI Site Only** Very Low: Inclusion of SuDS reduces the sensitivity of the receptor	**Main SRFI Site Only** Negligible	**Main SRFI Site Only** High

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
			Chapter includes details of the drainage system to be included which will include a 40% allowance for the effects of climate change.	the risk of flooding.			
Increase in winter rainfall	Infrastructure and site users	**Junction 15a** Indirect - An increase in winter rainfall could lead to an increased risk of surface water flooding which could impact site infrastructure and operation.	**Junction 15a** The COCP includes details of the surface water drainage strategy for the Junction 15a improvements which includes a 20% allowance for climate change.	**Junction 15a** Very Low: Seasonal impact where flooding could impact on the operation of the junction, however embedded mitigation anticipated to reduce the risk of flooding.	**Junction 15a** Very Low: Inclusion of SuDS reduces the sensitivity of the receptor.	**Junction 15a** Negligible	**Junction 15a** High
Increase in winter rainfall	Buildings and infrastructure	Direct - An increase in winter rainfall may increase the potential for impacts on the foundations of infrastructure and	No Embedded Mitigation proposed beyond that inherent in legislation.	Medium: Ground movement has the potential to have structural impacts to development	Medium: Buildings, roads, rail infrastructure sensitive to ground movement and foundation damage	Moderate Adverse	Medium

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
		buildings as a result of ground movement and subsidence.		elements.			
Decrease in summer rainfall	Habitats and species	Direct - A decrease in summer rainfall may have an adverse impact on site biodiversity	No Embedded Mitigation proposed.	Very Low: There could be an impact from water stress	Medium: Biodiversity is sensitive to reductions in water	Minor Adverse	Medium: Consideration of appropriate irrigation could enhance resilience to this effect.
Decrease in summer rainfall	**Main SRFI Site Only -** Building occupants and operations	**Main SRFI Site Only –** Indirect - A decrease in summer rainfall may lead to reduced water availability for the development affecting operation.	**Main SRFI Site Only -** Buildings to be designed to achieve a BREEAM Excellent rating which requires a 12.5% reduction in water consumption.	**Main SRFI Site Only -** Low: Seasonal impact with low potential for impacting operation	**Main SRFI Site Only -** Low: While the area is considered under 'water stress' the use of measures to reduce water consumption in accordance with BREEAM Excellent reduces the potential	**Main SRFI Site Only -** Minor Adverse	**Main SRFI Site Only** Medium: Targeting additional credits could further reduce the risk of

Climatic Variable	Identified Receptor	Potential Climatic Effect	Embedded Mitigation	Magnitude and Nature of Impact	Sensitivity of Receptor(s)	Level of Effect	Climate Change Resilience
					risk of shortages.		this effect to the development.

Adaptive Mitigation

21.240 This section sets out the Adaptive Mitigation proposed to reduce identified significant effects, or provide additional climate change resilience.

Main SRFI Site

21.241 The initial assessment of effects for the Main SRFI Site noted a number of significant effects during the operational phase. Table 21.30 sets out the Adaptive Mitigation proposed to mitigate significant effects and further enhance the resilience of the site to the effects of climate change.

Table .241.1.1.a.i.1: Main SRFI Site - Adaptive Mitigation

Potential Effect	Proposed Mitigation	Means of Implementation	Mechanism for securing Mitigation and DCO reference (where applicable)
Construction			
N/A			
Operation			
An increase in annual temperatures and changes in rainfall may impact on ground conditions and foundations	Use of best practice design and construction practices in line with relevant guidance, including the consideration of climate change.	Inclusion of climate change impacts and guidance in design specifications for foundations.	Schedule of Mitigation within CEMP
An increase in summer mean and maximum temperatures may lead to an increase in risk to human health through overheating.	Dynamic thermal modelling should be undertaken during detailed design to ensure overheating risks are identified and measures are put in place to reduce the risk of overheating in buildings. This should include the modelling of future climatic scenarios	Implementation of recommendations as a result of dynamic thermal modelling.	Schedule of Mitigation within CEMP
A reduction in summer rainfall may lead to	The embedded mitigation includes a reduction in water	Assessment of buildings against BREEAM, in	Schedule of Mitigation within

restrictions on water use, impacting on site operations.	consumption of 12.5% in accordance with the BREEAM Excellent requirements, achieving at least 2 credits will further reduce water consumption by 25% and enhance the climate change resilience of the Proposed Development.	particular ensuring buildings achieve 2 water efficiency credits, a 25% reduction in water consumption.	CEMP
A reduction in summer rainfall may have a negative impact on site biodiversity.	Provision of a Habitat Management Plan to facilitate the use of rainwater for irrigation.	Preparation of a Habitat Management Plan which includes consideration of climate change and reduced summer water availability.	Schedule of Mitigation within CEMP
Cumulative			
N/A			

Junction 15a Works & Minor Highways Works

21.242 The initial assessment of effects for the J15a Works and Minor Highways Works noted a number of significant effects during the operational phase. The following tables set out the Adaptive Mitigation proposed to mitigate the significant effects identified and further Adaptive Mitigation proposed to enhance the climate change resilience of the site.

Table .242.1.1.a.i.1: Junction 15a Works & Other Minor Highway Works - Adaptive Mitigation

Potential Effect	Proposed Mitigation	Means of implementation	Mechanism for securing mitigation and DCO reference (where applicable)
Construction			
N/A			
Operation			
During construction the increase in annual	Use of best practice design and construction	Inclusion of climate change impacts and guidance in design	Schedule of Mitigation within COCP

temperatures and changes in rainfall may impact on ground conditions and infrastructure foundations	practices in line with relevant guidance including consideration of climate change	specifications for infrastructure foundations.

Junction 15a Only

A reduction in summer rainfall may have a negative impact on site biodiversity. **Junction 15a Only**

Provision of a Habitat Management Plan to facilitate the use of rainwater for irrigation. **Junction 15a Only**

Preparation of a Habitat Management Plan which includes consideration of climate change and reduced summer water availability. .**Junction 15a Only**

Schedule of Mitigation within CEMPN/A
Cumulative
N/A

Residual Effects

21.243 The following tables set out the assessment of residual climate change effects taking into account the adaptive and enhanced mitigation measures proposed in the previous section. This includes an assessment of the climate change resilience of the development in this context. The tables set out the residual assessment for the individual development components.

Main SRFI Site

21.244 Table 21.32 sets out an assessment of the residual effects taking into account the proposed Adaptive Mitigation for the Main SRFI Site.

Table .244.1.1.a.i.1: Main SRFI Site - Assessment of Residual Effects

Description of Effect	Significance of Effect	Possible Mitigation Measures	Residual Effect	Climate Change Resilience
Construction				
Increase in winter mean temperature improving working conditions for construction employees and equipment	Minor Beneficial	No residual mitigation required	Minor Beneficial	High

Increase in summer mean and maximum temperatures potentially increasing the risk of overheating for employees	Minor Adverse	No residual mitigation required	Minor Adverse	High
Increase in winter rainfall potentially leading to an increase in flood risk impacting on construction	Negligible	No residual mitigation required	Negligible	High
Increase in winter rainfall potentially leading to an increase in flood risk impacting and pollution on habitats and species	Negligible	No residual mitigation required	Negligible	High
Decrease in summer rainfall may restrict water supplies impacting construction	Negligible	No residual mitigation required	Negligible	High
Decrease in summer rainfall may lead to an increase in dust generation impacting on site habitats and species	Negligible	No residual mitigation required	Negligible	High
Operation				
An increase in winter and summer temperatures are anticipated to impact on site habitats and species	Negligible Beneficial/ Adverse	No residual mitigation required	Negligible Beneficial/ Adverse	High
An increase in winter mean	Minor Beneficial	No residual mitigation required	Minor Beneficial	High

temperatures will reduce heating requirements for buildings				
An increase in annual temperatures and changes in rainfall may impact on ground conditions and foundations.Moder ate AdverseUse of best practice design and construction practices in line with relevant guidance, including the consideration of climate change.Minor AdverseHighIncrea sed summer mean and maximum temperatures may impact on site electrical equipment	Minor Adverse	No residual mitigation required	Minor Adverse	High
An increase in summer mean and maximum temperatures may lead to an increase in risk to human health through overheating.	Moderate Adverse	Dynamic thermal modelling should be undertaken during detailed design to ensure overheating risks are identified and measures are put in place to reduce the risk of overheating in buildings. This should include the modelling of future climatic scenarios	Minor Adverse	High
An increase in summer mean and maximum temperatures may lead to an	Minor Adverse	No residual mitigation required	Minor Adverse	Moderate

increased requirement for cooling and therefore an increase in GHG emissions				
An increase in summer rainfall is anticipated to increase flood risk	Negligible	No residual mitigation required	Negligible	High
A reduction in summer rainfall may have a negative impact on site biodiversity	Minor Adverse	Preparation of Habitat Management Plan which includes the consideration of climate change and reduced summer water availability	Minor Adverse	High
A reduction in summer rainfall may lead to restrictions on water use, impacting on site operations.	Minor Adverse	Provision of measures to further reduce water use in the operation of the proposed buildings, achieving at least 2 water efficiency credits and a 25% reduction in water consumption.	Minor Adverse	High
An increase in winter and summer temperatures are anticipated to impact on site habitats and species	Negligible Beneficial/ Minor Adverse	No residual mitigation required further achieving at least 2 water efficiency credits and a 25% reduction in water consumption.	Negligible Beneficial/ Adverse	High

Junction 15a Works and Minor Highway Works

21.245 Table 23.33 sets out an assessment of the residual effects taking into account the proposed adaptive mitigation for the Junction 15a Works and Minor Highway Works.

Table .245.1.1.a.i.1: Junction 15a Works - Assessment of Residual Effects

Description of Impact	Significance of Effect	Possible Mitigation Measures	Residual Effect	Climate Change Resilience

Construction				
Increase in winter mean temperature improving working conditions for construction employees and equipment.	Minor Beneficial	No residual mitigation required	Minor Beneficial	High
Increase in summer mean and maximum temperatures potentially increasing the risk of overheating for employees	Minor Adverse	No residual mitigation required	Minor Adverse	High
Increase in winter rainfall potentially leading to an increase in flood risk impacting on construction	Negligible	No residual mitigation required	Negligible	High
Increase in winter rainfall potentially leading to an increase in flood risk impacting and pollution on habitats and species	Negligible	No residual mitigation required	Negligible	High
Decrease in summer rainfall may restrict water supplies impacting construction	Negligible	No residual mitigation required	Negligible	High
Decrease in summer rainfall may lead to an increase in dust generation impacting on site habitats and species	Negligible	No residual mitigation required	Negligible	High
Operation				
An increase in	Negligible	No residual	Negligible	High

winter and summer temperatures are anticipated to impact on site habitats and species	Beneficial/ Adverse	mitigation required	Beneficial/ Adverse	
An increase in annual temperatures and changes in rainfall may impact on ground conditions and foundations.	Moderate Adverse	Use of best practice design and construction practices in line with relevant guidance, including the consideration of climate change.	Minor Adverse	High
An increase in summer rainfall is anticipated to increase flood risk	Negligible	No residual mitigation required	Negligible	High
A reduction in summer rainfall may have a negative impact on site biodiversity	Minor Adverse	Preparation of Habitat Management Plan which includes the consideration of climate change and reduced summer water availability	Minor Adverse	High

Cumulative Effects

21.246 This section sets out the inter-project, and intra-project cumulative effects of the Proposed Development.

Cumulative Assessment: Intra-Project Effects

21.247 As stated throughout this Chapter there are a number of noticeable interactions between the future effects of climate change and other ES topics. Where necessary relevant members of the technical team have been contacted to discuss these intra-project cumulative effects and appropriate assessment and mitigation undertaken accordingly.

21.248 Below is a summary of the interaction with the other ES Chapters, highlighting where climate change is anticipated to have an effect and those areas where there is no impact.

21.249 Given the nature of the Proposed Development it is considered climate change will have no impact in relation to:

.249.1 Chapter 9: Agricultural Land

.249.2 Chapter 10: Archaeology

.249.3 Chapter 11: Built Heritage

.249.4 Chapter 12: Ground Conditions

.249.5 Chapter 15: Landscape and Visual

.249.6 Chapter 16: Noise and Vibration

.249.7 Chapter 17: Highways

.249.8 Chapter 18: Socio-Economics

.249.9 Chapter 20: Waste and Resource Efficiency

21.250 **Chapter 8: Air Quality-** It is anticipated that the effects of climate change, in particular increased summer temperatures could increase dust emissions during construction. In this context the CEMP has been updated to ensure mitigation measures will be put in place to minimise this risk. With regard to the wider development and operation, the Air Quality Chapter confirms that there will be no measurable effects on air quality due to climate change.

21.251 **Chapter 13: Hydrology, Drainage and Flood Risk –** The impacts of climate change including increased winter rainfall have the potential to increase the risk of surface water run-off and flooding. In liaison with the Hydrology consultants the details of appropriate mitigation have been confirmed to minimise the risk of surface water flooding for all components of the development including an allowance for future climate change.

21.252 **Chapter 14: Biodiversity –** Climate change may involve increases in average temperatures, winter rainfall, summer drought, and extreme weather events, amounting to an increase in the Continental character of the climate. Because the biota of the site already lives under the relatively Continental climate of eastern England, there is less risk of adverse impact upon species than there might be elsewhere in Britain. The ecology consultant confirms that both positive and negative effects can be envisaged, and the net effect is unlikely to be significant. The Green Infrastructure Plan will enhance the resilience of the development to climate change by avoiding species that are invasive in a warmer climate, and by enhancing biodiversity to the extent that net gains should remain even after the impact of any species losses due to climate change.

21.253 **Chapter 19: Lighting –** Given the nature of the Proposed Development it is considered climate change will have no impact in relation to Lighting, albeit the use of LED lighting is noted as a potential measure for reducing energy use and GHG emissions.

21.254 Consultation with other consultants involved with the design of the Proposed Development included consideration of additional detail on potential effects and mitigation.

.254.1 **Human Health Assessment –** While there is potential for overheating impacting on the comfort and health and wellbeing of building occupations during operation the Human Health Assessment consultant has confirmed the inherent legislation on overheating and design will minimise this potential effect.

.254.2 **Utilities Assessment –** The assessment of operational effects notes the potential for increased temperatures to impact on the performance and/or damage onsite electrical equipment. Through liaison with the Utilities consultant and design team it has been confirmed the onsite infrastructure will be designed in accordance with best practice and regularly maintained. Where appropriate measures will be put in place to protect the system from future climate change.

Cumulative Assessment: Inter-Project Effects

21.255 In-combination with related cumulative development as noted in the list of cumulative schemes there is the potential for a greater increase in the risk of surface water flooding, however, as noted in this Chapter and the Hydrology Chapter, measures have been identified to limit this risk. These measures are regulatory and therefore it can be assumed that other relevant developments will include similar measures.

21.256 With regard to Climate Change Adaptation, no further inter-project cumulative effects are anticipated on the basis that the climatic effects and impacts identified are specific to this particular development and will not result in any additional impacts on neighbouring development.

Monitoring

21.257 The Adaptive Mitigation measures proposed to reduce the identified significant impacts are intended to be subject to requirements imposed on the Development Consent Order for the Proposed Development.

21.258 As the proposed Adaptive Mitigation measures would reduce any significant environmental effects and would be enforced as requirements of the DCO, no post-mitigation monitoring is required.

Limitations and Assumptions

21.259 There are a number of limitations and assumptions relevant to the climate change adaptation assessment carried out in this Chapter. These are summarised below.

Climate Change Projections

21.260 The future effects of climate change are based on data from the IPCC, reviewed and updated for the UK climate. The IPCC data is based on a range of assumptions relating to global GHG emissions and climate modelling results in a number of potential outcomes.

21.261 The UK projections as set out on the UKCP09 website provide climate projections for the UK for three different future GHG emission scenarios: low; medium; and high. The climate projections under each scenario differ, with greater variability in climate impacts projected using the medium emissions scenario and corresponding lower variability from the low emissions scenario. In this context the data and projections themselves may change in the future, however while the expected temperature or rainfall changes may alter it is anticipated the overall trends generated are proven and provide a sound basis for the assessment of effects set out in this Chapter.

21.262 At this time, the UKCP09 data is being updated in light of recent GHG emission data and internationally significant GHG emission reduction agreements such as the Paris Accord. These variances in data and predicted future climate must therefore be considered in the context of this assessment, particularly in relation to long-term operation.

21.263 The data and projections used in this assessment could, as a result of updated projections, change in the future, however while the expected temperature or rainfall changes may alter it is anticipated the overall trends generated are proven and provide a sound basis for the assessment of effects set out in this Chapter.

Climate Change Adaptation Assessment

21.264 Climate change adaptation is a unique assessment as it reviews the impacts of the changing climate and how this may affect the Proposed Development. As acknowledged within the IEMA Guidance, there is no regulated or agreed method of presenting climate information and approaches vary depending on the scale of the project and the application of professional judgement.

21.265 Where possible, as part of this assessment, evidence to determine the risks posed by climate change to the Proposed Development has been reviewed to provide context for the qualitative assessment carried out. This approach is considered suitable given the nature of the Proposed Development.

References

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The Rail Central Rail Freight Interchange
Appendix 21.1 Rail Central GHG Assessment

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Revisions

Revision	Date	Description
A	11/07/18	Updated freight and mode shift assumptions.
B	31/07/18	Updated BEIS Emission Factors
C	27/08/18	Updated phasing assumptions. Error in employee commuting and purchased electricity emissions corrected.

Executive Summary

This Appendix supports the Climate Change Mitigation assessment within ES Chapter 20 Climate Change. It sets out the methodology for assessing greenhouse gas (GHG) emissions for the Proposed Development at Rail Central and the calculation process for each emission category identified for the existing site baseline, construction phase (2019 – 2028), short-term operational phase (2028 – 2038) and long-term operational phase (2039 – 2088).

The long-term operational phase is further broken down and reviewed at 2050 to allow comparison with UK carbon budgets, which are only set to 2050.

1. Introduction

Purpose of the Greenhouse Gas Assessment

1.1 This Greenhouse Gas [GHG] Assessment has been prepared by Turley Sustainability to support ES Chapter 21 Climate Change Mitigation for Rail Central.

1.2 The aim of this Appendix is to assess the potential GHG emissions arising as a result of the Proposed Development; this includes the upstream and downstream emissions associated with the operation of the rail freight interchange.

Structure of the Report

1.3 The remainder of the GHG assessment is structured as follows:

- **Chapter 2: Methodology -** explains the assessment methodology and steps followed in undertaking this assessment of GHG emissions.
- **Chapter 3: The Proposed Development -** sets out the activities within the Proposed Development.
- **Chapter 4: Scope 1 Emissions Sources –** details the direct GHG emissions that occur as a result of the construction and operation of the development.
- **Chapter 5: Scope 2 Emissions Sources** - details the indirect GHG emissions that occur as a result of the use of purchased electricity, heat or steam consumed in the construction and operation of the development.
- **Chapter 6: Scope 3 Emissions Sources** – details other relevant indirect GHG emissions that occur upstream and downstream of the Proposed Development as a result of the construction and operation of the development.

2. Methodology

Overview of Approach

2.1 This assessment of GHG emissions is guided by a number of principles as set out in the IEMA Guidance *Assessing Greenhouse Gas Emissions and Evaluating their Significance* (**Ref 1**).

2.2 The IEMA guidance sets out an assessment process which involves determining the goal and scope of the study, setting study boundaries, deciding on an assessment methodology, collecting the necessary calculation data and calculating/ determining the GHG emission inventory.

2.3 The aspects of the methodology set out in Chapter 21 of the ES that relate specifically to this Appendix include:

- The establishment of the Scope and Boundaries of the GHG assessment as per Section 4 and 5 of the IEMA GHG guidance.
- An assessment of the GHG emissions arising from existing use of the site to establish the baseline as per Section 4 of the IEMA GHG guidance.
- An assessment of the GHG emissions arising during the construction and operation phases of the Proposed Development.
- An assessment of additionality and resulting net emissions taking into account comparator scenarios such as existing freight movements, commuter journeys and warehouse space that will be displaced from elsewhere as a result of the SRFI.

2.4 The goal and scope of the assessment are defined within the ES Chapter, including how GHG emissions information assessed in this Appendix will be interpreted and used in decision-making.

2.5 An assessment methodology and assessment boundaries have been developed through the application of the Greenhouse Gas Protocol Corporate Standard (**Ref 2**), known as the 'Protocol' from this point forward.

2.6 The Protocol sets out several principles which have been adopted and applied throughout:

- **Relevance:** ensuring that the GHG inventory appropriately reflects GHG emissions and serves the decision-making needs of users
- **Completeness:** Accounts and reports on all GHG emission sources and activities within the chosen inventory boundary. Exclusions are disclosed and justified.

- **Consistency:** Use consistent methodologies to allow for meaningful comparisons of emissions.
- **Transparency:** Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources.
- **Accuracy:** Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable.

2.7 The GHG Protocol Initiative is a multi-stakeholder partnership of businesses, non-governmental organisations [NGOs], governments, and others covered by the World Resources Institute [WRI] and the World Business Council for Sustainable Development [WBCSD]. Launched in 1998, the Initiative's mission is to develop internationally accepted GHG accounting and reporting standards for business.

2.8 The Protocol provides guidance for organisations preparing GHG emissions inventories. It covers the accounting and reporting of the six greenhouse gases covered by the Kyoto Protocol:

- Carbon dioxide [CO_2]
- Methane [CH_4]
- Nitrous Oxide [N_2O]
- Hydroflourocarbons [HFCs]
- Perflourocarbons [PFCs]
- Sulphur Hexaflouride [SF_6]

2.9 The GHGs identified above result in different levels of warming over different timeframes. In order to express the impact of GHG emissions in a simple manner, ratios of global warming potential [GWP] for each gas are applied. The resulting carbon dioxide equivalent [CO_2e] figure describes the total warming impact of each gas relative to CO_2 over a set period. The ratios applied in this assessment are based on factors published by the Intergovernmental Panel on Climate Change [IPCC] (**Ref 3**) that describe the total warming impact relative to CO_2 over 100 years. The terms 'emissions' and 'GHG emissions' are used interchangeably in this report and are measured in units of CO_2e.

2.10 This approach is consistent with UK Government emission factors and emission reporting in line with the UK carbon budgets, against which the GHG emissions calculated in this assessment will be evaluated in the Climate Change Mitigation section of **ES Chapter 21**.

Assessment Scope and Boundaries

2.11 The Protocol advocates the selection of an appropriate boundary and the reporting of emissions within that boundary. Although there will be no single entity with either financial or operational control of the Proposed Development through construction and operation, an operational control approach has been adopted, and applied in this context to the site itself.

2.12 All emissions that occur as a result of the Proposed Development, directly on-site, upstream of the Proposed Development, or downstream of the Proposed Development are therefore within scope (unless specifically scoped out of the assessment). Emission sources relating to the baseline, construction and operational phases are described in detail below.

Spatial Boundaries & Emission Sources

Existing Site

2.13 Prior to construction, Scope 1 and 2 existing site baseline emissions occur as a result of the combustion of fuels, release of gases and the use of purchased electricity associated with activities currently being undertaken within the boundary of the Proposed Development. Scope 3 emissions include all other emissions upstream and downstream of the Proposed Development. Relevant emission sources identified are outlined below:

- 2.13.1 Scope 1 Emission Sources
  - 2.13.1.1 Stationary combustion (e.g. production of heat in farming operations)
  - 2.13.1.2 Mobile combustion (e.g. farming equipment, on-site transportation transportation)
  - 2.13.1.3 Fugitive emissions (e.g. agricultural methane and fertilizer use)
- 2.13.2 Scope 2 Emissions Sources
  - 2.13.2.1 Stationary combustion (e.g. use of purchased electricity)
- 2.13.3 Scope 3 Emission Sources
  - 2.13.3.1 Mobile combustion (e.g. transportation of raw materials/ products/ waste, employee business travel, employee commuting, upstream and downstream transportation of goods (including freight))
  - 2.13.3.2 Process emissions (e.g. production of purchased materials)

2.14 Note that the upstream and downstream transportation of goods relates both the existing use of the site, and in the wider context, existing transport movements across the wider freight network.

Construction Phase

2.15 During the construction phase, Scope 1 and 2 emissions occur as a result of the combustion of fuels, release of gases and the use of purchased electricity associated with the construction of the Proposed Development within the site boundary. Scope 3 emissions include all other emissions upstream and downstream of the Proposed Development associated with its construction. This includes:

2.15.1 Scope 1 Emission Sources

2.15.1.1 Stationary combustion (e.g. production of heat in site cabins)

2.15.1.2 Mobile combustion (e.g. construction equipment, on-site construction transportation)

2.15.1.3 Fugitive emissions (e.g. HFCs during use of refrigeration and air-conditioning equipment)

2.15.2 Scope 2 Emissions Sources

2.15.2.1 Stationary combustion (e.g. use of purchased electricity, heat or steam)

2.15.3 Scope 3 Emission Sources

2.15.3.1 Mobile combustion (e.g. transportation of raw materials/ products/ waste, employee business travel, employee commuting, upstream and downstream transportation of goods)

2.15.3.2 Process emissions (e.g. Production of purchased materials)

2.16 Note that during the construction period (2019 – 2028), some operational emissions will occur as a result of the phased handover of completed site elements. These emissions are assessed as operational emissions but are reported separately under the construction phase.

Operational Phases

2.17 During the operational phases, Scope 1 and 2 emissions occur as a result of the combustion of fuels, release of gases and the use of purchased electricity associated with the operation of the site within the boundary of the Proposed Development. Scope 3 emissions include all other emissions upstream and downstream of the Proposed Development associated with its operation. This includes:

2.17.1 Scope 1 Emission Sources

2.17.1.1 Stationary combustion (e.g. production of heat and/or electricity)

2.17.1.2 Mobile combustion (e.g. combustion of fuel in mobile plant)

2.17.1.3 Fugitive emissions (e.g. HFCs during use of refrigeration and air-conditioning equipment)

2.17.2 Scope 2 Emissions Sources

2.17.2.1 Stationary combustion (e.g. use of purchased electricity, heat or steam)

2.17.3 Scope 3 Emission Sources

2.17.3.1 Mobile combustion (e.g. transportation of raw materials/ products/ waste, employee business travel, employee commuting, upstream and downstream transportation of goods)

2.17.3.2 Process emissions (e.g. production of purchased materials)

Temporal Boundaries

2.18 In accordance with **Chapter 5** of the ES, the following temporal ranges have been evaluated:

Table 2.1: Temporal boundaries

Timeframe	Construction	Operation 'Short-Term'	Operation 'Long-term'
Project Timeframe	2019-2029	2029-2039	2039-2089

2.19 However, in order not to double count emissions in 2019 and 2039, the following adjustment has been made:

Table 2.2: Adjusted Temporal Boundaries

Timeframe	Construction	Operation 'Short-Term'	Operation 'Long-term'
Project Timeframe	2019-2028	2029-2038	2039-2088

2.20 First operation is anticipated to be 2021 and full operation is anticipated to be 2031, allowing a period of time post-construction for the Proposed Development to reach full operational output.

2.21 In order to evaluate the significance of GHG effects, the GHG emissions as a result of the Proposed Development are assessed against the UK Government carbon budgets covering the same temporal ranges. The carbon budgets are developed in order to meet an 80% reduction in emissions (from a 1990 baseline) by 2050, so an additional assessment point of 2039 – 2050 is also calculated for the specific purpose of assessing long-term operational emissions against the carbon budgets. For the full long-term operational phase, it is assumed that the annual carbon budget for 2050 is applied to 2050 to 2088.

Baseline Assessments

2.22 The IEMA guidance states that *'The ultimate goal from establishing a baseline is being able to assess and report the net GHG impact of the proposed project'*. Whilst the IEMA guidance sets out that the current baseline relates to emissions that currently occur on the development site, it also refers to alternative approaches such as those set out in the GHG Project Protocol (**Ref 4**). These include the assessment of emissions that would otherwise occur elsewhere in a counterfactual scenario.

2.23 This assessment adopts a hybrid approach, including within the baseline the emissions associated with the existing site; emissions that would have otherwise occurred in a counterfactual scenario are relevant to certain emission sources (e.g. freight, employee commuting and the operation of warehousing facilities) and where there is a difference in emissions, these are considered within the assessment of construction and/or operational phase GHG emissions, resulting in net emissions being recorded and compared with the baselines described below.

Current Baseline (2018)

2.24 The current site baseline includes the on-site and upstream/ downstream emissions associated with the current use of the Proposed Development site.

2.25 The current emissions baseline is the UK Government 3rd carbon budget for 2018, which is equal to million 508.8 million tCO_2e.

Future Baseline (2019)

2.26 The future site baseline assesses the emissions associated with the use of the site immediately prior to construction; this factors in any changes in emission factors for various fuels over the period between the current site baseline and the commencement of construction.

2.27 The current emissions baseline is the UK Government 3rd carbon budget for 2019, which is equal to million 508.8 million tCO_2e.

Aggregated Future Baselines (2019 – 2028, 2029 – 2038 and 2038 - 2050)

2.28 Future aggregated baselines are also assessed, which provide an estimate of existing baseline emissions over time, were no development to go ahead. These are assessed on an annual basis, taking into account decarbonisation, but with no change in site activities.

2.29 Future aggregated emission baselines cover the assessment periods identified in **Table 2.2** and taken into account reducing annual emissions in line with current and future carbon budgets.

2.30 Carbon budgets have been published covering the periods up to 2032, and Government has noted that from this point forward (2018), an annual reduction in emissions of circa 3% is required to meet the 2050 target. On this basis, we have estimated the level of carbon budgets likely to be required post-2032 to

meet the 2050 target. **Table 2.3** sets out the carbon budgets, with those estimated in italics.

Table 2.3: Summary of Aggregated Baseline GHG Emissions

Period	GHG Emissions [million tonnes CO_2e]
1st carbon budget (2008 – 2012)	3,018
2nd carbon budget (2013 – 2017)	2,782
3rd carbon budget (2018 – 2022)	2,544
4th carbon budget (2023 – 2027)	1,950
5th carbon budget (2028 – 2032)	1,725
6th carbon budget (2033 – 2037)	*1,491*
7th carbon budget (2038 – 2042)	*1.255*
8th carbon budget (2043 – 2047)	*1,019*
9th carbon budget (2048 – 2050)	*468*

2.31 For the periods covered by this assessment, this results in aggregated carbon budgets of:

- 2019 – 2028: 4,378 million tCO_2e
- 2028 – 2038: 3,112 million tCO_2e
- 2039 – 2050: 2,491 million tCO_2e
- 2039 – 2088: 8,419 million tCO_2e

Assessment of Emissions

2.32 The basic approach for calculating GHG emissions is to multiply an appropriate emissions factor by the relevant activity data. The applicability of activities and sources of this data are reviewed in detail in the following sections for each of the activities and emissions sources identified in **Paragraphs 2.13, 2.15** and **2.17**.

2.33 The GHG emission profiles developed for these activities are then compared with UK Government carbon budgets to provide context for the scale of GHG emissions in **ES Chapter 21**.

Construction Phase (2019 – 2028)

2.34 The construction phase assessment is an estimate of emissions associated with construction activity of the scale and quantum proposed, with Embedded Mitigation measures included.

2.35 This assumes that the principles set out in the following documents are in place:

- Construction Environment Management Plan [CEMP]
- Green Infrastructure Plan [GIP]
- Parameters Plan [PP]

2.36 The construction phase assessment is evaluated on an annual basis to allow consideration of the decarbonisation of fuel and electricity supplies and changes that are expected to alter activity data over the period. Both annual totals and an aggregated total for the construction phase are provided.

Operation during Construction Phase (2019 – 2028)

2.37 The principles outlined in the following section apply to the assessment of operational phase GHG emissions that occur during the construction period.

2.38 Emissions during the construction period are estimate based on the proportion of development completed over the period.

Short-term Operation (2029 – 2038)

Operational Assessment

2.39 The operational assessment is based on the quantum of completed units and the anticipated impact that this will have on the operation of the site itself.

2.40 The operational assessment assumes that Embedded Mitigation is in place and the principles outlined in the documents set out in **Section 2.35** are included.

2.41 For B8 units, the operational assessment is based on the Applicant's standard building specification, which achieves a circa 20% reduction in CO_2 emissions over a Building Regulations compliant development (Part L 2013); all other units are assumed to be designed to comply with the energy and emissions criteria set out in Part L.

2.42 Once constructed, no further energy improvements are assumed over the life of the buildings and energy use is assumed to remain constant.

2.43 For infrastructure, the operational assessment is based on assumed standard practices, unless other principles are established in the CEMP. These are adjusted for anticipated changes in performance and/ or emissions over the period.

2.44 For freight movements, the operational assessment assumes that although the quantity of freight may increase over time, this increase is demand-led and not as a result of the proposed development; there is therefore no net increase in freight assumed as a result of the development, but there will be a modal shift from road to rail. The road movements displaced by rail are calculated and the net difference in emissions is presented; where this results in reduced emissions, this is a saving as a result of the Proposed Development and is subtracted from emission totals.

Long-term Operation (2039 – 2088)

2.45 A quantitative assessment of emissions beyond 2038 has been made, but there is significant uncertainty relating to activity data and emission data this far into the future.

2.46 Qualitatively, it is our professional judgement that emissions post-2038 will reduce significantly; indeed, this will be necessary to meet the UK's legally binding targets set for GHG emission reductions by 2050. This qualitative assessment is based on the following assumptions:

- By 2050 it is expected that emissions related to the use of electricity will reduce by over 86% compared with current (2018) grid emissions (**Ref 5**).
- There is significant research currently being undertaken into the development of alternative fuels for HGVs and rail uses, which could have a significant impact on both road and rail freight emissions.
- Innovations and cost reductions in battery storage are likely to make the use of renewable energy and electric vehicles more viable in the medium- to long-term, resulting in a market-driven shift (as opposed to policy driven) in the commercial and transportation sectors to renewable fuels and low/ zero emission vehicles
- Many European cities and member states have made commitments relating to the types of vehicles that can be sold in the future, and this is supported by a growing number of manufacturer commitments to produce more vehicles to support cleaner fuels.
- Behaviour changes and the 'sharing economy', supported by disruptive IT infrastructure could reduce the number of private vehicles on the road, particularly in relation to employee commuting.
- Greater collaboration and consolidation of freight could reduce the requirement for shorter-distance freight movements, typically carried out by road; rail legs of such journeys would likely remain.
- Demand-side response and energy efficiency measures, particularly at replacement intervals, are likely to reduce the energy demand form buildings further.

2.47 Some of these factors are considered in more detail in this assessment and the supporting assessment of freight emissions in **Volume 3, Appendix 21.2**; the majority of these factors, however, cannot be assessed with any certainty and have not been included.

2.48 Beyond 2050, no further emission reduction activities are assumed and emission factors projected at 2050 are applied to activity data for 2050 onwards.

Limitations of the Assessment

2.49 As this is a predictive assessment, there is inherent uncertainty in the results. As far as practicable, data specific to the Proposed Development has been used to develop the activity and emissions profiles, but in some cases, this is not possible and other external sources of data are used. In accordance with the principles of the GHG Protocol, all assumptions and data uncertainties are disclosed.

Activity Data

2.50 Information pertaining to the detailed design of the scheme is not yet available, so where necessary, proxy data has been used to provide an estimate of activity for both baseline and estimated actual emissions. Assumptions made have been fully disclosed in the *Data Sources* sub-section for each category of emissions; any uncertainty around those assumptions has been assessed in the relevant *Data Quality and Uncertainty* sub-section.

Emission Factors

2.51 The primary source for current emission factors used in this report is the *UK Government GHG Conversion Factors for Company Reporting 2018* (**Ref 6**), termed "*BEIS Emission Factors*" hereafter. The BEIS Emission Factors are provided for use by UK based organisations reporting on UK operations that occurred during the period 1st April 2017 to 31st March 2018. However, it should be noted that this data is two years out of date and relates to the period 1st April 20154 to 31st March 2016.

2.52 BEIS Emission Factors are based on various sources that are reviewed at different frequencies, some of which may not be annual. Where annual averages are provided, they may not be reflective of the actual supply that will be procured.

2.53 Assessments have been made of likely future emission factors based on data published by various sources relating to the decarbonisation of energy supplies.

2.54 For electricity, this includes projections up to 2100 as set out in *Data Table 1* supporting the *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal (***Ref 5***)*.

2.55 For gas, this includes:

- *Next steps for UK heat policy* (**Ref 7**), and the assumption that in order to meet the fifth carbon budget (central scenario), a reduction in heating emissions of 22% to 2030 relative to 2015 is required.
- *Decarbonising the Gas Network* (**Ref 8**)*,* which references the above and sets out that the most likely transition to a lower carbon network up to 2030 would include a biomethane injection of up to 4%. Post 2030, a range of measures, including hydrogen, could achieve larger savings. Urgent research is required to understand the costs of and technical issues posed by a hydrogen gas gird, but Government and industry

stakeholders advocate one of two broad strategies: hydrogen blending where up to 20% hydrogen could enter the grid, increasing as technologies mature and the supply chain develops; or 100% hydrogen switch which would rapidly achieve major carbon savings, but would require the conversion of all appliances (e.g. boilers) from natural gas to pure hydrogen.

2.56 It is therefore assumed that a linear reduction in emissions is achieved to 2030 by annual increases in the supply of biomethane to the gas grid. Beyond 2030, it is assumed that 20% hydrogen enters the grid, and that it is produced by electrolysis.

2.57 This has a reduction impact in terms of Scope 1 emissions, but increases Scope 3 emissions associated with WTT and T&D.

2.58 A separate assessment has been made for freight-related emission factors and is provided in **Volume 3, Appendix 21.2**.

3. Site Description

Proposed Development

3.1 The Proposed Development comprises of the following principal elements:

- Main SRFI Site
- J15a
- Minor Highways Works
- All Development within Order Limits

3.2 Chapter 5 of the ES describes the activities anticipated in relation to each element in further detail; these descriptions have been used to identify and assess the likely GHG impacts associated with the Proposed Development during construction and operation.

3.3 Data from other assessments has also been used to inform our assessment of activity data. Principally, this includes:

- Chapter 9 Agricultural Land
- Chapter 12 Ground Conditions
- Chapter 16 Noise & Vibration
- Chapter 19 Highways & Transportation
- Chapter 18 Socio-Economics
- Chapter 20 Waste

General Assumptions

3.4 The Illustrative Masterplan and Chapter 5 have been used as the basis for the likely size of individual units.

3.5 This includes that the details of warehousing to be used are flexible within the Parameters defined in the Parameters Plan; in particular, the maximum overall floorspace (Gross External Area (GEA) of 702,097m^2)

3.6 It is assumed that by 2021 (first operation), the following features of the Proposed Development are in place:

- 129,790 m^2 of Main SRFI floorspace
- J15a of the M1
- Access to the site from the A432
- Intermodal terminal with sufficient capacity to accept at least four trains per day.

3.7 It is possible that other Minor Highway Works will also be completed; for the purpose of this assessment, this is assumed to be the case.

3.8 For the purpose of this assessment, the remaining floorspoace is assumed to be constructed between 2022 and 2028, with completions evenly distributed on a linear basis.

3.9 In accordance with site traffic forecasts produced by MDS Transmodal **(Ref 9),** it is assumed that the SRFI will operate for 335 days per year,

Building Areas

3.10 **Chapter 5 Table 5.9** provides an overview of indicative floorspace, with a total GEA of approximately 689,755m3 allocated for warehouse, and a further 12,342m2 for ancillary uses (e.g. train maintenance depot).

3.11 It is assumed that the Gross Internal Area (GIA) is equivalent to 95% of GEA, resulting in the areas for each phase of development included in Table 3.1.

Table 3.1: Indicative GEA and GIA by Phase

Phase	GEA (m^2)	GIA (m^2)
Phase 1 (2019 – 2021)	129,790	123,301
Phase 2 (2022 – 2028)	559,965 warehousing + 12,342 ancillary	531,967 warehousing + 11,725 ancillary
TOTAL	702,097	666,992

Construction Spend

3.12 An estimation of construction spend has been included in Chapter 18; construction spend for the Main SRFI Site and associated access from the A43 will total approximately £377m. No figure is provided for the construction of J15a or Minor Highway Works; however, it is assumed that construction of J15a is likely to represent a small proportion of the overall cost of constructing the Main SRFI Site (assumed 3%). An additional £11.31m has therefore been assumed to cover the J15a and other Minor Highway Works.

4. Scope 1 Emissions

General Description

4.1 Scope 1 emissions are direct GHG emissions that occur as a result of the combustion of fuels or release of gases.

4.2 As summarised in **Paragraph 2.13**, the following activities have been identified in relation to the existing use of the Proposed Development site:

- Stationary combustion (e.g. production of heat in farming operations)
- Mobile combustion (e.g. farming equipment, on-site transportation transportation)
- Fugitive emissions (e.g. agricultural methane and fertilizer use)

4.3 As summarised in **Paragraph 2.15**, the following activities have been identified in relation to the construction of the Proposed Development:

- Stationary combustion (e.g. production of heat in site cabins)
- Mobile combustion (e.g. construction equipment, on-site construction transportation)
- Fugitive emissions (e.g. HFCs during use of refrigeration and air-conditioning equipment)

4.4 As summarised in **Paragraph 2.17**, the following activities have been identified in relation to the operation of the Proposed Development:

- Stationary combustion (e.g. production of heat and/or electricity in buildings)
- Mobile combustion (e.g. combustion of fuel in mobile plant and equipment)
- Fugitive emissions (e.g. HFCs during use of refrigeration and air-conditioning equipment)

Existing Site

4.5 Stationary combustion: Production of heat and electricity

4.5.1 Description of Process

The Main SRFI Site currently accommodates a number of farms and small industrial uses.

Land associated with J15a and Other Minor Highway Works is scoped out of this assessment due to the relative scale of land take.

It is assumed that heat is provided to all buildings that accommodate people and in addition, heat may be generated for use in some farming

activities. It is, however, assumed that the provision of heat to industrial units is minimal, so only heat consumed in farming uses is considered here.

4.5.2 Data Sources

*Farm energy use statistics (***Ref 10**), last updated in 2013, provide an estimate of energy consumed for different uses relating to different types of farm. The data is based on responses to an additional module on energy consumption within the annual Farm Business Survey. Around 200 farms submitted data, which is split into specific farm types.

This dataset includes an estimate of the quantity of heating oil consumed by the different farm types relevant to the proposed development site, set out in **Table 4.5.1**.

Table 4.5.1: Volume of fuel consumed per hectare of farmland by farming activity

Fuel Type	Cropland (cereals as proxy)	LFA Grazing Livestock
Heating oil [l]	0.1	0.4

The areas of each type of farmland (e.g. grazing land, cropland, grassland) have been assessed based on initial site survey data and assumptions relating to activities carried out in each field based on aerial images of the site (for example, the location of the field identified for sheep grazing can be identified from above).

Table 4.5.2: Site area by farmland activity

Farming Activity	Area [ha]
Cropland	2,596
Grazing (sheep)	113
TOTAL AREA	2,709

Heating oil is assumed to refer to burning oil/ kerosene and the appropriate BEIS Emission Factor of 2.53627 kgCO_2e/litre of fuel has been applied.

4.5.3 Calculation Procedure & Estimated Emissions

The estimated quantity of fuel consumed per hectare is multiplied by the area of each farm type.

Table 4.5.3: GHG emissions for use of fuel for the production of heat on the existing site

Farming Activity	Quantity of Fuel [l]
Cropland	260
Grazing (sheep)	45
TOTAL	305

Each fuel quantity is then multiplied by the BEIS Emission Factor for kerosene.

Table 4.5.4: GHG emissions for use of fuel for the production of heat on the existing site

Temporal Range	Total GHG Emissions [tCO_2e]	Aggregated GHG Emissions [tCO_2e]
Current Baseline (2018)	0.77	-
Future Baseline (2019)	0.77	
Construction (2019 – 2028)	-	8
Long-term Operation (2029 – 2038)	-	8
Long-term Operation (2039 – 2088)	-	39
TOTAL (2019 – 2088)	-	54

4.5.4 Data Limitations & Uncertainty

The activity data is representative of the mean energy use for a small sample of survey respondents (38 for cereals and 44 for LFA grazing livestock), which may not be representative of wider agricultural practices or the current practices on this specific site.

Assumptions have been made regarding the fuel type which may be incorrect.

4.6 Mobile combustion: Fuel use in mobile plant and equipment

4.6.1 Description of Process

Mobile equipment is used to carry out farming activities, such as the ploughing of fields.

4.6.2 Data Sources

As outlined in **Section 4.5.2**, *farm energy use statistics* (**Ref 10**), last updated in 2013, provide an estimate of energy consumed for different uses relating to different types of farm.

This dataset includes an estimate of the quantity of different fuels consumed by the different farm types; these are assumed to relate to mobile combustion uses and are outlined in **Table 4.6.1**.

Table 4.6.1: Volume of fuel used per hectare

Fuel type	Cropland (cereals as proxy)	LFA grazing livestock
Road fuel [l]	11	10.3
Red diesel [l]	106.9	15
Red diesel used by contractors [l]	8.7	2.2
LPG [kg]	2	0.5
Kerosene [l]	11.8	6.2

BEIS Emission Factors are applicable to all fuels identified above and are applied are as follows:

- Road fuel (forecourt diesel 'average biodiesel blend') = 2.62694kgCO_2e/litre
- Red diesel (gas oil) = 2.97049 kgCO_2e/litre
- LPG = 1.51906 kgCO_2e/litre
- Kerosene (burning oil) = 2.53627 kgCO_2e/litre

4.6.3 Calculation Procedure & Estimated Emissions

The area of each type of farmland is multiplied by the fuel type and associated emission factor.

Table 4.6.2: Estimated annual fuel consumption for existing site

Farm Type	Road fuel [kWh/year]	Red diesel [litres/year]	Kerosene [litres/year]	LPG [kg/year]
Cropland	28,557	300,106	30,634	5,192
Grazing (sheep)	1,162	1,940	699	56
TOTAL	29,718	302,046	31,333	5,249

This is then multiplied by the annual emission factor for grid electricity. For illustrative purposes, the aggregated emissions that would be generated across each temporal range if the land were to remain in its current use have also been assessed.

Table 4.6.3: GHG emissions for use of fuel in plant and equipment at existing site

Temporal Range	Total GHG Emissions [tCO_2e]	Aggregated GHG Emissions [tCO_2e]
Current Baseline (2018)	1,070	-
Future Baseline (2019)	1,070	-
Construction (2019 – 2028)	-	10,702
Short-term Operation (2029 – 2038)	-	10,702
Long-term Operation (2039 – 2050)		12,842
Long-term Operation (2039 – 2088)	-	53,509
TOTAL (2019 – 2088)	-	74,912

4.6.4 Data Limitations & Uncertainty

The activity data is representative of the mean energy use for a small sample of survey respondents (38 for cereals and 44 for LFA grazing livestock), which may not be representative of wider agricultural practices.

Assumptions have been made regarding the fuel type and heat generation method, which may be incorrect.

4.7 Fugitive Emissions: Agricultural emissions

4.7.1 Description of Processes

There are several mechanisms by which GHG emissions are released during agricultural activity. These include:

- Nitrous oxide is produced from soil through microbial processes that convert nitrogen from nitrogen fertilizers, manure, and crop residues into various nitrogen gases, including N_2O, which is a GHG 298 times more potent than CO_2.
- Methane, 25 times more potent than CO_2, is also released as a result of the digestion processes of cattle.
- Soil disturbance during tillage tends to stimulate soil carbon loses through enhanced decomposition and erosion.

Whilst these emissions may be significant, they are dependent on many local factors and practices of which we have no knowledge.

These emissions have therefore been scoped out for reasons of proportionality to the assessment.

Construction

4.8 Stationary combustion: Production of heat and electricity

4.8.1 Description of Process

It is possible that a small quantity of fuel will be consumed for the generation of heat and electricity during the early stages of the construction process, before an electricity supply is established. This would involve the use of generators to run site compound facilities.

Additional generators may be used to run other site plant.

Emissions associated with stationary combustion of fuels are included within the assessment of fuel use in mobile plant and equipment (**Section 4.9**)

4.9 Mobile combustion: Fuel use in plant and equipment

4.9.1 Description of Process

Fuels will be consumed in mobile plant and equipment used in the construction of the Proposed Development, including (but not limited to) cranes, diggers and piling rigs. In addition, some plant may be run off generators (used to generate electricity).

4.9.2 Data Sources

All UK quoted companies are required, as a minimum, to provide an assessment of their annual Scope 1 and Scope 2 GHG emissions, alongside appropriate intensity metrics. Scope 1 and 2 emissions are those generated as a result of activities within the operational or financial control of the company, and for construction companies, typically include emissions related to their site operations.

Whilst a main contractor has not been selected for the construction of the Proposed Development, data from main contractors who have been involved in similar-scale projects can be applied to estimate emissions; this is achieved by calculating emissions per £m revenue and using this as a proxy for project-based emissions. A summary of Scope 1 data is provided in **Table 4.9.1**.

Table 4.9.1: Scope 1 Emission Intensity of UK Quoted Main Contractors

Company	2017 Emissions Intensity [tCO_2e/£m turnover]	2016 Emissions Intensity [tCO_2e/£m turnover	2015 Emissions Intensity [tCO_2e/£m turnover]
Balfour Beatty (**Ref 11**)	22.02	27.03	25.59
Carillion (**Ref 12**)	30.63	31.41	33.07
Kier Group (**Ref 13**)	27.71	31.71	44.98
North Midland Construction (**Ref 14**)	33.49	34.49	32.17
AVERAGE	28.46	31.16	33.95

This data is not broken down by fuel use and includes both fuel used in generators for the generation heat and electricity (**Section 4.8**) and fuel used in mobile combustion equipment.

As there are multiple fuels contained within each total, it is not possible to assess the likely activity data, but it is assumed that emission factors relating to fuels used for construction purposes remain stable over the construction period.

The data presented in **Table 4.9.1** relates to the most recent reporting years for each organisation and shows a reduction of circa 8% in emissions over the last two reporting years. This is assumed to be as a result of commitments in place by each of the contractors identified above to reduce their GHG emissions.

The reduction in emissions related to fuels is likely to be the reason there is an increase in emissions associated with electricity use (described in **Section 5.6**); over recent years there has been a push to reduce the use of generators on construction sites, particularly for supplies to site compounds, by switching to grid supplies as early as possible. This is in an effort to reduce overall GHG emissions and improve local air quality.

It is our view that although a circa 8% reduction in emissions has been achieved on average over the past two reporting periods, this reduction is likely to reduce year-on-year as opportunities to reduce emissions further become more limited. For this reason, it is assumed that the current (2017) level of emissions are representative of standard industry practice and in a worst-case scenario will remain at this level throughout the construction phase.

An benchmark for fuel-related (i.e. Scope 1) emissions of 27.34tCO_2e/£m contractor turnover is therefore included within the CEMP and is considered Embedded Mitigation.

No additional action is proposed to reduce emissions further at this stage.

Phasing

It is assumed that the J15A and other Minor Highway Works are completed between 2019 and 2021, along with 129,790m2 GEA of warehousing. The estimated construction cost for the Main SRFI site is split proportional to floorspace, which after 2021 is assumed to be completed at an equal rate between 2022 and 2028. Profiled construction spend can be found in **Table A.3** of **Appendix A**.

4.9.1 Calculation Procedure & Estimated Emissions

Profiled emissions per £m of turnover are multiplied by profiled construction spend.

Table 4.9.2: GHG emissions for construction fuel use in plant and equipment

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019 – 2028)	11,052

A full breakdown of annual activity data and resultant emissions is provided in **Table A.3** in **Appendix A** of this document.

4.9.2 Data Limitations & Uncertainty

Given that that the construction period extends over several years, it is likely that improvements in the design and energy efficiency of plant and equipment will be made over the period, reducing energy demand. There are also likely to be advances in fuel technology, particularly where as a result of air quality issues in the wider construction industry, there is a switch to less locally polluting fuels.

The emissions per £m turnover for the companies from whom data was obtained are all within a small range, which provides a good level of certainty regarding the use of this as data as a proxy.

Operation

4.10 Stationary combustion: Production of heat and electricity

4.10.1 Description of Process

Fuel will be combusted in the generation of space heating and hot water in individual buildings; it is assumed that this will be generated via gas boilers.

Backup generators will be provided to generate electricity in case of a power failure, but their use is not considered to be material and they have been scoped out.

4.10.2 Data Sources

Warehousing

The anticipated regulated hot water and space heating requirements of the proposed buildings is estimated using calculation outputs for notional buildings generated using the Standard Building Energy Model [SBEM], used for demonstrating compliance with Part L Conservation of Fuel and Power requirements.

Embedded Mitigation measures include a commitment to reduce emissions by 20% over the requirements of Part L 2013 and to achieve at least a BREEAM Excellent standard (which includes minimum criteria relating to energy use).

Calculations have been produced by Kelly Taylor (**Appendix F**) to demonstrate how compliance with Part L and the specific energy-related requirements of the BREEAM Excellent rating that the Applicant has committed to could be achieved.

This assumes a heated warehouse space (worst-case) and that although the majority of improvement is as a result of LED lighting (affecting **Section 5.6**), some improvements are also recorded in relation to heating and hot water delivery through building fabric measures.

Table 4.10.1 outlines the anticipated electricity demand including Embedded Mitigation where a 20% improvement over Part L is delivered.

Table 4.10.1: Energy demand for space heating and hot water in B8 uses

	Area	Heating [kWh/m^2]	Hot Water [kWh/m^2]	Total [kWh/m^2]
Sample Unit 1	55,118	2.60	4.78	7.38
Sample Unit 2	29,904	5.71	4.90	10.61
AVERAGE	42,511	4.16	4.84	9.00

As the level of improvement proposed is a reduction in total regulated emissions, an assessment of the emissions associated with space heating, hot water, and the regulated electrical uses outlined in **Section 5.6** must be made, using emissions factors set out in the Part L methodology. It is assumed that heat is generated by gas boilers and the emission factors used in accordance with the SBEM model are therefore:

- Gas: 0.216 $kgCO_2$ per kWh
- Electricity: 0.519 $kgCO_2$ per kWh

The N*on-Domestic Building Services Compliance Guide* (**Ref 15**) sets out the minimum requirements for building services to comply with Building Regulations; this states that gas boilers should have a minimum efficiency of 91%. Space heating and hot water demand is therefore assumed to be delivered via 91% efficient gas boilers, increasing overall energy demand to 9.88 kWh/m^2.

Ancillary Buildings

It is assumed that terminal control building and lorry park/ health provision are office based (B1 Use Class) and that the train maintenance depot is general industrial (B2 Use Class).

Similarly, it is assumed that heating is delivered via 91% efficient gas boilers; total gas demand is presented in **Table 4.10.2**.

Table 4.10.2: Baseline heating energy demand for B1 & B2 uses

B1 & B2 Units	Area	Heating Demand [kWh/m^2]	Hot Water Demand [kWh/m^2]	Total Gas Demand [kWh/m^2]
B1 Sample Unit	227	17.83	3.51	21.34
B2 Sample Unit	2,091	16.35	4.77	21.11

Phasing

As stated under General Assumptions in **Section 3**, 129,790m^2 GEA is assumed to be completed and operational by 2021; all other floorspace is assumed to be equally distributed and completed between 2022 and 2028.

Displacement Effects

It should be noted that a central assumption in relation to the displacement of freight is that the SRFI will not increase the quantity of freight across the network. This assumption also relates to warehousing space and MDS Transmodal state:

'Firstly, a significant proportion of new-build warehousing is simply replacing existing capacity, which has become life-expired or reached the end of its useful economic life, on a like-for-like basis.' and:

'Alongside this, distributors have commissioned large single warehouse units to replace multiple smaller units, thereby generating economies of scale.

However, at this stage, it is not possible to determine the proportion of warehouse units that will be replaced by the SRFI to confirm any level of saving made. It is therefore conservatively assumed that 50% of emissions are displaced by the new warehousing facilities at Rail Central, with the remaining 50% additional and accounted for as part of this assessment.

Emission Factors

Part L emission factors are applied to assess the change in energy use required to achieve a % improvement over current Building Regulations, but they are not used to assess the emissions associated with the buildings in use for the following reasons:

- They are based on a three-year rolling average, last updated in 2011, and therefore do not reflect current or future emission projections.
- They include emissions upstream and downstream of those in-use, which are taken into account elsewhere (see **Section 6.12**).

BEIS Emission Factors for gas, adjusted to take into account future decarbonisation (**Appendix B**) have been applied to gas demand to calculate future emissions.

4.10.1 Calculation Procedure & Estimated Emissions

The SBEM methodology includes area convention guidelines which are similar to those used in assessing GIA; the GIA of B1, B2, and B8 uses has therefore been multiplied by the energy intensity of those uses to determine total kWh consumption.

; this is assessed on an annual basis to take into account the quantum of floor space anticipated to be delivered throughout the construction period.

Table 4.10.3: GHG emissions for operational fuel use in the production of heat at full build-out

Building Use	Total GIA [m^2]	Annual Energy Demand with Embedded Mitigation [kWh/year]
B1 Uses	847	19,872
B2 Uses	10,878	252,334
B8 Uses [1]	327,634	3,819,198
TOTAL	340,066	4,092,198

The total annual energy consumption is then multiplied by the corresponding annual emission factor to provide an estimate of GHG emissions.

Table 4.10.4: GHG emissions for operational fuel use in the production of heat and electricity

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019 – 2028)	3,447
Short-term Operation (2029 – 2038)	6,627
Long-term Operation (2039 – 2050)	7,770
Long-term Operation (2039 – 2088)	32,374
TOTAL (2019 – 2088)	42,448

4.10.2 Data Limitations & Uncertainty

SBEM BRUKL predictions of annual energy use are affected by a number of input parameters relating to the building location (e.g. orientation) and fabric specification. These can have a significant impact on estimated energy demand and may not reflect the as-built design of the buildings.

The 'performance gap' phenomenon is also well-publicised, with potentially significant differences arising between design emissions and those in use.

[1] 50% of total warehousing floorspace assumed 'additional' due to displacement effects

It is likely that over the lifetime of the buildings, heat generating plant will need replacing several times (likely every 15 years); at each replacement interval, plant is likely to be more efficient, further reducing energy demand. The predictions of consumption in the short- and long-term operational scenarios are therefore likely to over-estimate actual emissions.

The emissions as a result of the operation of warehousing unit sis likely to be an over-estimate as it is likely that more than 50% of the existing warehouse stock will be displaced by the new warehouse facilities proposed. Additionally, by displacing older warehousing stock with newer, more energy efficient buildings, further emissions savings are likely to be achieved.

4.11 Mobile combustion: Fuel use in mobile plant & equipment

4.11.1 Description of Process

Mobile plant and equipment will be operated, predominantly in the movement of goods between locations around the Proposed Development.

Specific equipment relating to the operation of the SRFI will be required; **Chapter 16** identifies the following fuel-consuming equipment:

- Three reach stackers have been assumed to be operational on the intermodal platform from Konecranes (reach stackers for intermodal handling, 41 to 45 tons).
- Six tugs have been assumed shuttling trailers between the intermodal platform and warehouses.

However, we have been unable to source data for these items of plant from the manufacturer and on the basis of proportionality, have scoped their use out of this assessment.

5. Scope 2 Emissions

General Description

5.1 Scope 2 emissions are indirect GHG emissions that occur as a result of the use of purchased electricity

5.2 As summarised in **Section 2.13**, the following activities have been identified in relation to the existing use of the Proposed Development site:

- Stationary combustion (e.g. use of purchased electricity in existing buildings)

5.3 As summarised in **Section 2.15**, the following activities have been identified in relation to the construction of the Proposed Development:

- Stationary combustion (e.g. use of purchased electricity for site operations)

5.4 As summarised in **Section 2.17**, the following activities have been identified in relation to the operation of the Proposed Development:

- Stationary combustion (e.g. use of purchased electricity in occupied buildings and site infrastructure).

Existing Site

5.5 Stationary combustion: Use of purchased electricity in buildings & infrastructure

5.5.1 Description of Process

In the baseline scenario, electricity will be used in buildings and across the site (e.g. for external lighting).

5.5.2 Data Sources

As outlined in **Section 4.5.2**, *farm energy use statistics* (**Ref 10**), last updated in 2013, provide an estimate of energy consumed for different uses relating to different types of farm.

This dataset includes an estimate of the quantity of electricity consumed; this is set out in **Table 5.5.1** below.

Table 5.5.1: Estimated volume of electricity consumption per hectare

Fuel Type	Cropland (cereals as proxy)	LFA Grazing Livestock
Electricity	115.5	66.1

No unit is provided for electricity consumption, but based on additional information provided within the report and datasets; we assume this is in kWh.

The 2017 BEIS Emission Factor is applied to electricity consumption in 2018 (current baseline) and 2019 (future baseline), with small adjustments made to take into account decarbonisation over the two periods.

5.5.3 Calculation Procedure & Estimated Emissions

The area of each type of farmland is multiplied by the estimated quantity of electricity required per hectare to determine the total quantity of electricity required on an annual basis.

Table 5.5.2: Estimated Annual Electricity Consumption for Existing Site

Farm Type	Annual Electricity Consumption [kWh]
Cropland	299,846
Grazing (sheep)	7,455
TOTAL	307,301

This is then multiplied by the annual emission factor for grid electricity. For illustrative purposes, the aggregated emissions that would be generated across each temporal range if the land were to remain in its current use have also been assessed.

Table 5.5.3: GHG Emissions for Use of Purchased Electricity at Existing Site

Temporal Range	Total GHG Emissions [tCO_2e]	Aggregated GHG Emissions [tCO_2e]
Current Baseline (2018)	63	-
Future Baseline (2019)	60	-
Construction (2019 – 2028)	-	452
Short-term Operation (2029 – 2038)	-	221
Long-term Operation (2039 – 2050)	-	140
Long-term Operation (2039 – 2088)	-	434
TOTAL (2019 – 2088)	-	1,108

5.5.4 Data Limitations & Uncertainty

The activity data is representative of the mean energy use for a small sample of survey respondents (38 for cereals and 44 for LFA grazing livestock), which may not be representative of wider agricultural practices.

Construction

5.6 Stationary combustion: Use of purchased electricity in buildings & infrastructure

5.6.1 Description of Process

During the construction phase, electricity will be procured for use across the site compound.

5.6.2 Data Sources

Main SRFI Site

The precise layout of the construction site, the number of site cabins, and the expected energy consumption of such cabins is yet to be determined.

As specific data is not currently available, data published by construction companies who are subject to the UK Mandatory Greenhouse Gas reporting requirements is used to provide an estimate of the quantity of emissions and electricity consumption per £million of turnover; this can then be multiplied by the expected construction expenditure at Rail Central to estimate site electricity consumption and emissions.

Table 5.6.1: Scope 2 emissions intensity of listed main contractors

Company	2016 Emissions intensity [tCO_2e/£m turnover]	2015 Emissions intensity [tCO_2e/£m turnover	2015 Emissions intensity [tCO_2e/£m turnover]
Balfour Beatty (**Ref 11**)	8.08	8.17	10.41
Carillion (**Ref 12**)	4.07	4.79	6.17
Kier Group (**Ref 13**)	3.68	4.84	5.42
North Midland Construction (**Ref 14**)	2.05	2.44	3.01
AVERAGE	4.47	5.06	6.25

By applying historic emission factors used in each reporting year, the annual energy consumption per £m turnover is calculated; these are reported in **Table 5.6.2.**

Table 5.6.2: Annual equivalent energy intensity

Company	2017 Energy intensity [kWh/£m turnover]	2016 Energy intensity [kWh/£m turnover	2015 Energy intensity [kWh/£m turnover]
Balfour Beatty	22,987	19,836	22,527
Carillion	11,566	11,618	13,345
Kier Group	10,476	11,744	11,725
North Midland Construction	5,822	5,922	6,503
AVERAGE	12,713	12,280	13,525

The reduction in emissions related to fuels is likely to be the reason there is an increase in emissions associated with electricity for Balfour Beatty, who are the greatest consumer (refer to **Section 4.9**); over recent years there has been a push to reduce the use of generators on construction sites, particularly for supplies to site compounds, by switching to grid supplies as early as possible. This is in an effort to reduce GHG emissions and improve local air quality.

We have assumed that electricity consumption will on average remain stable at 2017 levels, relying on grid decarbonisation to achieve emissions reductions.

A target of 12,700kWh/£m spend is therefore included within the CEMP; this is therefore considered embedded mitigation.

No additional action is proposed to reduce emissions further at this stage.

All companies used in this comparison have polices in place for the reduction of GHG emissions over the medium-term, but from the above data it appears that this is currently reliant on grid decarbonisation; an increase in average consumption in 2017 still results in emissions that are 12% lower than in 2016.

On this basis, the 2017 energy consumption figures are assumed to be representative of standard industry practice and no reductions in electricity consumption over the construction phase are assumed; emissions reductions will be achieved however through the decarbonising electricity grid.

Projected emission factors for electricity, taking into account future grid decarbonisation are applied over the construction period; a full breakdown is provided in **Appendix A**.

Phasing

It is assumed that the J15A and other Minor Highway Works are completed between 2019 and 2021, along with 129,790m^2 GEA of warehousing. The estimated construction cost for the Main SRFI site is split proportional to floorspace, which after 2021 is assumed to be completed at an equal rate between 2022 and 2028. Profiled construction spend can be found in **Table A.3** of **Appendix A**.

5.6.3 Calculation Procedure & Estimated Emissions

Annual electricity consumption is estimated based on the expected annual construction expenditure and the average electricity consumption per £m turnover of the construction companies identified in **Table 5.6.2**

Annual electricity consumption is multiplied by the projected emission factors for electricity over each construction year.

Table 5.6.3: GHG Emissions for the Use of Purchased Electricity during Construction

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019 – 2028)	694

5.6.4 Data Limitations & Uncertainty

Given that that the construction period extends over many years, it is likely that improvements in the design and energy efficiency of site cabins and plug-in equipment will reduce over the period, reducing energy demand.

As outlined above, there is significant difference between the emissions per £m turnover for the companies from whom data was obtained; an average figure has been applied but this could either under- or over-estimate consumption.

Emissions will vary based on the type of electricity-consuming activities taking place across different businesses, and will also include any consumption associated with head-office and corporate functions. An average of the figures reported in **Table 5.6.2** is therefore calculated and is applied with caution.

Operation

5.7 Stationary combustion: Use of Purchased Electricity in Buildings & Infrastructure

5.7.1 Description of Process

During the operational phase, electricity will be procured for use in buildings and on-site infrastructure (e.g. lighting, cranes).

5.7.2 Data Sources

Main SRFI Site

Warehousing

The anticipated regulated electricity requirements of the proposed buildings is estimated using calculation outputs for notional buildings generated using the Standard Building Energy Model [SBEM], used for demonstrating compliance with Part L Conservation of Fuel and Power requirements.

Embedded Mitigation measures include a commitment to reduce emissions by 20% over the requirements of Part L 2013 and to achieve at least a BREEAM Excellent standard (which includes minimum criteria relating to energy use).

Calculations have been produced by Kelly Taylor (**Appendix F**) to demonstrate how compliance with Part L and the specific energy-related requirements of the BREEAM Excellent rating that the Applicant has committed to could be achieved.

This assumes that the majority of improvement is as a result of LED lighting, although some improvements are also recorded in relation to heating and hot water delivery through building fabric measures.

Table 5.7.1 outlines the anticipated electricity demand including Embedded Mitigation where a 20% improvement over Part L is delivered (average figures are provided in italics).

Table 5.7.1: Electricity demand for B8 use

Unit Type	Cooling [kWh/m^2]	Auxiliary [kWh/m^2]	Lighting [kWh/m^2]	Equipment [kWh/m^2]
B8	0.39	7.70	13.66	35.75

Ancillary Buildings

It is assumed that terminal control building and lorry park/ health provision are office based (B1 Use Class) and that the train maintenance depot is general industrial (B2 Use Class).

Table 5.7.2: Electricity demand for B1 & B2 uses

Unit Type	Cooling [kWh/m^2]	Auxiliary [kWh/m^2]	Lighting [kWh/m^2]	Equipment [kWh/m^2]
B1	0.00	0.98	16.37	41.13
B2	0.00	1.58	19.45	31.61

Phasing

As stated under General Assumptions in **Section 3**, 129,790m^2 GEA is assumed to be completed and operational by 2021; all other floorspace is assumed to be equally distributed and completed between 2022 and 2028.

Displacement Effects

It should be noted that a central assumption in relation to the displacement of freight is that the SRFI will not increase the quantity of freight across the network. This assumption also relates to warehousing space and MDS Transmodal state:

'Firstly, a significant proportion of new-build warehousing is simply replacing existing capacity, which has become life-expired or reached the end of its useful economic life, on a like-for-like basis.' and:

'Alongside this, distributors have commissioned large single warehouse units to replace multiple smaller units, thereby generating economies of scale.

However, at this stage, it is not possible to determine the proportion of warehouse units that will be replaced by the SRFI to confirm any level of saving made. It is therefore conservatively assumed that 50% of emissions are displaced by the new warehousing facilities at Rail Central, with the remaining 50% additional and accounted for as part of this assessment.

Emission Factors

Part L emission factors are applied to assess the change in energy use required to achieve a % improvement over current Building Regulations, but they are not used to assess the emissions associated with the buildings in use for the following reasons:

- They are based on a three-year rolling average, last updated in 2011, and therefore do not reflect current or future emission projections.
- They include emissions upstream and downstream of those in-use, which are taken into account elsewhere (see **Section 6.18**).

BEIS forecast emission factors for electricity (**Ref 5**) have therefore instead been applied to assess Scope 2 emissions during operation.

Site Uses

In addition to the purchase of electricity for the operation of buildings, electricity will be required for other site uses, the most significant of which is likely to be lighting. The SRFI Operational Lighting Parameters Plan identifies the following areas with lighting requirements:

- Roundabout / Conflict Zone lighting (CE3)
- Main Access road lighting (ME4a)
- Site Access road lighting (S3)
- HGV parking lighting
- Car parking lighting
- Service Yard lighting
- Loading/Unloading lighting
- Checkpoints
- Express freight platform / Intermodal Terminal

Suggestions for the types of lighting are made, including the extensive use of LEDs, but no estimates on the quantities of each lighting type are available at this stage.

To estimate a baseline for operational emissions, we have applied data reported by SEGRO, a listed operator of industrial units and sites, who publish an annual Data Pack to support their sustainability reporting. In their most recently published report (**Ref 16**), they report an energy intensity figure of 66kWh/m^2/year of floorspace

for external common areas. This includes shared services to both tenant areas (e.g. tenant specific car parking areas) and non-tenant areas (site access etc.).

No annual consumption reduction assumptions have been made, but there may be opportunities to reduce electricity consumption in operation.

In addition, specific equipment relating to the operation of the SRFI will be required; **Chapter 16** identifies the following equipment:

- Intermodal vehicle cranes – three electric rail mounted gantry cranes [RMG] have been assumed to be operational on the intermodal platform.

- One small general purpose electric forklift truck has been assumed to be operational at the rail served warehouse platforms of Units 5, 6 and 7. Based on data provided by Konecranes for a fully electric RMG (**Ref 17)**

It is our professional opinion that the emissions associated with the electric forklift will be minimal compared with the scale of other emissions assessed in this report and they have therefore been scoped out of this assessment.

The Rail Report sets out that at DIRFT, which handles a similar number of trains per day as expected at Rail Central, (9.3 compared with 8), container handling movements are in the region of 130,000 lifts per annum. A similar quantity of movements has been assumed at Rail Central on a pro-rata basis.

Table 5.7.3: Annual Container Movements at Full Capacity

Site	Trains per day	Annual intermodal container movements
DIRFT	9.3	c. 130,000
SRFI	8	c. 111,828

[Source: MDS Transmodal Rail Central SFRI Draft Rail Report]

Environmental Product Declaration (EPD) data has been sought from Konecranes (**Ref 17**), which identifies that an RMG consumes on average 2kWh per container move (assuming a container weight of 20 tonnes).

Emission factors for electricity, taking into account grid decarbonisation, are applied.

5.7.3 Calculation Procedure & Estimated Emissions

The SBEM methodology includes area convention guidelines which are similar to those used in assessing GIA; the GIA of B1, B2, and B8 uses is therefore multiplied by the energy intensity of those uses to determine total kWh consumption; this is assessed on an annual basis to take into account the quantum of floor space anticipated to be delivered throughout the construction period.

The total number of intermodal movements is multiplied by the electricity consumption per RMG movement to calculate the total estimated annual electricity consumption for major site equipment uses; general site electricity uses are estimated based on the GIA of all occupied space; this is presented for each use in **Table 5.7.4**.

Table 5.7.4: Annual Electricity Consumption at Full Operation

Use	Annual Electricity Consumption [kWh/year]
B1 Uses	49,556
B2 Uses	572,428
B8 Uses[2]	18,838,933
Site Electricity Uses	44,021,482
Major Site Equipment Uses	223,656
TOTAL	63,706,056

Annual electricity consumption is then multiplied by the relevant electricity emission factor.

Table 5.7.5: GHG Emissions for Purchased Electricity during Operation

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019 – 2028)	38,808
Short-term Operation (2019 – 2038)	45,880
Long-term Operation (2039 – 2050)	29,044
Long-term Operation (2039 – 2088)	90,056
TOTAL (2019 – 2088)	142,842

5.7.4 Data Limitations & Uncertainty

SBEM predictions of annual energy use are affected by a number of input parameters relating to the building location (e.g. orientation) and fabric specification. These can have a significant impact on estimated energy demand and may not reflect the as-built design of the buildings.

The baseline for comparison is a 'policy compliant' solution; presently this is a building that meets the energy requirements of Part L 2013, illustrated through the SBEM data used above. The 'performance gap' between energy consumption and emissions predicted at design stage using this methodology, and observed performance in operation is well-

[2] 50% of total warehousing floorspace assumed 'additional' due to displacement effects

documented but due to a lack of data has not been taken into account in this assessment.

It is likely that over the lifetime of the buildings, plant and equipment will need replacing several times; at each replacement interval, plant is likely to be more efficient, further reducing energy demand. The predictions of consumption in the short- and long-term operational scenarios are therefore likely to over-estimate actual emissions.

The predictions of consumption in the short- and long-term operational scenarios are therefore likely to over-estimate actual emissions.

6. Scope 3 Emissions

General Description

6.1 Scope 3 emissions occur upstream and downstream of the Proposed Development site.

6.2 As summarised in **Section 2.13**, the following activities have been identified in relation to the existing site baseline of the Proposed Development site:

- Mobile Combustion (e.g. transportation of goods and waste)
- Process emissions (e.g. agrochemical production and use)

6.3 As summarised in **Section 2.15**, the following activities have been identified in relation to the construction of the Proposed Development:

- Mobile combustion (e.g. transportation of raw materials/ products/ waste, employee business travel, employee commuting)
- Process emissions (e.g. production of purchased materials, fuel and energy elated emissions)

6.4 As summarised in **Section 2. 17**, the following activities have been identified in relation to the operation of the Proposed Development:

- Mobile combustion (e.g. transportation of raw materials/ products/ waste, employee business travel, employee commuting, upstream and downstream transportation of freight)
- Process emissions (e.g. fuel and energy elated emissions)

Existing Site

6.5 Mobile Combustion: Transportation of goods & waste

6.5.1 Description of Process

Goods are transported to the Proposed Development site (upstream) to facilitate farming and other business activity that currently takes place.

Goods (including crops and cattle) and waste are transported from the site for onward sale, distribution or disposal.

It is our professional judgement that the emissions associated with the transportation of goods and waste to and from the site are small in the context of the Proposed Development; the evaluation of such emissions would be disproportionate to this assessment and they have been scoped out.

6.6 Process Emissions: Agrochemical production and use

6.6.1 Description of Process

Agrochemicals are widely used in farming and the production of crops and their production is an emissions intensive process.

6.6.2 Data Sources

The report *Estimation of the greenhouse gas emissions from agricultural pesticide manufacture and use,* (**Ref 16**) prepared for the Crop Protection Association, provides an estimate of standard pesticide energy input to arable crops per hectare. This applies a weighted average of pesticide production energies per unit mass of the different types of pesticide.

This results in an average for different crop types of 1364 MJ per hectare. The report advises that a factor of 0.069 $kgCO_2e$ per MJ pesticide should be applied, resulting in an average of 94$kgCO_2e$ per hectare of arable crop.

For crops such as wheat and barley, pesticide use accounts for circa 8.9% of overall emissions associated with farming, and fertiliser use accounts for circa 49.7%. Using this ratio, we estimate the emissions associated with pesticide use to be in the region of 523$kgCO_2e$ per hectare of arable crop.

It is assumed that fields will be in rotation and that 30% of the fields will not be in use in any given year.

6.6.3 Calculation Procedure & Estimated Emissions

The emissions factors noted above are applied to the area of cropland.

Table 6.6.1: GHG Emissions for Agrochemical Production and Use at the Existing Site

Temporal Range	Total GHG Emissions [tCO_2e]	Aggregated GHG Emissions [tCO_2e]
Current Baseline (2018)	1,602	-
Future Baseline (2019)	1,602	
Construction (2019 – 2028)	-	16,018
Short-term Operation (2029 – 2038)	-	16,018
Long-term Operation (2039 – 2050)	-	19,221
Long-term Operation (2039 – 2088)	-	80,089
TOTAL (2019 – 2088)	-	112,124

6.6.4 Data Limitations & Uncertainty

The data presented above is based on a report published in 2009; production processes, associated emission assumptions, and usage patterns may have changed in the intervening period; the results presented above are likely to over-estimate emissions.

The authors of the original report identified that there was inherent uncertainty in the calculation process and that emissions depend on the specific crop and time of year.

Emissions for fertilizer production are inferred from the report and are not based on an assessment of any underlying data; however, it is our professional opinion that this approach is proportional to the assessment.

Construction

6.7 Mobile Combustion: Transportation of materials

6.7.1 Description of Process

Construction materials are transported to the Proposed Development site from various suppliers of building materials.

6.7.2 Data Sources

Main SRFI Site

For certain materials, average distances and emissions associated with transportation to the construction site are included within the assessment of material process emissions within **Section 6.11**. This relates to the following materials:

- Cladding
- Reinforced Concrete
- Precast Concrete

As this data is included elsewhere, it is not duplicated here.

Transportation to the construction site is known as stage A4 of a full Life Cycle Assessment [LCA], and is identified as a separate stage for the following materials:

- Precast concrete kerbs (6.62E-03kgCO_2e/kg)
- Plasterboard (1.28E-02kgCO_2e/kg)
- Tarmac (asphalt) (6.87E-03kgCO_2e/kg)
- Aggregate (3.78E-03kgCO_2e/kg)

Further information on the LCA assessment process and its relevance to this assessment can also be found in **Section 6.11**.

Material quantities and anticipated vehicle movements are identified within the Construction Materials Assessment Report produced by RPS (**Appendix G**) along with the anticipated number of associated vehicle movements.

It is assumed that all remaining materials are transported by articulated lorry [A] the RPS report makes assumptions regarding the payload of each vehicle.

Only the vehicle movement assessed with delivering the material to site is considered here.

Steelwork is assumed to be supplied by British Steel, with steel sections sourced from either British Steel sites in Scunthorpe (216km) or Teesside (316km); an average of the two distances is applied.

It is assumed that M&E fittings are specialist items and are not manufactured locally; a distance of 200km is assumed.

All other items are assumed to be more readily available and within a 50km driving distance of the Proposed Development

Table 6.7.1: Estimates of material travel distances from site of manufacturer to the Proposed Development

Material	Average distance assumed [km]	Quantity [tonnes]	Total materials moved [tonne.km]
Steelwork	266	38,012	10,111,192
Pipes	50	6,223	311,150
Manholes	50	1,192	59,600
M&E Fittings/ Fittings	200	13,863	2,772,600
Fencing	50	2,019	100,950
Trees & Plants	50	3,170	158,500
Seeds	50	1,268	63,400
TOTAL	-	65,747	13,577,392

Junction 15a Works

A total of 110,208 tonnes of material (asphalt and aggregates) are estimated to be required to construct the Junction 15a Works; **Section**

6.11 outlines the data sources and process for quantifying materials and is not repeated here.

Other Minor Highway Works

A total of 14,426 tonnes of material (asphalt and aggregates) are estimated to be required to construct the other Minor Highway Works; **Section 6.11** outlines the data sources and process for quantifying materials and is not repeated here.

The timing of other Minor Highway Works will be dependent on build-out and demand; for the purpose of this assessment, it is assumed that they occur in the first phase of construction, although this has no bearing on the emissions projected.

Where data is obtained from an LCA, emissions are based on emissions factors in place at the time the LCA was produced; no adjustment has been made for this in this assessment.

Emission Factors

Where emissions are assessed based on the distance travelled by HGV, the 2018 BEIS Emission Factors for an average laden, average HGV are applied; no assumptions are made relating to the decarbonisation of fuels:

- Direct (Scope 1) = 0.1136 $kgCO_2e$/tonne.km
- Indirect (Scope 3) = 0.02704 $kgCO_2e$/tonne.km

For consistency with the LCA figures, both direct and upstream emissions are included; upstream emissions are therefore excluded from the assessment of FERA emissions in **Section 6.18**.

Material usage has been profiled throughout the construct period; a full breakdown of material tonnages and emissions by year can be found in **Table C.5** and **Table C.6** of **Appendix A** for the Main SRFI site.

The transportation of asphalt and aggregates are covered by LCA Stage A4 data and the quantity of each material is multiplied by the LCA A4 factor in **Table 6.7.2** to calculate GHG emissions associated with the transportation of these materials.

Table 6.7.2: LCA Data for Aggregates & Asphalt

Material	LCA A4 Emissions [kgCO2e/tonne]	Quantity J15a Works [tonnes]	Quantity Minor Highway Works [tonnes]
Asphalt	6.87	20,160	4,003
Aggregate	3.78	90,048	10,422

TOTAL	-	110,208	14,426

6.7.3 Calculation Procedure & Estimated Emissions

Where LCA Phase A4 data is available, this is multiplied by the tonnage of each material type.

For the movement of other materials, the total number of trips is multiplied by the estimated distance travelled and then multiplied by the emission factor for an average laden average HGV.

Table 6.7.3: GHG Emissions for the Transportation of Materials

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019-2028)	4,523

6.7.4 Data Limitations & Uncertainty

Data obtained from LCAs provides more accurate assumptions relating to the distances travelled as it is based on actual distances from manufacturing points to average customer locations. However, the emissions factors used are static and do not take into account the future decarbonisation of HGV transport, so are likely to produce an over-estimate of emissions.

Other distances travelled are estimates, with the exception of steel, which is considered to be an accurate reflection of the likely sourcing point for the material.

No estimation has been made relating to the decarbonisation of fuel supplies over the construction period, which could result in a circa 20% reduction in emissions reported.

6.8 Mobile Combustion: Transportation of waste

6.8.1 Description of Process

Waste generated during construction will be segregated for recycling and transported to a local waste handling facility.

6.8.2 Data Sources

Chapter 20 of this ES sets out the assumptions in relation to the quantity of waste anticipated as a result of the construction of the Proposed Development. It identifies the following potential waste sources as:

- Site clearance: Vegetation

- Excavation: Made ground, soil and subsoil
- Construction (Main SRFI Site): General construction waste
- Construction (All Other Highway Works): Carriageway planings, materials from existing structures and drainage and general construction waste

Site Clearance

Vegetation Waste

The quantity of vegetation waste is anticipated to be minimal and would be dealt with locally; this is not estimated in Chapter 20 and has been scoped out of this assessment.

Excavation Waste

The brief for the development is to retain all excavated material on site. There is a low probability that contaminated material that requires off-site treatment will be discovered, so it is therefore assumed that there are no vehicle movements associated with the transport of excavation waste.

Construction Waste (Main SRFI)

The vast majority of construction waste will be generated by the development of the main SRFI site, which for the purposes of the waste assessment includes the industrial units, maintenance depot and control buildings.

Using a benchmark of 12.6 tonnes/100m^2 GEA of development, a total of 88,464 tonnes of waste is anticipated in **Chapter 20**.

Chapter 20 identifies a range of suitable waste and recycling locations within 10km of the site; it is therefore assumed tha the distance traveleld is 10km per vehicle movement. This results in the movement 884,462 tonne.kms of waste.

BEIS Emission Factors for all HGVs, average laden are applied; this includes both direct and indirect emissions associated with fuel use.

6.8.3 Calculation Procedure & Estimated Emissions

The total tonnage of materials estimated using the benchmark data is profiled throughout the construction period and multiplied by the average distance to calculate the tonne.km moved. This is multiplied by the emission factors described above.

Table 6.8.1: GHG emissions for the of transportation of waste during construction

Temporal Range	GHG Emissions with

	Embedded Mitigation [tCO_2e]
Construction (2019-2028)	124

6.8.4 Data Limitations & Uncertainty

Waste estimates are based on benchmark average data, which given that most construction companies have processes in place to reduce waste, may not necessarily be reflective of current average practices.

6.9 Mobile Combustion: Employee Business travel

6.9.1 Description of Process

Employees of the various parties involved in the construction of the development will be required to travel for meetings and site visits during the construction of the Proposed Development.

It is assumed that business trips relating to the development are included within the trips generated and assessed under employee commuting in **Section 6.11**.

6.10 Mobile Combustion: Employee commuting

6.10.1 Description of Process

The construction of the Proposed Development will employ up to 482 FTEs at the peak of activity, who will travel to the site on a daily basis.

6.10.2 Data Sources

Vehicle Trips

The Construction Traffic Management Plan sets out the estimated number of cars and LGVs that will travel to site on a daily basis for each of the construction phases based on the number of FTEs/ day for different elements of the project; it is assumed that 90% of employee commuting will be by car or LGV.

Annual car and LGV trips are calculated by multiplying the number of cars and LGVs per day by the number of days of anticipated construction activity during each period and then doubled represent inbound and outbound trips.

Table 6.10.1: Car & LGV vehicle numbers

Phase	Days	FTE/day	Cars & LGV / day	Annual Car& LGV Trips
Phase 1 (Highways Works)	530	653	588	622,962

Phase 1 (Main SRFI Site)	245	401	361	176,841
Phase 2 (Main SRFI Site)	2,295	201	181	830,790

Vehicle Distances

An estimation of commuting distance travelled is made based on Census data looking at the Method of Travel to work for South Northamptonshire (**Ref 19**). This sets out that of the 94.5% of the population who travel by vehicle to work, 91.5% do so in single occupancy vehicles, with the remaining participating in some form of car share. Further, **Table 6.10.2** sets out the distances travelled via each mode.

Table 6.10.2: Distances Travelled to Work by Car and Van in South Northamptonshire

Distance Travelled to Work	Assumed Distance [km]	Driving car or van	Passenger in car or van
Less than 2km	1	8.45%	11.86%
2km to less than 5km	2.5	9.20%	12.87%
5km to less than 10km	7.5	22.36%	28.63%
10km to less than 20km	15	29.21%	26.92%
20km to less than 30km	25	13.07%	10.52%
30km to less than 40km	35	6.33%	4.38%
40km to less than 60km	50	4.95%	1.98%
60km and over	60	6.43%	2.83%

Based on this data, the average distance travelled to work in single occupancy vehicles is 18.19km, and 13.48km in car share vehicles.

In applying this data, it is assumed that there are two passengers per car share vehicle.

Table 6.10.3: Car & LGV vehicle numbers

Phase	Annual Car& LGV Trips	Annual Distance Single Occupancy [km]	Annual Distance Car Share [km]
Phase 1 (Highways Works)	622,962	10,371,849	355,380
Phase 1 (Main SRFI Site)	176,841	2,944,270	456,262
Phase 2 (Main SRFI Site)	830,790	13,832,029	473,939

TOTAL	-	27,148,147	930,200

Emission Factors

An emission profile has not been developed for LGVs and given the small proportion of trips estimated using LGVs, it is considered proportionate in this instance to apply the same emission factor as for cars.

The methodology applied to assess the annual average emissions of cars is described in **Section 6.16** and the emission factors developed in relation to employee commuting during the operational phases of the development are also applicable during the construction phase.

An emissions profile has not been developed for LGVs, and given the small proportion of trips estimated using LGVs, it is considered proportionate in this instance to apply the same emission factor as for cars.

6.10.3 Calculation Procedure & Estimated Emissions

The annual distance travelled is multiplied by the average vehicle emission factors calculated in **Section 6.16** for each construction year.

A full profile of assumed average annual emission factors taking into account the anticipated vehicle mix is provided in **Tables D.1 to D.4** of **Appendix D**; annual distances travelled by each mode are provided in **Tables A.5 to A.8** of **Appendix A**.

Table 6.10.4: GHG Emissions for Employee Commuting during Construction

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019-2028)	3,586

6.10.4 Data Limitations & Uncertainty

The application of average car emissions for LGVs is likely to under-estimate emissions associated with these vehicles. This is dues to the larger size of these vehicles and a potentially different decarbonisation trajectory.

Other limitations outlined in **Section 6.16** are also applicable here.

6.11 Process Emissions: Production of construction materials

6.11.1 Description of Process

The processes involved in the manufacture of construction materials and products will involve energy and emissions. These form the first phase of what is commonly referred to as 'life-cycle impacts', 'embodied energy' or 'embodied carbon'.

6.11.2 Data Sources

Main SRFI Site

Material quantities for the project were calculated by RPS based on an initial Illustrative Masterplan and assumptions regarding the build-up of buildings and roads (**Appendix G**). This was carried out for the purposes of assessing construction traffic impacts, but is equally relevant to the assessment of GHG impacts associated with the manufacture, transportation and end-of-life use of materials used in the construction of the Proposed Development.

The assessment breaks down the quantities of materials into the following categories:

- Estate Roads & Temporary Construction Access
- Bridges on A43 Road & to Northampton Road
- Buildings
- Landscaping
- Intermodal
- Express Freight Platform

The assessment excludes the rail track required to connect freight terminals to the wider rail network.

A summary of total material tonnages is provided in **Table 6.12.1**.

Assessments of embodied energy and GHG emissions are complex and are dependent on the manufacturer of each item procured and their specific processes.

In accordance with best-practice guidance published by the Royal Institute of Chartered Surveyors (**Ref 20**), the following hierarchy has been applied in obtaining data on the embodied GHG Emissions associated with the materials that will be used at Rail Central:

- Type III Environmental Declarations to EN 15804
- Type III Environmental Declarations to EN ISO 21930
- Type III Environmental Declarations to ISO 14067

- Type III Environmental Declarations to ISO 14025, ISO 14040 and ISO 14044
- Type III Environmental Declarations to PAS 2050
- Other published data.

Note that 'other published data' is in addition to the hierarchy identified by RICS, but given the stage in the project and the lack of detailed specification data at this stage, generic data has been utilised where data in accordance with the above standards is not available.

There are four distinct modules within a Life Cycle Assessment:

- A: Manufacturing to Installation
- B: In-use
- C: Demolition
- D: Reuse/ Recovery/ Recycling Potential

Not all assessments include the emissions associated with all phases, so this assessment includes the emissions associated with Phases A1-A3:

- A1: Raw material supply
- A2: Transport to factory
- A3: Manufacturing

Transport to site (A4) is accounted for in **Section 6.7** (unless otherwise stated). Based on data available for some profiles, emissions associated with the remaining A – C categories is negligible, and is accounted for in other emission categories (e.g. emissions associated with the installation of products are accounted for under Scope 1 and Scope 2 construction site emissions). Phase D emissions, where available are accounted for as part of the decommissioning phase impacts.

Cladding

Michael Sparks Architects have confirmed that the most likely cladding manufacturer for the warehouse buildings is CA Group; CA is part of Tata Steel, who have produced Environmental Performance Declarations for their range of wall and roof cladding products (**Ref 21**). A weighted-average of the emissions associated with their standard Twin-Therm roof and wall products has been calculated, assuming that the quantities profiled by RPS include 30% roof and 70% walls.

Plasterboard

An average of the emissions associated with two common plasterboard manufacturers (Knauf and Gyproc) has been assessed based on EPDs produced by each manufacturer (**Ref 22** & **Ref 23**).

Structural steel

Bauforumstahl, the independent steel promotional organisation in Germany has published an EPD (**Ref 24**) based on data collected from the biggest hot rolled steel sections and plates manufacturers in Europe. This 'European EPD' includes the most up to date embodied carbon data currently available for these products and is based on the Module D approach from BS EN 15804.

Rail track

Network Rail (**Ref 25**) state that 96% of rail steel in the UK is sourced from the British Rail plant in Scunthorpe, with the remainder sourced from elsewhere in Europe. British Steel do not provide any LCA data for their products, so data for generic hot-rolled steel set out in the Steel Construction Embodied Carbon(**Ref 26**) report has been applied.

The quantity of rail steel is currently not available and at this stage has not been included in our calculations.

In-situ concrete

The Concrete Centre (part of the UK Mineral Products Association) has been undertaking work assessing embodied emissions with its members for several years and have targets in place for their reduction. Although in 2017, a report titled Specifying Sustainable Concrete (**Ref 27**) was published setting out embodied emissions for the components of concrete (i.e. cementitious materials, aggregates and reinforcement) as well as a number of reinforced concrete mixes, there is no data regarding how these figures have been calculated.

Referring back to an earlier publication titled '*Embodied carbon dioxide (CO_2e) of concrete used in buildings'* (**Ref 28**), similar figures to those found in the 2017 document can be found, alongside a description of how they have been calculated.

This sets out that the scope of the data has been updated in accordance with PAS 2050 and ISO EN 15804 (Stages A1 – A4) and includes emissions associated with transport to site based on average industry data.

The following concrete grades have been assumed for the uses identified:

- GEN I: Blinding, mass fill, strip footings, mass foundations, trench foundationsC30: Pavements
- RC28/30: Reinforced foundations
- RC32/40: Structural: in situ floors, superstructure, walls, basements

- RC40/50: High-strength concrete

The breakdown of materials provided splits out in-situ concrete used in building construction (assumed to be 50% RC28/30 for foundations and 50% RC32/40 for floors); the drainage elements (assumed to be GEN I); intermodal and express freight platforms (assumed to be RC40/50); and roads (assumed to be RC40/50).

Data is provided for CEM I, a 30% fly ash substitution and a 50% GGBS substitution. Baseline embodied emissions are assumed to include CEM I without any cementitious material substitutions.

Although in-situ concrete and reinforcement have been accounted for separately in terms of material quantities, the emission factors for concrete in accordance with the assumptions above take into account the emissions associated with reinforcement for stages A1 – A4.

There is a significant opportunity to reduce emissions associated with the use of concrete on site through the specification of alternative cementitious materials (such as fly ash or GGBS) and/or the use of recycled aggregates. A requirement to identify opportunities to reduce embodied emissions is identified in the CEMP, and it is expected that the reduction of emissions associated with concrete will play a significant part in delivering further GHG reduction.

Precast concrete

Limited data has been obtained for precast concrete sections, and the reinforced precast concrete floor emissions of 171 kgCO2e/tonne stated in the MPA (**Ref 27**) document cited above have been applied.

Kerbs

The British Precast association has developed an EPD (**Ref 29**) for 1 tonne of UK manufactured generic precast concrete paving products (blocks, slabs, channels and kerbs).

Aggregates & Tarmac

Tarmac have developed EPDs for generic aggregates (**Ref 30**) and tarmac (**Ref 31**).

Other materials

Data for other materials has been obtained from the Inventory of Carbon and Energy, developed by the University of Bath (**Ref 32**). Until the introduction and mainstream use of EPDs, this was the main source for industry-wide cradle-gate emissions data for a wide variety of materials. This does not comply with any of the standards identified by RICs, but where data is otherwise unavailable, it is considered an appropriate source to use.

The quantities of M&E fittings and fencing have been identified, but we are not in a position to make any assumptions regarding likely materials for these items and they have therefore been excluded from the assessment.

Table 6.11.1: Material Quantities and Emission Factors

Material	Quantity [tonnes]	Emission Factor [$kgCO_2e$/tonne]
Steelwork	38,012	1735
Cladding[3]	8,423	2467
Precast concrete[4]	7,000	171
Concrete in-situ (GEN I)[2]	1,838	77
Concrete in-situ (RC28/30)[2]	272,983	133
Concrete in-situ (RC32/40)[2]	272,983	134
Concrete in-situ (RC40/50)[2]	95,359	154
Aggregates	636,470	7
Kerbs	3,046	131
Tarmac (asphalt)	94,870	70
Pipes[6]	6,223	2520
Manholes (ductile iron)	1,192	2030
Plasterboard	520	279
TOTAL	1,441,250	-

In addition, a total of 13,621 tonnes of M&E fittings, 1,859 tonnes of fencing and an unknown quantity of railtrack will be consumed. Data is not available to allow the assessment of these items.

A total of 6,948 tonnes of reinforcement is also anticipated, however this is assumed to be accounted for within reinforced concrete emissions.

A full breakdown of materials and life cycle impact data can be found in **Appendix C**.

There is significant opportunity to reduce LCA emissions through the specification of materials with lower embodied impacts. Specific

[3] Aggregated data and includes A4 Transportation to site and A5 Construction – Installation emissions.
[4] Aggregated data and includes A4 Transportation to site emissions.
[6] Assumed to be manufactured from HDPE.

opportunities identified include the use of concrete with an alternative to cement such as fly ash or ground granulated blast furnace slag (GGBS); as by-products of other industries, the emissions associated with their production are significantly lower.

Aggregates obtained from crushed materials found on site during the demolition phase, or the use of other recycled aggregates provides a further opportunity for reduction.

Other Minor Highway Works

In TPA produced a Technical Note in January 2018 describing the quantity (sqm) of physical Minor Highway Works (**Appendix H**). This relates to:

- Junction Four - A5076/ Upton Way
- Junction Six – A5076/ Hunsbury Hill
- Junction Seven – Towcester Road/ Tesco
- Junction Fourteen – Tove
- Junction Fifteen - Abthorpe
- Junction Nineteen – Upton Way/ Telford Way
- Junction Twenty – Upton Way/ High Street

The proposed works include:

- Carriageway resurfacing
- Carriageway construction
- Footway/island construction
- Earthworks/ Re-grade

It also includes site clearance work and other prelims, the installation of traffic signal equipment and the construction of verges; these are considered small components of the works and due to a lack of available information, have been scoped out of the assessment.

The resurfacing of existing carriageways is a benefit of the scheme and in all likelihood would have been required at some point as part of standard maintenance procedures. The SRFI will have the effect of reducing road transport, so on the whole, will marginally reduce the need for resurfacing across the wider road network. Emissions associated with the materials used have therefore been scoped out of the assessment.

The construction of new carriageways is considered additional, required to mitigate the local traffic impacts of the scheme. Emissions associated with the construction of new carriageways and footways have therefore been assessed, along with an assumption that they will require resurfacing after 25 years.

In terms of materials, carriageway construction is assumed to consist of:

- Surface course: 40mm asphalt
- Binder course: 60mm asphalt
- Base course: 250mm aggregate
- Sub-base course: 420mm aggregate

Similarly, assuming a light-vehicle footway/ cycleway with very occasional vehicle overrun (**Ref 33**):

- Surface course: 20mm asphalt
- Binder course: 50mm asphalt
- Sub-base: 225mm aggregate

Resurfacing associated with these roads is likely to be required after circa 25 years, however as stated above, road freight as a result of the Proposed Development is expected to reduce, so the impact across the network will be lower than existing traffic impacts. On this basis, emissions associated with resurfacing these roads are excluded.

Table 6.11.2: Material Quantities and Emission Factors

Material	Quantity [tonnes]	Emission Factor [tCO_2e/kg]
Aggregates	4,003	0.005
Tarmac (asphalt)	10,422	0.066
TOTAL	14,426	-

Junction 15a Works

No construction breakdown is currently available for the Junction 15a works, but an area of highways works totalling 8.4 hectares is identified on TPA drawing SK164.

Conservatively assuming that 100% of this area is the construction of carriageway to the same specification identified for the Minor Highways Works above, **Table 6.11.3** sets out the expected material quantities and emission factors.

Table 6.11.3: Material Quantities and Emission Factors

Material	Quantity [tonnes]	Emission Factor [tCO_2e/kg]
Aggregates	20,160	0.005
Tarmac (asphalt)	90,048	0.066
TOTAL	110,208	-

6.11.3 Calculation Procedure & Estimated Emissions

The LCA stage A1 – A3 emissions intensity for each material/ product type has been multiplied by the quantity of each material/ product.

Table 6.11.4: GHG Emissions for each Project Element

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Main SRFI Site	
Buildings	167,657
Infrastructure	30,755
J15A	
Infrastructure	2,015
Other Minor Highway Works	
Infrastructure	350

Table 6.11.5: GHG Emissions for the Production of Materials used in Construction

Temporal Range	GHG emissions with Embedded Mitigation [tCO_2e]
Construction (2019 – 2028)	200,778

6.11.4 Data Limitations & Uncertainty

The quality of the data sources identified in **Section 6.11.2** varies considerably, meaning that like-for-like comparisons cannot be made and there may be some under- or over-estimates of emissions.

Some data is several years old, and particularly where energy intensive processes are involved in the manufacture of products (e.g. steel and concrete), emissions will have reduced since the data was published as a result of decarbonisation of our energy supplies. This cannot be retrospectively calculated without a breakdown of fuel inputs, so is accepted as an over-estimate in the results.

Certain materials include additional life-cycle stages; where this is the case, this is stated and where possible, accounted for elsewhere (e.g. in the calculation of transport emissions to site).

6.12 Process Emissions: Fuel and energy related emissions (FERA)

6.12.1 Description of Process

FERA emissions relate are as a result of fuel and energy consumption that are unaccounted for elsewhere in this assessment.

Well-to-tank [WTT] account for the upstream Scope 3 emissions associated with extraction, refining and transportation of the raw fuel sources prior to combustion.

Transmission and distribution [T&D] account for emissions associated with grid losses (the energy loss that occurs in getting the electricity from the power plant to organisations that purchase it).

6.12.2 Data Sources

Activity data is the same as is calculated in **Section 4** and **Section 5** of this report, relating to 'Scope 1' and 'Scope 2' emissions. Whilst upstream and downstream emissions will be associated with other 'Scope 3' emissions, we consider the assessment of those emissions to be outside the assessment boundary and disproportionate to the assessment. The relevant activity data can be found in sections:

- 4.8 Stationary Combustion – Production of heat and electricity
- 4.9 Mobile Combustion – Fuel use in plant & equipment
- 5.6 Purchased Electricity – Buildings & infrastructure

For 4.8 and 4.9, no activity data is available and emissions data is calculated based on benchmark emissions per £100m turnover. We have therefore scoped out related FERA emissions.

Whilst these emissions will be affected by changing fuel patterns and grid decarbonisation, the impact on overall emissions will be minimal, so we do not consider it proportionate to this assessment to develop a longer-term profile of emission actors. Current BEIS Emission factors, set out in **Table 6.12.1** below, are therefore applied to all fuels consumed.

Table 6.12.1: FERA emission factors for fuels used in this assessment

Fuel	2018 Emission Factor [$kgCO_2e/kWh$]	Unit
Well-to-Tank		
Grid Electricity (generation)	0.04198	$kgCO_2e/kWh$
Grid Electricity (T&D)	0.00538	$kgCO_2e/kWh$
Transportation & Distribution		
Grid Electricity	0.02413	$kgCO_2e/kWh$

6.12.3 Calculation Procedure & Estimated Emissions

Annual fuel and electricity consumption identified in **Section 4** and **Section 5** is multiplied by the relevant WTT and T&D emission factors.

Table 6.12.2: GHG emissions from fuel and energy related uses during construction

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019-2028)	344

6.12.4 Data Limitations & Uncertainty

Efforts to reduce losses are likely to be made over time by power distributors, which will result in lower T&D emissions in the future.

The changing mix of fuels for gas and electricity distribution may have an impact on the WTT figures over the longer term.

Uncertainty associated with the activity data is outlined in **Section 4** and **Section 5.**

Operation

6.13 Mobile Combustion: Transportation of freight

6.13.1 Description of Process

Freight will be transported to (upstream of) and from (downstream of) the development, as a consequence of the operation of the rail freight terminal. In the counterfactual scenario, the same quantity of freight would be moved via alternative modes.

6.13.2 Data Sources

A separate assessment of freight emissions is presented in **Volume 3, Appendix 21.2** of this ES and should be referred to in relation to data sources for this section. A summary of the resultant emissions is reproduced in **Appendix E** of this document.

Only direct emissions associated with the transportation of freight are included in this section; upstream emissions associated with the production and transportation of fuels are assessed in **Section 6.18**.

6.13.3 Calculation Procedure & Estimated Emissions

As above, the separate technical Appendix should be referred to for a full assessment of freight emissions and their calculation. Emissions are presented here in summary:

Table 6.13.1: GHG Emissions for the transportation of freight

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019-2028)	-61,746
Short-term Operation (2029 – 2038)	-224,397
Long-term Operation (2039 – 2050)	-313,538
Long-term Operation (2039- 2088)	-1,227,994
TOTAL (2019 – 2088)	-1,514,137

6.13.4 Data Limitations & Uncertainty

Refer to **Volume 3, Appendix 21.2.**

6.14 Mobile Combustion: Transportation of waste

6.14.1 Description of Process

Waste will be generated by the businesses operating from the Proposed Development; this will be transported to local waste facilities.

6.14.2 Data Sources

Chapter 20 anticipates that during the operation of the Proposed Development, 3,380,340 litres (3,380m^3) of waste will be generated at the Main SRFI Site. Other wastes are considered likely to be small and have not been assessed.

Assuming that the majority of waste collected is general refuse, Environment Agency conversion factors (**Ref 34**) assume that 1m^3 = 1 tonne.

Chapter 20 identifies a range of suitable waste and recycling locations within 10km of the site; it is therefore assumed tha the distance traveleld is 10km per vehicle movement.

6.14.3 Calculation Procedure & Estimated Emissions

The waste load moved in tonne.km is calculated by multiplying the total tonnage of waste by the total distance travelled. BEIS Emission Factors for average articulated (>33t) HGV emission factors are applied to the total tonne.km moved to calculate annual emissions.

During the construction phase, operational waste is assumed to be proportional to the quantum of floorspace completed.

Table 6.14.1: Annual operational waste at full operation

Waste Type	Waste Tonnes per week [Tonnes]	Waste per annum [Tonnes]	Waste Moved per annum [tonne.km]
Operational	3,380	175,778	1,757,777

Annual waste moved is then multiplied by the appropriate annual emission factor for HGV transport.

Table 6.14.2 GHG emissions for the transportation of waste during operation

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019-2028)	755
Short-term Operation (2029 – 2038)	2,406
Long-term Operation (2039 – 2050)	2,780
Long-term Operation (2039- 2088)	11,585
TOTAL (2019 – 2088)	14,746

6.14.4 Data Limitations & Uncertainty

Waste quantities are estimated on benchmark data which may not reflect the actual waste generated in use; the types and quantities of waste generated will depend on the types of companies operating from the Proposed Development site and any policies in place for waste reduction.

6.15 Mobile Combustion: Employee business travel

6.15.1 Description of Process

Employees will travel to and from the Proposed Development for business purposes.

Business travel during the operation of the development has been scoped out of the assessment on the basis that estimations of such emissions are highly dependent on the businesses that will occupy the Proposed Development, none of which are currently known.

Assumptions regarding the total number of daily trips to and from the development are provided within the transport assessment; this is based on data from a number of sources, including similar developments elsewhere. It is therefore sensible to assume that some of these trips include travel for business purposes and this assessment, covered in further detail in **Section 6.17** adequately covers business travel.

6.16 Mobile Combustion: Employee commuting

6.16.1 Description of Process

A significant number of people will eventually be employed at the Proposed Development, all of whom will travel to and from the site on a regular basis.

6.16.2 Data Sources

The Transport Assessment produced by TPA and included within this ES, sets out the anticipated trip attraction as a result of the completed development (**Table 6.16.1**) and likely mode shares (**Table 6.16.2**).

Table 6.16.1: Summary of person trip attraction

Trips	Daily (24 hour)		
	Arr	Dep	Total
Total Person Trips	8,426	8,296	16,722

[Source: Transport Assessment Table 7.2]

This results in the generation of 0.025 trips per sqm GIA of total floorspace.

The Transport Assessment also provides a breakdown of modal share for these trips. Walking and cycling are likely to account for 4% of the total journeys, with travel by public transport accounting for a further 1.5%. As there are zero emissions associated with walking and cycling, and the proportion of travel by public transport is insignificant, this assessment only addresses the contribution of privately owned vehicles.

Table 6.16.2: Rail Central baseline mode shares

Method of Travel to Work	Rail Central (Baseline)
Total Vehicles	90.5%
(Single Occupancy Vehicles)	*(86.5%)*
(Car Share)	*(8.0%)*
Public Transport (incl. Taxi)	1.5%
Walking	3.0%
Cycling	1.0%

[Source: Transport Assessment Table 8.9]

Census data for South Northamptonshire (**Ref 19**) provides a breakdown of the distance travelled by each mode; the proportions travelled by

single occupancy vehicles and passengers for each distance range are shown below:

Table 6.16.3: Distances Travelled to Work by Car in South Northamptonshire

Distance travelled to work	Average Distance Assumed [km]	Total Trips	Driving car or van	Passenger in car or van
Less than 2km	1	4,828	2,410	222
2km to less than 5km	2.5	3,182	2,623	241
5km to less than 10km	7.5	7,478	6,376	536
10km to less than 20km	15	9,348	8,331	504
20km to less than 30km	25	4,159	3,727	197
30km to less than 40km	35	2,013	1,804	82
40km to less than 60km	50	1,536	1,413	37
60km and over	60	2,795	1,833	53

*[Source: Census 2011 DC7701EWla – Method of travel to work (2001 specification) by distance travelled to work (**Ref 19**)]*

Sub-national road transport fuel consumption statistics (**Ref 35**) set out the tonnes of oil equivalent of different fuel types used at local authority level in 2015 (the most recent year for which data is available) on different types of road; this indicates that in 2015, 53% of vehicle fuel was diesel and 47% was petrol; this data includes hybrid vehicles (petrol and diesel).

Element Energy was appointed by the Low Carbon Vehicle Partnership in 2014 to carry out analysis regarding in the short-term, how to comply with the Renewable Energy Directive; and in the longer-term, to develop a Fuels Roadmap for transport fuels to deliver carbon reductions to 2030. The final report (**Ref 36**) responded to a Department for Transport 'call for evidence on advanced fuels.

This analysis assessed the likely mix of vehicles on the road considering policies current at the time. It presented two scenarios for 2030, one assuming that 30% of new passenger cars would be electric vehicles (EV) and another assuming a higher uptake at 60%; the former presenting moderate uptake, and the latter considered what would be required to meet the targets set by the Carbon Plan. At the time, the 30% target appeared more likely, but it is now considered that the 60% the most likely scenario (this is explored further in **Section 6.16.4**).

Table 6.16.4: New Car/ Van EV Sale Scenarios

Emission Scenario	2015	2020	2030	2050
Moderate ambition	<1%	3%	30%	100%
CCC Targets	<1%	9%	60%	100%

Table 6.16.5: Projected Vehicle Stocks over Time (in thousands)

Vehicle Stock	2020	2025	2030	2050
Electric	300	1,500 – 2,500	4,000 – 8,000	20,000 – 25,000
Hydrogen	2	180 – 350	680 – 1,400	4,200 – 16,800
Liquid fuel	30,000	32,000	32,000	6,000 – 31,000

[Source: Transport Energy Infrastructure Roadmap to 2050]

Liquid fuels include gasoline, diesel, LPG and bio-propane; methane is assumed for use in non-passenger vehicles only so has been excluded from the table above.

The data presented in the report assumes that vehicle ownership will continue to rise, which does not align with current trends (see Section 6.17.4 for further discussion); however, this is assumed to be the case for the sake of assessing proportions of vehicles on the road and providing a conservative estimate of lower emission vehicles.

Assuming a scenario where there is high EV uptake and hydrogen and liquid fuels are deployed at the lower estimate levels, the proportion of each vehicle stock on the road over the periods identified is as follows:

Table 6.16.6: Proportion of each Vehicle Stock over time assuming High EV Deployment

Vehicle Stock	2020	2025	2030	2050
Electric	0.99%	7.21%	19.67%	71.02%
Hydrogen	0.01%	0.52%	1.67%	11.93%
Liquid fuel	99.00%	92.27%	78.66%	17.05%

This provides a low short-term estimate, as the 2020 figures have already been exceeded according to vehicle sales data from the Society of Motor Manufacturers and Traders [SMMT] (**Ref 37**); however, this is deemed to provide a reasonable breakdown of vehicle ownership over

the medium- to long-tern. Estimates of proportions for intervening periods are made using a linear interpolation of the figures above.

There is no estimate available for the average emissions associated with all vehicles in use, but historic average in use emissions data published by SMMT (**Ref 39**) can be compared with new car emissions and this indicates that from 2012 onwards, average emissions are circa 20% higher than the new car emissions each year. As the vast majority (circa 99%) of vehicles currently on the road are internal combustion engine [ICE], this difference is added to the estimate of emissions from new ICE vehicles up to 2030 to provide an estimate of average ICE emissions for all vehicles. This assumes then that all electric and hydrogen vehicles are new.

As there is no estimate available for the emissions associated with ICE vehicles post-2030, it is assumed that no further advancements are made to reduce emissions further after this point, and the average emissions associated with ICE vehicles begin to converge to the average new ICE emissions allowing for an 8 year replacement period.

Estimates of hydrogen emissions are based on data published by UKH2Mobility (**Ref 38**), a partnership between UK industry leaders and Government. Estimates are based on a hydrogen production mix roadmap for 2030 which is forecast to deliver 51% via water electrolysis, 47% by steam methane reforming and 2% using existing capacities.

Table 6.16.7: Estimate of Average in-use Emissions by Vehicle Type

Vehicle Fuel Type	Average Vehicle Emissions [gCO_2/km]			
	2020	2025	2030	*2050*
Internal Combustion Engine (new)	117	101	86	86
Internal Combustion Engine (average)	140	122	104	86
Hybrid Electric Vehicles	105	90	76	*76*
Plug-in Electric Vehicles	36	31	26	*26*
Hydrogen	55	45	35	*35*

As outlined in **Section 4.10**, freight is demand-based and the quantity of freight moved is not affected by the delivery of additional industrial units. On this basis, some of the journeys included in this assessment will displace journeys that would have otherwise been made elsewhere.

The socio-economic assessment assumes the following displacement of employment:

- 50% (local level/ South Northamptonshire)
- 25% (wider impact area)
- 10% (national level)

Apportioning average journey distances travelled to work by car in South Northamptonshire from **Table 6.16.3** to the expected trip generation figures for single occupancy and car share journeys, and then considering the displacement levels above, the additional trips generated as a result of the development are calculated and presented in **Table 6.16.8.**

Table 6.16.8 Additionality of Commuting Journeys in relation to Rail Central

Distance travelled to Work	Level	Additional Single Occupancy Trips	Additional Car Share Trips
Less than 2km	Local	611	79
2km to less than 5km	Local	665	86
5km to less than 10km	Local	1,617	192
10km to less than 20km	Local	2,113	180
20km to less than 30km	Wider	1,418	106
30km to less than 40km	Wider	686	44
40km to less than 60km	Wider	538	20
60km and over	National	837	34
TOTAL	-	8,485	740

Multiplying by average trip distances and dividing by the total calculated employment GIA of 666,992m^2 allows a ratio to be calculated that can be used to multiply by the quantity of development completed throughout the construction period. This results in 0.2738 km/m^2 GIA for single occupancy journeys and 0.0175 km/m^2 IA for car share trips.

6.16.3 Calculation Procedure & Estimated Emissions

Walking and cycling are assumed to have zero emissions and therefore require no further assessment.

An estimate of the annual distance travelled in single occupancy vehicles and by passengers has been made based on the total number of trips per sqm GEA that will be generated as a result of the Proposed Development, multiplied by the proportion of journeys carried out by each mode for each distance band, multiplied by the average distance for each band.

This is multiplied by the proportion of journeys that are attributable to the Proposed Development.

Table 6.16.9: Annual Distances Travelled at Full Operation

Journey Type	Distance Travelled [km]
Single occupancy vehicle	61,186,276
Multiple occupancy vehicle	1,950,872

The annual average in-use fuel mix calculated for each year using the data outlined in **Section 6.16.4** is applied to the total distance travelled.

Car share journeys are assumed to comprise of two passengers, 'halving' the emissions per journey.

This results in the following emissions directly associated with the Proposed Development:

Table 6.16.10: GHG Emissions from Employee Commuting during Operation

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019-2028)	33,532
Short-term Operation (2028 – 2038)	50,577
Long-term Operation (2039 – 2050)	46,524
Long-term Operation (2039- 2088)	178,615
TOTAL (2019 – 2088)	262,724

6.16.4 Data Limitations & Uncertainty

Data is reported in CO_2 and does not take into account other GHG emissions.

A number of assumptions have been made due to the limited data available regarding future vehicle fuel pathways. A discussion of the likely uncertainties is outlined below.

The fleet and fuel mix is likely to change over the period of operation for a number of key reasons: in the short-term, concerns over the emissions associated with diesel and their impact on air quality are likely to result in incentives for the replacement of those vehicles with cleaner alternatives (e.g. diesel vehicle scrappage schemes or higher taxes on diesel cars or fuel); and in the medium-term, ultra-low emission vehicle [ULEV] uptake is expected to increase significantly. In addition, the growth of the 'sharing economy' and the potential impacts of autonomous vehicles could change patterns of vehicle ownership and increase the portion of vehicle sharing.

Over the medium-term, EU targets in place for the emissions of new vehicles will also reduce the average CO_2 emission per km for petrol and diesel vehicles.

The Vehicle Fuel Roadmap was produced in 2015 and in the short space of time since this was commissioned, there have been significant shifts in the new vehicle market that are likely to have significant impacts on the forecast modal share.

By December 2017, alternative fuel vehicles reached 5.6% of the new car market share, an increase of 37% compared with the previous year. At the same time, sales of diesel vehicles were down 31.1%, petrol vehicles down 2.1% (**Ref 37**).

Bloomberg New Finance's *Electric Vehicle Outlook in 2017* (**Ref 40**) cites battery costs falling faster than expected and rising commitments from automakers as the reason for increasing their EV forecast in 2017 over their 2016 forecast. The report predicts that by 2040, 54% of new car sales and 33% of the global car fleet will be electric. EV sales to 2025 will remain relatively low, and inflection point in adoption between 2025 and 2030 will occur as EVs become economical on an unsubsidized total cost of ownership across mass-market vehicle classes.

Other forecasts predict widely different, but upward estimates:

- Exxon Mobil Corp. (**Ref 41**) raised its 2017 forecast for 2040 to 100 million EVs (from 64.8 million in 2016).
- BP (**Ref 42**) projects 100 million by 2035 (from 71.4 million in 2016).
- ING Economics Department (**Ref 43**) predict that all new cars sold in Europe will be electric by 2030.

The International Energy Agency [IEA] (**Ref 44**) predicts that in the next 10 to 20 years the electric car market will likely transition from early deployment to mass market adoption. Assessments of country targets, OEM announcements and scenarios on electric car deployment seem to confirm these positive signals; indicating that the electric car stock may range between 9 million and 20 million by 2020 and between 40 million and 70 million by 2025.

Given the significant uncertainty around the market share and market penetration of electric vehicles and other scenarios that could affect emissions, the estimate of emissions presented here is considered to be a conservative one.

6.17 Fugitive Emissions: Refrigerants

6.17.1 Description of Process

It is likely that some goods being transported will require refrigeration, both within vehicles and buildings. This could lead to the release of fugitive gases with high global warming potential.

It is assumed however that all refrigeration equipment will meet current European Standards, limiting the use of gases with the most significant potential for impact, and that refrigeration and air-conditioning equipment will be serviced to reduce the potential for leaks.

This has therefore been scoped out of the assessment.

6.18 Process Emissions: Fuel and energy related emissions [FERA]

6.18.1 Description of Process

FERA emissions relate are as a result of fuel and energy consumption that are unaccounted for elsewhere in this assessment.

Well-to-tank [WTT] account for the upstream Scope 3 emissions associated with extraction, refining and transportation of the raw fuel sources prior to combustion.

Transmission and distribution [T&D] account for emissions associated with grid losses (the energy loss that occurs in getting the electricity from the power plant to organisations that purchase it).

6.18.2 Data Sources

Activity data is the same as is calculated in Section 4 and Section 5 of this report, relating to ‘Scope 1’ and ‘Scope 2’ emissions. Whilst upstream and downstream emissions will be associated with other ‘Scope 3’ emissions, we consider the assessment of those emissions to be outside the assessment boundary and disproportionate to the assessment. The relevant activity data can be found in sections:

- 4.10 Stationary Combustion – Production of heat and electricity
- 4.11 Mobile Combustion – Fuel use in plant & equipment
- 5.7 Purchased Electricity – Buildings & infrastructure
- 6.14 Mobile Combustion – Transportation of freight

Profiled emission factors as set out in **Appendix B Table B.2** are applied to the consumption of gas, electricity and vehicle fuels.

6.18.3 Calculation Procedure & Estimated Emissions

Annual fuel and electricity consumption identified in **Section 4** and **Section 5** is multiplied by the relevant WTT and T&D emission factors.

Table 6.18.2: GHG Emissions from Fuel and Energy Related Activities during Operation

Temporal Range	GHG Emissions with Embedded Mitigation [tCO_2e]
Construction (2019-2028)	-7,924
Short-term Operation (2029 – 2038)	-2,372
Long-term Operation (2039 – 2050)	-41,836
Long-term Operation (2039- 2088)	-259,478
TOTAL (2019 – 2088)	-269,774

6.18.4 Data Limitations & Uncertainty

Efforts to reduce losses are likely to be made over time by power distributors, which will result in lower T&D emissions in the future.

The changing mix of fuels for gas and electricity distribution may have an impact on the WTT figures over the longer term.

Uncertainty associated with the activity data is outlined in Sections 4 and 5.

Appendix A: Profiled Emissions by Phase

Table A.1: Site Baseline Emissions (2018 – 2028)

Existing Site	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
4.5: Stationary Combustion - Production of heat											
Agricultural use of heating oil (l)	305	305	305	305	305	305	305	305	305	305	305
Annual GHG Emissions [tCO_2e]	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***
Aggregated GHG Emissions [tCO_2e]	***-***	***0.77***	***1.55***	***2.32***	***3.09***	***3.86***	***4.64***	***5.41***	***6.18***	***6.96***	***7.73***
4.6 Mobile Combustion - Plant & equipment											
Road fuel [l]	29,718	29,718	29,718	29,718	29,718	29,718	29,718	29,718	29,718	29,718	29,718
Red diesel [l]	279,212	279,212	279,212	279,212	279,212	279,212	279,212	279,212	279,212	279,212	279,212
Red diesel used by contractors [l]	22,834	22,834	22,834	22,834	22,834	22,834	22,834	22,834	22,834	22,834	22,834
LPG [kg]	5,249	5,249	5,249	5,249	5,249	5,249	5,249	5,249	5,249	5,249	5,249
Kerosene [l]	31,333	31,333	31,333	31,333	31,333	31,333	31,333	31,333	31,333	31,333	31,333
Annual GHG Emissions [tCO_2e]	***1,070***	***1,070***	***1,070***	***1,070***	***1,070***	***1,070***	***1,070***	***1,070***	***1,070***	***1,070***	***1,070***
Aggregated GHG Emissions [tCO_2e]	***1,070.18***	***1,070.18***	***2,140.36***	***3,210.53***	***4,280.71***	***5,350.89***	***6,421.07***	***7,491.25***	***8,561.42***	***9,631.60***	***10,701.78***
5.5 Purchased Electricity - Buildings & infrastructure											
Agricultural electricity consumption [kWh]	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301
Annual GHG Emissions [tCO_2e]	**63**	**60**	**56**	**53**	**45**	**44**	**46**	**43**	**35**	**37**	**33**
Aggregated GHG Emissions [tCO_2e]	**62.99**	**122.81**	**178.40**	**230.91**	**276.33**	**320.66**	**366.79**	**410.05**	**445.15**	**481.83**	**515.14**
Annual Scope 1 & 2 GHG Emissions [tCO_2e]	***1,128***	***1,131***	***1,127***	***1,123***	***1,116***	***1,115***	***1,117***	***1,114***	***1,106***	***1,108***	***1,104***
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	***-***	***1,131***	***2,257***	***3,381***	***4,497***	***5,612***	***6,730***	***7,844***	***8,950***	***10,057***	***11,162***
6.2 Process Emissions: Agrochemical production & use											
Pesticide production and use	244	244	244	244	244	244	244	244	244	244	244
Fertilizer production and use	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358
Annual GHG Emissions [tCO_2e]	**1,602**	**1,602**	**1,602**	**1,602**	**1,602**	**1,602**	**1,602**	**1,602**	**1,602**	**1,602**	**1,602**
Aggregated GHG Emissions [tCO_2e]	**1,602**	**1,602**	**3,204**	**4,805**	**6,407**	**8,009**	**9,611**	**11,212**	**12,814**	**14,416**	**16,018**
6.3 Fuel and energy related emissions (FERA)											
5.5 Electricity [kWh]	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301
Annual GHG Emissions [tCO_2e]	***21***	***21***	***21***	***21***	***21***	***21***	***21***	***21***	***21***	***21***	***21***
Aggregated GHG Emissions [tCO_2e]	-	***21***	***43***	***64***	***86***	***107***	***128***	***150***	***171***	***193***	***214***
Annual Scope 3 GHG Emissions [tCO_2e]	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***
Aggregated Scope 3 GHG Emissions [tCO_2e]		***1,623***	***3,246***	***4,870***	***6,493***	***8,116***	***9,739***	***11,362***	***12,986***	***14,609***	***16,232***
Annual Baseline GHG Emissions [tCO_2e]	**2,754**	**2,754**	**2,750**	**2,747**	**2,740**	**2,738**	**2,740**	**2,737**	**2,729**	**2,731**	**2,727**
Aggregated Baseline GHG Emissions [tCO_2e]	**-**	**2,754**	**5,504**	**8,250**	**10,990**	**13,728**	**16,469**	**19,206**	**21,935**	**24,666**	**27,394**

Table A.2: Site Baseline Emissions (2029 – 2038)

Existing Site	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
4.5: Stationary Combustion - Production of heat										
Agricultural use of heating oil (l)	305	305	305	305	305	305	305	305	305	305
Annual GHG Emissions [tCO_2e]	1	1	1	1	1	1	1	1	1	1
Aggregated GHG Emissions [tCO_2e]	**0.77**	**1.55**	**2.32**	**3.09**	**3.86**	**4.64**	**5.41**	**6.18**	**6.96**	**7.73**
4.6 Mobile Combustion - Plant & equipment										
Road fuel [l]	29,718	29,718	29,718	29,718	29,718	29,718	29,718	29,718	29,718	29,718
Red diesel [l]	279,212	279,212	279,212	279,212	279,212	279,212	279,212	279,212	279,212	279,212
Red diesel used by contractors [l]	22,834	22,834	22,834	22,834	22,834	22,834	22,834	22,834	22,834	22,834
LPG [kg]	5,249	5,249	5,249	5,249	5,249	5,249	5,249	5,249	5,249	5,249
Kerosene [l]	31,333	31,333	31,333	31,333	31,333	31,333	31,333	31,333	31,333	31,333
Annual GHG Emissions [tCO_2e]	**1,070**	**1,070**	**1,070**	**1,070**	**1,070**	**1,070**	**1,070**	**1,070**	**1,070**	**1,070**
Aggregated GHG Emissions [tCO_2e]	**1,070.18**	**2,140.36**	**3,210.53**	**4,280.71**	**5,350.89**	**6,421.07**	**7,491.25**	**8,561.42**	**9,631.60**	**10,701.78**
5.5 Purchased Electricity - Buildings & infrastructure										
Agricultural electricity consumption [kWh]	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301
Annual GHG Emissions [tCO2e]	***30***	***32***	***29***	***24***	***23***	***20***	***17***	***17***	***15***	***14***
Aggregated GHG Emissions [tCO2e]	***29.52***	***61.55***	***90.90***	***114.76***	***137.65***	***158.09***	***174.98***	***191.71***	***207.11***	***221.31***
Annual Scope 1 & 2 GHG Emissions [tCO_2e]	***1,100***	***1,103***	***1,100***	***1,095***	***1,094***	***1,091***	***1,088***	***1,088***	***1,086***	***1,085***
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	***1,100***	***2,203***	***3,304***	***4,399***	***5,492***	***6,584***	***7,672***	***8,759***	***9,846***	***10,931***
6.2 Process Emissions: Agrochemical production & use										
Pesticide production and use	244	244	244	244	244	244	244	244	244	244
Fertilizer production and use	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358	1,358
Annual GHG Emissions [tCO_2e]	***1,602***	***1,602***	***1,602***	***1,602***	***1,602***	***1,602***	***1,602***	***1,602***	***1,602***	***1,602***
Aggregated GHG Emissions [tCO_2e]	***1,602***	***3,204***	***4,805***	***6,407***	***8,009***	***9,611***	***11,212***	***12,814***	***14,416***	***16,018***
6.3 Fuel and energy related emissions (FERA)										
5.5 Electricity [kWh]	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301	307,301
Annual GHG Emissions [tCO_2e]	***21***	***21***	***21***	***21***	***21***	***21***	***21***	***21***	***21***	***21***
Aggregated GHG Emissions [tCO_2e]	***21***	***43***	***64***	***86***	***107***	***128***	***150***	***171***	***193***	***214***
Annual Scope 3 GHG Emissions [tCO_2e]	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***	***1,623***
Aggregated Scope 3 GHG Emissions [tCO_2e]	***1,623***	***3,246***	***4,870***	***6,493***	***8,116***	***9,739***	***11,362***	***12,986***	***14,609***	***16,232***
Annual Baseline GHG Emissions [tCO_2e]	**2,724**	**2,726**	**2,723**	**2,718**	**2,717**	**2,715**	**2,711**	**2,711**	**2,710**	**2,708**
Aggregated Baseline GHG Emissions [tCO_2e]	**2,724**	**5,450**	**8,173**	**10,891**	**13,608**	**16,323**	**19,034**	**21,745**	**24,454**	**27,163**

Table A.3: Construction Phase Emissions (2019 – 2028) with Embedded Mitigation

Rail Central	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Construction Spend (£m)	**6**	**6**	**70**	**44**	**44**	**44**	**44**	**44**	**44**	**44**
Construction Area [sqm GEA buildings)	**0**	**0**	**129,790**	**81,758**	**81,758**	**81,758**	**81,758**	**81,758**	**81,758**	**81,758**
Construction Area [sqm GIA buildings]	**0**	**0**	**123,301**	**77,670**	**77,670**	**77,670**	**77,670**	**77,670**	**77,670**	**77,670**
4.9 Mobile combustion - Fuel use in mobile plant & equipment										
GHG Emissions per £100m turnover [tCO_2e/£m]	28.462	28.462	28.462	28.462	28.462	28.462	28.462	28.462	28.462	28.462
Annual GHG Emissions [tCO_2e]	***161***	***161***	***1,984***	***1,250***	***1,250***	***1,250***	***1,250***	***1,250***	***1,250***	***1,250***
Aggregated GHG Emissions [tCO_2e]	***161***	***322***	***2,306***	***3,555***	***4,805***	***6,054***	***7,304***	***8,553***	***9,803***	***11,052***
5.7 Purchased Electricity: Buildings & infrastructure										
Site Electricity Emissions [kWh]	71,819	71,819	885,094	557,544	557,544	557,544	557,544	557,544	557,544	557,544
Annual GHG Emissions [tCO_2e]	***14***	***13***	***151***	***82***	***80***	***84***	***78***	***64***	***67***	***60***
Aggregated GHG Emissions [tCO_2e]	***14***	***27***	***178***	***261***	***694***	***14***	***27***	***178***	***261***	***694***
Scope 1 & 2 Annual GHG Emissions [tCO_2e]	***175***	***174***	***2,135***	***1,332***	***1,310***	***175***	***174***	***2,135***	***1,332***	***1,310***
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	***175***	***349***	***2,484***	***3,816***	***11,746***	***175***	***349***	***2,484***	***3,816***	***11,746***
6.8 Mobile combustion: Transportation of materials										
Non-LCA materials moved by articulated truck [HGV-km]	361,902	361,902	2,280,529	1,477,594	1,477,594	1,477,594	1,477,594	1,477,594	1,592,544	1,592,544
LCA A4 Emissions [tCO_2e]	475	250	369	265	265	274	274	267	276	265
Annual GHG Emissions [tCO_2e]	***516***	***291***	***628***	***433***	***433***	***442***	***442***	***435***	***457***	***446***
Aggregated GHG Emissions [tCO_2e]	***516***	***807***	***1,435***	***1,868***	***2,301***	***2,743***	***3,185***	***3,620***	***4,077***	***4,523***
6.9 Mobile combustion: Transportation of waste										
Construction waste generated (tonnes)	10,302	10,302	10,302	10,302	10,302	10,302	10,302	10,302	10,302	10,302
Waste moved [tonne.km]	0	0	163,535	103,015	103,015	103,015	103,015	103,015	103,015	103,015
Annual GHG Emissions [tCO_2e]	***0***	***0***	***23***	***14***	***14***	***14***	***14***	***14***	***14***	***14***
Aggregated GHG Emissions [tCO_2e]	***0***	***0***	***23***	***37***	***52***	***66***	***81***	***95***	***110***	***124***
6.17 Mobile combustion: Employee commuting										
Single occupancy vehicles: Distance travelled [km]	5,185,924	5,185,924	2,944,270	1,976,004	1,976,004	1,976,004	1,976,004	1,976,004	1,976,004	1,976,004
Shared vehicles: Distance travelled [passenger km]	177,690	177,690	100,882	67,706	67,706	67,706	67,706	67,706	67,706	67,706
Annual GHG Emissions [tCO_2e]	***749***	***749***	***414***	***268***	***259***	***249***	***240***	***229***	***219***	***209***
Aggregated GHG Emissions [tCO_2e]	***749***	***1,499***	***1,913***	***2,181***	***2,440***	***2,689***	***2,929***	***3,158***	***3,377***	***3,586***
6.12 Process emissions - Production of construction materials										
Main SRFI Quantity of materials used in buildings [tonnes]	*0*	*0*	*192,474*	*138,523*	*138,523*	*138,523*	*138,523*	*138,523*	*138,523*	*138,523*
Main SRFI Quantity of materials used in infrastructure [tonnes]	*139,559*	*139,559*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Main SRFI Total quantity of materials [tonnes]	139,559	139,559	192,474	138,523	138,523	138,523	138,523	138,523	138,523	138,523
J15a Quantity of materials used in infrastructure [tonnes]	55,104	55,104	0	0	0	0	0	0	0	0
Other Highway Works Quantity of materials used in infrastructure [tonnes]	7,213	7,213	0	0	0	0	0	0	0	0
Total Quantity of Materials [tonnes]	341,434	341,434	384,948	277,045	277,045	277,045	277,045	277,045	277,045	277,045
Annual GHG Emissions [tCO_2e]	***16,561***	***16,561***	***29,190***	***19,781***	***19,781***	***19,781***	***19,781***	***19,781***	***19,781***	***19,781***
Aggregated GHG Emissions [tCO_2e]	***16,561***	***33,121***	***62,311***	***82,092***	***101,873***	***121,654***	***141,435***	***161,216***	***180,997***	***200,778***
6.19 Process Emissions: Fuel & energy related activity										
5.6 Related [kWh]	71,819	71,819	885,094	557,544	557,544	557,544	557,544	557,544	557,544	557,544
Annual GHG Emissions [tCO_2e]	***5***	***5***	***62***	***39***	***39***	***39***	***39***	***39***	***39***	***39***
Aggregated GHG Emissions [tCO_2e]	***5***	***10***	***72***	***111***	***149***	***188***	***227***	***266***	***305***	***344***
Scope 3 Annual GHG Emissions [tCO_2e]	***17,831***	***17,606***	***30,317***	***20,536***	***20,526***	***20,525***	***20,516***	***20,498***	***20,510***	***20,489***
Aggregated Scope 3 GHG Emissions [tCO2e]	***17,831***	***35,437***	***65,753***	***86,289***	***106,816***	***127,341***	***147,857***	***168,356***	***188,866***	***209,355***
Total Annual GHG Emissions [tCO_2e]	***18,006***	***17,780***	***32,451***	***21,868***	***21,856***	***21,859***	***21,844***	***21,812***	***21,826***	***21,799***
Aggregated GHG Emissions [tCO_2e]	***18,006***	***35,786***	***68,237***	***90,105***	***111,961***	***133,820***	***155,664***	***177,476***	***199,302***	***221,101***

Table A.4: Construction Phase Operational Emissions (2019 – 2028) with Embedded Mitigation

Rail Central	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
B8 area completed in year [sqm GIA]			**129,790**	**79,995**	**79,995**	**79,995**	**79,995**	**79,995**	**79,995**	**79,995**
Aggregated completed B8 area [sqm GIA]			**129,790**	**209,785**	**289,780**	**369,775**	**449,770**	**529,765**	**609,760**	**689,755**
B1 area completed in year [sqm GIA]			**0**	**127**	**127**	**127**	**127**	**127**	**127**	**127**
Aggregated B1 area [sqm GIA]			**0**	**127**	**255**	**382**	**510**	**637**	**765**	**892**
B2 area complete in year [sqm GIA]			**0**	**1,636**	**1,636**	**1,636**	**1,636**	**1,636**	**1,636**	**1,636**
Aggregated B2 area [sqm GIA]			**0**	**1,636**	**3,271**	**4,907**	**6,543**	**8,179**	**9,814**	**11,450**
Annual operating days			**335**	**335**	**335**	**335**	**335**	**335**	**335**	**335**
4.10 Stationary combustion: Production of heat and electricity										
B1 Building Gas Consumption (Part L Compliant) [kWh]			0	2,839	5,678	8,517	11,355	14,194	17,033	19,872
B2 Building Gas Consumption (Part L Compliant) [kWh]			0	36,048	72,095	108,143	144,191	180,239	216,286	252,334
B8 Building Gas Consumption (Part L Compliant) [kWh]			718,801	1,161,829	1,604,856	2,047,883	2,490,910	2,933,938	3,376,965	3,819,992
Total Gas Consumption [kWh]			***718,801***	***1,200,715***	***1,682,629***	***2,164,543***	***2,646,457***	***3,128,370***	***3,610,284***	***4,092,198***
Annual GHG Emissions [tCO2e]			***131***	***217***	***304***	***390***	***475***	***560***	***644***	***727***
Aggregated GHG Emissions [tCO2e]			***131***	***348***	***652***	***1,041***	***1,516***	***2,076***	***2,719***	***3,447***
5.7 Purchased Electricity: Buildings & infrastructure										
B1 Building Electricity Consumption (Part L Compliant) [kWh]			0	7,079	14,159	21,238	28,318	35,397	42,477	49,556
B2 Building Electricity Consumption (Part L Compliant) [kWh]			0	81,775	163,551	245,326	327,102	408,877	490,653	572,428
B8 Building Electricity Consumption (Part L Compliant) [kWh]			3,544,889	5,729,753	7,914,616	10,099,480	12,284,343	14,469,207	16,654,070	18,838,933
Site Electricity Consumption [kWh]			8,137,833	13,264,069	18,390,304	23,516,540	28,642,775	33,769,011	38,895,246	44,021,482
Major Site Equipment Electricity Consumption [kWh]			42,085	68,024	93,962	119,901	145,840	171,779	197,717	223,656
Total Electricity Consumption [kWh]			11,724,807	19,150,700	26,576,593	34,002,485	41,428,378	48,854,270	56,280,163	63,706,056
Annual GHG Emissions [tCO2e]			***2,003***	***2,831***	***3,834***	***5,104***	***5,833***	***5,580***	***6,718***	***6,905***
Aggregated GHG Emissions [tCO2e]			***2,003***	***4,834***	***8,668***	***13,772***	***19,605***	***25,185***	***31,903***	***38,808***
Scope 1 & 2 Annual GHG Emissions [tCO2e]			***2,134***	***3,048***	***4,138***	***5,493***	***6,308***	***6,140***	***7,362***	***7,632***
Aggregated Scope 1 & 2 GHG Emissions [tCO2e]			***2,134***	***5,182***	***9,320***	***14,813***	***21,121***	***27,261***	***34,622***	***42,254***
Road HGV distance [000 tonne.km]			-109,388,421	-176,809,075	-244,229,729	-311,650,383	-379,071,037	-446,491,692	-513,912,346	-581,333,000
Rail freight [000 tonne.km]			150,984,709	71,035,725	125,210,264	206,472,072	314,821,150	450,257,497	612,781,114	802,392,000
HGV GHG Emissions [tCO2e]			-8,584	-13,601	-18,432	-23,091	-27,595	-31,956	-36,187	-40,301
Rail GHG Emissions [tCO2e]			4,802	2,209	3,817	6,184	9,211	12,743	16,996	21,598
Annual GHG Emissions [tCO2e]			***-3,782***	***-11,392***	***-14,615***	***-16,907***	***-18,384***	***-19,213***	***-19,191***	***-18,703***
Aggregated GHG Emissions [tCO2e]			***-3,782***	***-15,174***	***-29,789***	***-46,697***	***-65,080***	***-84,294***	***-103,485***	***-122,188***
Waste generation [m^3or tonnes]			33,076	53,462	73,848	94,234	114,620	135,006	155,392	175,778
Goods moved [tonne.km]			330,758	534,618	738,478	942,337	1,146,197	1,350,057	1,553,917	1,757,777
Annual GHG Emissions [tCO_2e]			***32***	***51***	***69***	***87***	***104***	***121***	***137***	***153***
Aggregated GHG Emissions [tCO_2e]			***32***	***84***	***153***	***240***	***344***	***465***	***602***	***755***
6.17 Mobile combustion: Employee commuting										
Single occupancy vehicles: Distance travelled [km]			11,310,735	18,282,013	25,328,675	32,416,956	39,546,857	46,718,377	53,931,517	61,186,276
Shared vehicles: Distance travelled [passenger km]			360,633	582,906	807,583	1,033,587	1,260,918	1,489,576	1,719,560	1,950,872
Annual GHG Emissions [tCO2e]			***1,564***	***2,439***	***3,258***	***4,017***	***4,715***	***5,324***	***5,868***	***6,348***
Aggregated GHG Emissions [tCO2e]			***1,564***	***4,003***	***7,261***	***11,278***	***15,993***	***21,317***	***27,184***	***33,532***
6.19 Process Emissions: Fuel & energy related activity										
4.10 Related [kWh]			718,801	1,200,715	1,682,629	2,164,543	2,646,457	3,128,370	3,610,284	4,092,198
5.7 Related [kWh]			11,724,807	19,150,700	26,576,593	34,002,485	41,428,378	48,854,270	56,280,163	63,706,056
6.14 Road freight [000 tonne.km]	0	0	-109,388,421	-176,809,075	-244,229,729	-311,650,383	-379,071,037	-446,491,692	-513,912,346	-581,333,000
6.14 Rail freight [000 tonne.km]	0	0	150,984,709	71,035,725	125,210,264	206,472,072	314,821,150	450,257,497	612,781,114	802,392,000
Annual GHG Emissions [tCO_2e]	***0***	***0***	***19***	***31***	***44***	***56***	***69***	***82***	***94***	***107***
Aggregated GHG Emissions [tCO_2e]	***0***	***0***	***817***	***1,335***	***1,852***	***2,370***	***2,887***	***3,405***	***3,922***	***4,440***
Scope 3 Annual GHG Emissions [tCO_2e]	***0***	***0***	***-2,096***	***-3,339***	***-4,549***	***-5,729***	***-6,883***	***-8,015***	***-9,127***	***-10,223***
Aggregated Scope 3 GHG Emissions [tCO_2e]	***0***	***0***	***1,159***	***543***	***953***	***1,564***	***2,373***	***3,378***	***4,576***	***5,964***
Total Annual GHG Emissions [tCO_2e]	***0***	***0***	***-101***	***-1,430***	***-1,700***	***-1,740***	***-1,554***	***-1,151***	***-535***	***287***
Total Aggregated GHG Emissions [tCO_2e]	***0***	***0***	***-101***	***-1,532***	***-3,232***	***-4,972***	***-6,526***	***-7,677***	***-8,212***	***-7,924***

Table A.5: Long-term Operational Emissions (2029 – 2050) with Embedded Mitigation

Rail Central	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
B1 area [sqm]	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847
B2 area [sqm]	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878
B8 area [sqm]	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267
Annual operating days	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335
4.10 Stationary combustion: Production of heat and electricity																						
B1 Building Gas Consumption (Part L Compliant) [kWh]	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872
B2 Building Gas Consumption (Part L Compliant) [kWh]	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334
B8 Building Gas Consumption (Part L Compliant) [kWh]	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992
Total Fuel Consumption [kWh]	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***
Annual GHG Emissions [tCO_2e]	***725***	***723***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***
Aggregated GHG Emissions [tCO_2e]	***725***	***1,448***	***2,095***	***2,743***	***3,390***	***4,038***	***4,685***	***5,333***	***5,980***	***6,627***	***647***	***1,295***	***1,942***	***2,590***	***3,237***	***3,885***	***4,532***	***5,180***	***5,827***	***6,475***	***7,122***	***7,770***
5.7 Purchased Electricity: Buildings & infrastructure																						
B1 Building Electricity Consumption (Part L Compliant) [kWh]	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556
B2 Building Electricity Consumption (Part L Compliant) [kWh]	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428
B8 Building Electricity Consumption (Part L Compliant) [kWh]	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933
Site Electricity Consumption [kWh]	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482
Major Site Equipment Electricity Consumption [kWh]	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656
Total Electricity Consumption [kWh]	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***
Annual GHG Emissions [tCO_2e]	***6,120***	***6,641***	***6,084***	***4,948***	***4,744***	***4,238***	***3,501***	***3,470***	***3,191***	***2,945***	***3,073***	***3,117***	***2,965***	***2,814***	***2,663***	***2,512***	***2,361***	***2,210***	***2,059***	***1,908***	***1,757***	***1,606***
Aggregated GHG Emissions [tCO_2e]	***6,120***	***12,760***	***18,844***	***23,791***	***28,536***	***32,774***	***36,274***	***39,744***	***42,935***	***45,880***	***3,073***	***6,189***	***9,155***	***11,969***	***14,632***	***17,145***	***19,506***	***21,716***	***23,774***	***25,682***	***27,439***	***29,044***
Scope 1 & 2 Annual GHG Emissions [tCO_2e]	***6,845***	***7,363***	***6,731***	***5,595***	***5,392***	***4,885***	***4,148***	***4,117***	***3,839***	***3,593***	***3,720***	***3,764***	***3,613***	***3,462***	***3,311***	***3,160***	***3,009***	***2,857***	***2,706***	***2,555***	***2,404***	***2,253***
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	***6,845***	***14,208***	***20,939***	***26,534***	***31,926***	***36,811***	***40,959***	***45,076***	***48,915***	***52,508***	***3,720***	***7,484***	***11,097***	***14,559***	***17,870***	***21,029***	***24,038***	***26,895***	***29,602***	***32,157***	***34,561***	***36,814***
6.14 Mobile combustion: Transportation of freight																						
Road HGV distance [thousand tonne.km]	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000
Rail freight [thousand tonne.km]	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000
HGV GHG Emissions [tCO_2e]	-39,702	-39,136	-39,082	-39,017	-38,634	-38,230	-37,784	-37,293	-36,758	-36,178	-35,552	-34,879	-34,158	-33,388	-32,570	-31,702	-30,783	-29,813	-28,792	-27,718	-26,591	-25,434
Rail GHG Emissions [tCO_2e]	20,890	20,483	19,258	17,788	16,579	15,224	13,717	12,509	11,161	9,809	8,674	7,493	6,904	6,310	5,710	5,105	4,496	3,881	3,261	2,635	2,005	1,369
Annual GHG Emissions [tCO_2e]	***-18,812***	***-18,653***	***-19,824***	***-21,229***	***-22,055***	***-23,006***	***-24,066***	***-24,784***	***-25,598***	***-26,370***	***-26,878***	***-27,386***	***-27,254***	***-27,079***	***-26,860***	***-26,596***	***-26,288***	***-25,933***	***-25,531***	***-25,083***	***-24,587***	***-24,065***
Aggregated GHG Emissions [tCO_2e]	***-18,812***	***-37,465***	***-57,289***	***-78,518***	***-100,573***	***-123,579***	***-147,645***	***-172,430***	***-198,027***	***-224,397***	***-26,878***	***-54,263***	***-81,517***	***-108,596***	***-135,456***	***-162,052***	***-188,340***	***-214,273***	***-239,804***	***-264,887***	***-289,474***	***-313,538***
6.15 Mobile combustion: Transportation of waste																						
Waste generation [tonnes]	175,778	173,418	173,418	173,418	173,418	173,418	173,418	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747
Waste moved [tonne.km]	1,757,777	1,734,180	1,734,180	1,734,180	1,734,180	1,734,180	1,734,180	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471
Annual GHG Emissions [tCO_2e]	***247***	***244***	***244***	***244***	***244***	***244***	***244***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***
Aggregated GHG Emissions [tCO_2e]	***247***	***491***	***735***	***979***	***1,223***	***1,467***	***1,711***	***1,942***	***2,174***	***2,406***	***232***	***463***	***695***	***927***	***1,159***	***1,390***	***1,622***	***1,854***	***2,085***	***2,317***	***2,549***	***2,780***
6.17 Mobile combustion: Employee commuting																						
Single occupancy vehicles: Distance travelled [km]	61,185,246	60,109,685	60,109,685	60,109,685	60,109,685	60,109,685	60,109,685	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246
Shared vehicles: Distance travelled [passenger km]	1,950,839	1,916,546	1,916,546	1,916,546	1,916,546	1,916,546	1,916,546	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839
Annual GHG Emissions [tCO_2e]	***6,139***	***5,647***	***5,436***	***5,235***	***5,043***	***4,860***	***4,685***	***4,671***	***4,508***	***4,353***	***4,280***	***4,207***	***4,133***	***4,060***	***3,987***	***3,913***	***3,840***	***3,767***	***3,694***	***3,620***	***3,547***	***3,476***
Aggregated GHG Emissions [tCO_2e]	***6,139***	***11,786***	***17,222***	***22,457***	***27,500***	***32,360***	***37,045***	***41,716***	***46,224***	***50,577***	***4,280***	***8,486***	***12,620***	***16,680***	***20,666***	***24,580***	***28,420***	***32,187***	***35,881***	***39,501***	***43,048***	***46,524***
6.19 Process Emissions: Fuel & energy related activity																						
4.10 Related [kWh]	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198
5.7 Related [kWh]	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056
6.14 Road HGV distance [thousand tonne.km]	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000	- 581,333,000
6.14 Rail freight [thousand tonne.km]	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000
Annual GHG Emissions [tCO_2e]	***352***	***408***	***308***	***167***	***-21***	***-228***	***-453***	***-698***	***-962***	***-1,245***	***-1,546***	***-1,866***	***-2,171***	***-2,494***	***-2,835***	***-3,195***	***-3,573***	***-3,969***	***-4,382***	***-4,814***	***-5,264***	***-5,727***
Aggregated GHG Emissions [tCO_2e]	***352***	***759***	***1,067***	***1,235***	***1,214***	***986***	***533***	***-166***	***-1,128***	***-2,372***	***-1,546***	***-3,412***	***-5,583***	***-8,077***	***-10,912***	***-14,107***	***-17,679***	***-21,648***	***-26,030***	***-30,845***	***-36,108***	***-41,836***
Scope 3 Annual GHG Emissions [tCO_2e]	***-12,074***	***-12,355***	***-13,836***	***-15,583***	***-16,789***	***-18,130***	***-19,591***	***-20,579***	***-21,820***	***-23,030***	***-23,912***	***-24,813***	***-25,060***	***-25,281***	***-25,477***	***-25,646***	***-25,788***	***-25,903***	***-25,989***	***-26,045***	***-26,071***	***-26,084***
Aggregated Scope 3 GHG Emissions [tCO_2e]	***-12,074***	***-24,429***	***-38,265***	***-53,848***	***-70,636***	***-88,766***	***-108,357***	***-128,937***	***-150,757***	***-173,786***	***-23,912***	***-48,726***	***-73,785***	***-99,066***	***-124,543***	***-150,189***	***-175,977***	***-201,880***	***-227,869***	***-253,914***	***-279,985***	***-306,070***
Total Annual GHG Emissions [tCO_2e]	***-5,229***	***-4,992***	***-7,105***	***-9,988***	***-11,397***	***-13,245***	***-15,443***	***-16,462***	***-17,981***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***
Total Aggregated GHG Emissions [tCO_2e]	***-5,229***	***-10,221***	***-17,326***	***-27,313***	***-38,711***	***-51,955***	***-67,398***	***-83,860***	***-101,842***	***-121,278***	***-20,192***	***-39,629***	***-59,065***	***-78,502***	***-97,938***	***-117,375***	***-136,812***	***-156,248***	***-175,685***	***-195,122***	***-214,558***	***-233,995***

Table A.6a: Long-term Operational Emissions (2051 – 2088) with Embedded Mitigation (2051 – 2070)

Rail Central	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070
B1 area [sqm]	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847
B2 area [sqm]	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878
B8 area [sqm]	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267
Annual operating days	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335
4.10 Stationary combustion: Production of heat and electricity																				
B1 Building Gas Consumption (Part L Compliant) [kWh]	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872
B2 Building Gas Consumption (Part L Compliant) [kWh]	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334
B8 Building Gas Consumption (Part L Compliant) [kWh]	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992
Total Fuel Consumption [kWh]	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***
Annual GHG Emissions [tCO$_2$e]	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***
Aggregated GHG Emissions [tCO$_2$e]	***8,417***	***9,065***	***9,712***	***10,360***	***11,007***	***11,654***	***12,302***	***12,949***	***13,597***	***14,244***	***14,892***	***15,539***	***16,187***	***16,834***	***17,482***	***18,129***	***18,777***	***19,424***	***20,072***	***20,719***
5.7 Purchased Electricity: Buildings & infrastructure																				
B1 Building Electricity Consumption (Part L Compliant) [kWh]	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556
B2 Building Electricity Consumption (Part L Compliant) [kWh]	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428
B8 Building Electricity Consumption (Part L Compliant) [kWh]	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933
Site Electricity Consumption [kWh]	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482
Major Site Equipment Electricity Consumption [kWh]	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656
Total Electricity Consumption [kWh]	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056
Annual GHG Emissions [tCO$_2$e]	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***
Aggregated GHG Emissions [tCO2e]	***30,650***	***32,256***	***33,861***	***35,467***	***37,072***	***38,678***	***40,283***	***41,889***	***43,495***	***45,100***	***46,706***	***48,311***	***49,917***	***51,523***	***53,128***	***54,734***	***56,339***	***57,945***	***59,550***	***61,156***
Scope 1 & 2 Annual GHG Emissions [tCO$_2$e]	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***
Aggregated Scope 1 & 2 GHG Emissions [tCO$_2$e]	***39,067***	***41,320***	***43,573***	***45,826***	***48,079***	***50,332***	***52,585***	***54,838***	***57,091***	***59,345***	***61,598***	***63,851***	***66,104***	***68,357***	***70,610***	***72,863***	***75,116***	***77,369***	***79,622***	***81,875***
6.14 Mobile combustion: Transportation of freight																				
Road HGV distance [thousand tonne.km]	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000
Rail freight [thousand tonne.km]	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000
HGV GHG Emissions [tCO$_2$e]	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434
Rail GHG Emissions [tCO$_2$e]	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369
Annual GHG Emissions [tCO$_2$e]	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***
Aggregated GHG Emissions [tCO$_2$e]	***-337,603***	***-361,668***	***-385,732***	***-409,797***	***-433,861***	***-457,926***	***-481,991***	***-506,055***	***-530,120***	***-554,184***	***-578,249***	***-602,314***	***-626,378***	***-650,443***	***-674,508***	***-698,572***	***-722,637***	***-746,701***	***-770,766***	***-794,831***
6.15 Mobile combustion: Transportation of waste																				
Waste generation [tonnes]	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747
Waste moved [tonne.km]	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471
Annual GHG Emissions [tCO$_2$e]	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***
Aggregated GHG Emissions [tCO$_2$e]	***3,012***	***3,244***	***3,476***	***3,707***	***3,939***	***4,171***	***4,402***	***4,634***	***4,866***	***5,097***	***5,329***	***5,561***	***5,793***	***6,024***	***6,256***	***6,488***	***6,719***	***6,951***	***7,183***	***7,414***
6.17 Mobile combustion: Employee commuting																				
Single occupancy vehicles: Distance travelled [km]	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246
Shared vehicles: Distance travelled [passenger km]	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839
Annual GHG Emissions [tCO$_2$e]	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476	3,476
Aggregated GHG Emissions [tCO$_2$e]	50,000	53,476	56,952	60,428	63,905	67,381	70,857	74,333	77,809	81,285	84,761	88,237	91,713	95,189	98,665	102,141	105,617	109,093	112,570	116,046
6.19 Process Emissions: Fuel & energy related activity																				
4.10 Related [kWh]	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198
5.7 Related [kWh]	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056
6.14 Road HGV distance [thousand tonne.km]	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000
6.14 Rail freight [thousand tonne.km]	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000
Annual GHG Emissions [tCO$_2$e]	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***
Aggregated GHG Emissions [tCO$_2$e]	***-47,563***	***-53,291***	***-59,018***	***-64,745***	***-70,473***	***-76,200***	***-81,928***	***-87,655***	***-93,383***	***-99,110***	***-104,837***	***-110,565***	***-116,292***	***-122,020***	***-127,747***	***-133,475***	***-139,202***	***-144,929***	***-150,657***	***-156,384***
Scope 3 Annual GHG Emissions [tCO$_2$e]	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***
Aggregated Scope 3 GHG Emissions [tCO$_2$e]	***-332,154***	***-358,238***	***-384,322***	***-410,407***	***-436,491***	***-462,575***	***-488,659***	***-514,744***	***-540,828***	***-566,912***	***-592,996***	***-619,081***	***-645,165***	***-671,249***	***-697,333***	***-723,418***	***-749,502***	***-775,586***	***-801,671***	***-827,755***
Total Annual GHG Emissions [tCO$_2$e]	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***
Total Aggregated GHG Emissions [tCO$_2$e]	***-253,431***	***-272,868***	***-292,305***	***-311,741***	***-331,178***	***-350,614***	***-370,051***	***-389,488***	***-408,924***	***-428,361***	***-447,798***	***-467,234***	***-486,671***	***-506,107***	***-525,544***	***-544,981***	***-564,417***	***-583,854***	***-603,290***	***-622,727***

Table A.6b: Long-term Operational Emissions (2051 – 2088) with Embedded Mitigation (2071 – 2088)

Rail Central	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088
B1 area [sqm]	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847
B2 area [sqm]	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878	10,878
B8 area [sqm]	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267	655,267
Annual operating days	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335
4.10 Stationary combustion: Production of heat and electricity																		
B1 Building Gas Consumption (Part L Compliant) [kWh]	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872	19,872
B2 Building Gas Consumption (Part L Compliant) [kWh]	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334	252,334
B8 Building Gas Consumption (Part L Compliant) [kWh]	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992	3,819,992
Total Fuel Consumption [kWh]	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***	***4,092,198***
Annual GHG Emissions [tCO_2e]	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***	***647***
Aggregated GHG Emissions [tCO_2e]	***21,367***	***22,014***	***22,661***	***23,309***	***23,956***	***24,604***	***25,251***	***25,899***	***26,546***	***27,194***	***27,841***	***28,489***	***29,136***	***29,784***	***30,431***	***31,079***	***31,726***	***32,374***
5.7 Purchased Electricity: Buildings & infrastructure																		
B1 Building Electricity Consumption (Part L Compliant) [kWh]	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556	49,556
B2 Building Electricity Consumption (Part L Compliant) [kWh]	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428	572,428
B8 Building Electricity Consumption (Part L Compliant) [kWh]	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933	18,838,933
Site Electricity Consumption [kWh]	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482	44,021,482
Major Site Equipment Electricity Consumption [kWh]	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656	223,656
Total Electricity Consumption [kWh]	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***	***63,706,056***
Annual GHG Emissions [tCO_2e]	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***	***1,606***
Aggregated GHG Emissions [tCO2e]	***62,762***	***64,367***	***65,973***	***67,578***	***69,184***	***70,789***	***72,395***	***74,001***	***75,606***	***77,212***	***78,817***	***80,423***	***82,029***	***83,634***	***85,240***	***86,845***	***88,451***	***90,056***
Scope 1 & 2 Annual GHG Emissions [tCO_2e]	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***	***2,253***
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	***84,128***	***86,381***	***88,634***	***90,887***	***93,140***	***95,393***	***97,646***	***99,899***	***102,152***	***104,406***	***106,659***	***108,912***	***111,165***	***113,418***	***115,671***	***117,924***	***120,177***	***122,430***
6.14 Mobile combustion: Transportation of freight																		
Road HGV distance [thousand tonne.km]	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000
Rail freight [thousand tonne.km]	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000
HGV GHG Emissions [tCO_2e]	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434	-25,434
Rail GHG Emissions [tCO_2e]	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369	1,369
Annual GHG Emissions [tCO_2e]	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***	***-24,065***
Aggregated GHG Emissions [tCO_2e]	***-818,895***	***-842,960***	***-867,025***	***-891,089***	***-915,154***	***-939,218***	***-963,283***	***-987,348***	***-1,011,412***	***-1,035,477***	***-1,059,541***	***-1,083,606***	***-1,107,671***	***-1,131,735***	***-1,155,800***	***-1,179,865***	***-1,203,929***	***-1,227,994***
6.15 Mobile combustion: Transportation of waste																		
Waste generation [tonnes]	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747	164,747
Waste moved [tonne.km]	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471	1,647,471
Annual GHG Emissions [tCO_2e]	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***	***232***
Aggregated GHG Emissions [tCO_2e]	***7,646***	***7,878***	***8,110***	***8,341***	***8,573***	***8,805***	***9,036***	***9,268***	***9,500***	***9,731***	***9,963***	***10,195***	***10,427***	***10,658***	***10,890***	***11,122***	***11,353***	***11,585***
6.17 Mobile combustion: Employee commuting																		
Single occupancy vehicles: Distance travelled [km]	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246	61,185,246
Shared vehicles: Distance travelled [passenger km]	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839	1,950,839
Annual GHG Emissions [tCO_2e]	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***	***3,476***
Aggregated GHG Emissions [tCO_2e]	***119,522***	***122,998***	***126,474***	***129,950***	***133,426***	***136,902***	***140,378***	***143,854***	***147,330***	***150,806***	***154,282***	***157,759***	***161,235***	***164,711***	***168,187***	***171,663***	***175,139***	***178,615***
6.19 Process Emissions: Fuel & energy related activity																		
4.10 Related [kWh]	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198	4,092,198
5.7 Related [kWh]	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056	63,706,056
6.14 Road HGV distance [thousand tonne.km]	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000	-581,333,000
6.14 Rail freight [thousand tonne.km]	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000	802,392,000
Annual GHG Emissions [tCO_2e]	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***	***-5,727***
Aggregated GHG Emissions [tCO_2e]	***-162,112***	***-167,839***	***-173,566***	***-179,294***	***-185,021***	***-190,749***	***-196,476***	***-202,204***	***-207,931***	***-213,658***	***-219,386***	***-225,113***	***-230,841***	***-236,568***	***-242,296***	***-248,023***	***-253,750***	***-259,478***
Scope 3 Annual GHG Emissions [tCO_2e]	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***	***-26,084***
Aggregated Scope 3 GHG Emissions [tCO_2e]	***-853,839***	***-879,923***	***-906,008***	***-932,092***	***-958,176***	***-984,260***	***-1,010,345***	***-1,036,429***	***-1,062,513***	***-1,088,597***	***-1,114,682***	***-1,140,766***	***-1,166,850***	***-1,192,935***	***-1,219,019***	***-1,245,103***	***-1,271,187***	***-1,297,272***
Total Annual GHG Emissions [tCO_2e]	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***	***-19,437***
Total Aggregated GHG Emissions [tCO_2e]	***-642,164***	***-661,600***	***-681,037***	***-700,473***	***-719,910***	***-739,347***	***-758,783***	***-778,220***	***-797,657***	***-817,093***	***-836,530***	***-855,966***	***-875,403***	***-894,840***	***-914,276***	***-933,713***	***-953,149***	***-972,586***

Appendix B: Emission Factors

Table B.1: Gas Grid Decarbonisation Effects

Fuel Proportion (%)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Natural Gas	100%	99%	99%	99%	98%	98%	98%	98%	97%	97%	97%
Biomethane	0%	1%	1%	1%	2%	2%	2%	2%	3%	3%	3%
Hydrogen (produced by electrolysis)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Scope 1 Main Fuel Emission Factor [kgCO_2e/lWh]											
Natural Gas (Gross CV)	0.18396	0.182807859	0.182242	0.181676	0.18111	0.180544	0.179978	0.179412	0.178846	0.178279	0.177713
Biomethane	0.000377	2.36167E-06	3.52E-06	4.68E-06	5.84E-06	7E-06	8.16E-06	9.32E-06	1.05E-05	1.16E-05	1.28E-05
Hydrogen (produced by electrolysis)	0	0	0	0	0	0	0	0	0	0	0
Scope 3 Main Fuel Emission Factor [kgCO_2e/lWh]											
Natural Gas (Gross CV)	0.02557	0.025409855	0.025331	0.025252	0.025174	0.025095	0.025016	0.024938	0.024859	0.02478	0.024702
Biomethane	0.044323	0.000277592	0.000414	0.00055	0.000687	0.000823	0.000959	0.001096	0.001232	0.001369	0.001505
Hydrogen (produced by electrolysis)	0.1	0	0	0	0	0	0	0	0	0	0
Combined 'Gas Grid' Emission Factor [kgCO_2e/lWh]											
Scope 1	0.18396	0.18281	0.18225	0.18168	0.18112	0.18055	0.17999	0.17942	0.17886	0.17829	0.17773
Scope 3 (WTT)	0.02557	0.02569	0.02575	0.02580	0.02586	0.02592	0.02598	0.02603	0.02609	0.02615	0.02621

Fuel Proportion (%)	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Natural Gas	96%	96%	86%	86%	86%	86%	86%	86%	86%	86%
Biomethane	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Hydrogen (produced by electrolysis)	0%	0%	10%	10%	10%	10%	10%	10%	10%	10%
Scope 1 Main Fuel Emission Factor [kgCO_2e/lWh]										
Natural Gas (Gross CV)	0.177147	0.176602	0.158206	0.158206	0.158206	0.158206	0.158206	0.158206	0.158206	0.158206
Biomethane	1.4E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05	1.51E-05
Hydrogen (produced by electrolysis)	0	0	0	0	0	0	0	0	0	0
Scope 3 Main Fuel Emission Factor [kgCO_2e/lWh]										
Natural Gas (Gross CV)	0.024623	0.024547	0.02199	0.02199	0.02199	0.02199	0.02199	0.02199	0.02199	0.02199
Biomethane	0.001641	0.001773	0.001773	0.001773	0.001773	0.001773	0.001773	0.001773	0.001773	0.001773
Hydrogen (produced by electrolysis)	0	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Combined 'Gas Grid' Emission Factor [kgCO_2e/lWh]										
Scope 1	0.17716	0.17662	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822
Scope 3 (WTT)	0.02626	0.02632	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376

Table B.2: Emission Factors applied in the GHG Assessment

Fuel/ Activity Data	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Grid 'Gas' [kgCO_2e/kWh]	0.18396	0.18281	0.18225	0.18168	0.18112	0.18055	0.17999	0.17942	0.17886	0.17829	0.17773
Grid Electricity [kgCO_2e/kWh]	0.20497	0.19466	0.18089	0.17088	0.14781	0.14426	0.15010	0.14079	0.11422	0.11937	0.10839
Diesel (Average laden HGV) [kgCO_2e/tonne.km]	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353
Road fuel [kgCO_2e/l]	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694
Red Diesel (aka 'Gas oil') [kgCO_2e/l]	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049
LPG [kgCO_2e/kg]	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732
Kerosene (aka 'Burning oil' and 'kerosene') [kgCO_2e/l]	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627
Heating oil (kerosene) [l]	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627
Diesel (forecourt) [l]	2.62694	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852
WTT Natural Gas	0.02557	0.02569	0.02575	0.02580	0.02586	0.02592	0.02598	0.02603	0.02609	0.02615	0.02621
WTT Grid electricity (generation)	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198
WTT Grid electricity (T&D)	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358
T&D Grid electricity	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413
WTT Gas Grid	0.02557	0.02569	0.02575	0.02580	0.02586	0.02592	0.02598	0.02603	0.02609	0.02615	0.02621
Calculated >33t HGV Emissions [tonne.km]	0.08482	0.08227	0.08011	0.07847	0.07693	0.07547	0.07409	0.07280	0.07157	0.07042	0.06932
Calculated >33t HGV WTT Emissions [tonne.km]	0.01997	0.01989	0.01946	0.01917	0.01889	0.01862	0.01838	0.01816	0.01795	0.01776	0.01759
Rail Freight [tonne.km]	0.03246	0.03243	0.03238	0.03180	0.03110	0.03048	0.02995	0.02926	0.02830	0.02774	0.02692
WTT Rail Freight [tonne.km]	0.00771	0.00771	0.00771	0.00768	0.00764	0.00761	0.00757	0.00754	0.00750	0.00747	0.00743
All HGVs (average laden) [tonne.km]	0.1136	0.1136	0.1136	0.1136	0.1136	0.1136	0.1136	0.1136	0.1136	0.1136	0.1136
All HGVs (average laden) WTT [tonne.km]	0.02704	0.02704	0.02704	0.02704	0.02704	0.02704	0.02704	0.02704	0.02704	0.02704	0.02704

Fuel/ Activity Data	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Grid 'Gas' [kgCO_2e/kWh]	0.17716	0.17662	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822
Grid Electricity [kgCO_2e/kWh]	0.09606	0.10424	0.09550	0.07766	0.07447	0.06652	0.05495	0.05446	0.05009	0.04624
Road fuel [kgCO_2e/l]	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353
Red Diesel (aka 'Gas oil') [kgCO_2e/l]	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694
LPG [kgCO_2e/kg]	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049
Kerosene (aka 'Burning oil' and 'kerosene') [kgCO_2e/l]	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732
Diesel (forecourt) [kgCO_2e/l]	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627
WTT Natural Gas	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627
WTT Grid electricity (generation)	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852
WTT Grid electricity (T&D)	0.02626	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632
T&D Grid electricity	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198
WTT Gas Grid	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358
Calculated >33t HGV Emissions [tonne.km]	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413
Calculated >33t HGV WTT Emissions [tonne.km]	0.02626	0.02632	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376
Rail Freight [tonne.km]	0.06829	0.06732	0.06723	0.06712	0.06646	0.06576	0.06500	0.06415	0.06323	0.06223
WTT Rail Freight [tonne.km]	0.01743	0.01728	0.01741	0.01755	0.01778	0.01804	0.01833	0.01865	0.01901	0.01940

Fuel/ Activity Data	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Grid 'Gas' [kgCO_2e/kWh]	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822	0.15822
Grid Electricity [kgCO_2e/kWh]	0.04824	0.04892	0.04655	0.04418	0.04180	0.03943	0.03706	0.03469	0.03232	0.02995	0.02757	0.0252029
Road fuel [kgCO_2e/l]	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353	0.96353
Red Diesel (aka 'Gas oil') [kgCO_2e/l]	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694	2.62694
LPG [kgCO_2e/kg]	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049	2.97049
Kerosene (aka 'Burning oil' and 'kerosene') [kgCO_2e/l]	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732	2.93732
Diesel (forecourt) [kgCO_2e/l]	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627
WTT Natural Gas	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627	2.53627
WTT Grid electricity (generation)	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.10852	3.1085204
WTT Grid electricity (T&D)	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.02632	0.0263201
T&D Grid electricity	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198	0.04198
WTT Gas Grid	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358	0.00358
Calculated >33t HGV Emissions [tonne.km]	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413	0.02413
Calculated >33t HGV WTT Emissions [tonne.km]	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376	0.03376
Rail Freight [tonne.km]	0.06116	0.06000	0.05876	0.05743	0.05603	0.05453	0.05295	0.05128	0.04953	0.04768	0.04574	0.043751
WTT Rail Freight [tonne.km]	0.01982	0.02027	0.02076	0.02128	0.02182	0.02240	0.02301	0.02366	0.02433	0.02503	0.02577	0.0265269

Appendix C: Life Cycle Assessment & Materials

Table C.1: Life Cycle Assessment Data by Declared Unit

Life Cycle Assessment Phase		A1	A2	A3	A4	A5	C1	C2	C3	C4	D
Material/ Product	Declared Unit	Raw Material Supply	Transport to Factory	Manufacturing	Transport to site	Construction - installation	Demolition	Transport	Waste Processing	Disposal	Reuse/ Recovery/ Recyling Potential
Gyproc - Plasterboard	$kgCO_2/m^2$	2.10E+00			7.70E-02	3.30E-01	0	1.90E-02	0	0	MND
Plasterboard - Knauf Generic GIPS	$kgCO_2e/m^2$	3.92E+00			2.10E-01	9.17E-02	MND	1.54E-01	7.77E-02	1.03E-02	-6.37E-01
UK CARES - Reinforcement	$kgCO_2e$/tonne	839			16.1	94.8	2.06	38.9	0	1.28	350
Bauforumstahl - Structural Steel	$kgCO_2e$/tonne	1735			MND	MND	MND	MND	MND	MND	-959
Brickwork	$kgCO_2e/kg$	0.16			MND	MND	0.0048	0.0015	0.0021	0.0016	-0.0207
Concrete Blockwork	$kgCO_2e/kg$	0.09			MND	MND	0.0048	0.0017	0.0024	0.0014	-0.0053
Tarmac - Readymix Concrete	$kgCO2e/m^3$	316			3.7	1.83	15.6	10.6	9.04	-0.416	-9.74
Hot rolled plate and structural sections (unfabricated)	$kgCO_2e/kg$	1.735			MND	MND	0.02	0.04	0	0	-0.0959
Hot formed structural hollow sections	$kgCO_2e/kg$	2.49			MND	MND	0.02	0.04	0	0	-1.38
Reinforcing steel	$kgCO_2e/kg$	1.27			MND	MND	0.019	0.042	0	0	-0.0426
Steel deck	$kgCO_2e/kg$	2.52			MND	MND	0.02	0.04	0	0	-1.45
Roofing - Twin-Therm Roof CA LT 17 1000S Liner Panel (U-Value 0.14W/m^2K)	$kgCO_2e/m^2$	43.01					MND	MND	MND	MND	-16.77
Twin-Therm Wall (U-Value 0.20W/m^2K)	$kgCO_2e/m^2$	34.59					MND	MND	MND	MND	-13.61
British Precast - Concrete Kerbs	$kgCO_2e$/tonne	131			6.62	1	-0.43	3.46	-1.6	1.31	MND
MPA - GEN I	$kgCO_2e$/tonne	77				MND	MND	MND	MND	MND	MND
MPA - RC25/30 with 100kg/m^3 reinforcement	$kgCO_2e$/tonne	133				MND	MND	MND	MND	MND	MND
MPA - RC28/35 with 30kg/m^3 reinforcement	$kgCO_2e$/tonne	134				MND	MND	MND	MND	MND	MND
RC32/40 with 100kg/m^3 reinforcement	$kgCO_2e$/tonne	154				MND	MND	MND	MND	MND	MND
RC40/50 with 100kg/m^3 reinforcement	$kgCO_2e$/tonne	178				MND	MND	MND	MND	MND	MND
Tarmac - Asphalt	$kgCO_2e$/tonne	70			6.87	6.04	4.54	4.35	4.07	0.0538	-14.6
Tarmac - Generic Aggregate	$kgCO_2e$/tonne	6.71			3.78	0	6.39	4.35	3.7	0.538	-3.99

MND – Material Not declared

Table C.2: Life Cycle Assessment Data by $kgCO_2e$/tonne of material/ product

Life Cycle Assessment Phase	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
Material/ Product	Raw Material Supply	Transport to Factory	Manufacturing	Transport to site	Construction - installation	Demolition	Transport	Waste Processing	Disposal	Reuse/ Recovery/ Recycling Potential
Gyproc - Plasterboard	251.5			9.2	39.5	MND	2.3	MND	MND	MND
Plasterboard - Knauf Generic GIPS	305.8			16.4	7.2	MND	12.0	6.1	0.8	-49.7
Plasterboard Average	***278.6***			***12.8***	***23.3***	***MND***	***7.1***	***6.1***	***0.8***	***-49.7***
UK CARES - Reinforcement	839.0			16.1	94.8	2.1	38.9	0.0	1.28	350.0
Bauforumstahl - Structural Steel	1735.0			MND	MND	MND	MND	MND	MND	-1.0
Tarmac - Readymix Concrete	160.0			MND	MND	4.8	1.5	2.1	1.6	-20.7
Hot rolled plate and structural sections (unfabricated)	129.6			1.5	0.8	6.4	4.3	3.7	-0.1705617	-4.0
Hot formed structural hollow sections	1735.0			MND	MND	20.0	40.0	MND	MND	-95.9
Reinforcing steel	2490.0			MND	MND	20.0	40.0	MND	MND	-1380.0
Steel deck	1270.0			MND	MND	19.0	42.0	MND	MND	-42.6
Roofing - Twin-Therm Roof CA LT 17 1000S Liner Panel (U-Value 0.14W/m2K)	2833.3					MND	MND	MND	MND	-1104.7
Twin-Therm Wall (U-Value 0.20W/m^2K)	2310.6					MND	MND	MND	MND	-909.2
Cladding/ Roofing Average (30% roofing, 70% walls)	***2467.4***					***MND***	***MND***	***MND***	***MND***	***-967.8***
British Precast - Concrete Kerbs	77.0				MND	MND	MND	MND	MND	MND
MPA - GEN I	133.0				MND	MND	MND	MND	MND	MND
MPA - RC25/30 with 100kg/m^3 reinforcement	134.0				MND	MND	MND	MND	MND	MND
MPA - RC28/35 with 30kg/m^3 reinforcement	154.0				MND	MND	MND	MND	MND	MND
RC32/40 with 100kg/m^3 reinforcement	178.0				MND	MND	MND	MND	MND	MND
RC40/50 with 100kg/m^3 reinforcement	77.0				MND	MND	MND	MND	MND	MND
Tarmac - Asphalt	70.0			6.9	6.0	4.5	4.4	4.1	0.1	-14.6
Tarmac - Generic Aggregate	6.7			3.8	0.0	6.4	4.4	3.7	0.5	-4.0

MND = Material Not declared

Table C.3: Main SRFI Site Material Quantities for Buildings by Zone

Material Type	Weight [t]	
	Phase 1	Phase 2
Steelwork	7,892	28,376
Claddings	1,679	6,365
Precast walls	1,097	4,996
M&E fittings	2,753	10,431
Concrete in-situ (RC28/30)	54,291	218,692
Concrete in-situ (RC32/40)	54,291	218,692
Aggregates	102,130	422,053
Reinforcement	642	2,677
Ceilings/Plasterboard	113	407
Kerbs	313	1,399
Tarmac	5,247	26,438
Pipes	783	4,040
Backfill	10,307	53,185
Manholes	162	839
Concrete in-situ (GEN I)	298	1,540
Fittings	39	203
Total	***242,039***	***1,000,331***

Table C.4: Material Quantities for all Infrastructure Elements within Order Limits

Material Type	Main SRFI Site				Other Minor Highways Works							J15A	Landscaping
	Estate Roads & Temp Access	Bridges on A43 & Northampton Rd	Intermodal	Express Freight Platform	J4	J6	J7	J14	J15	J19	J20		
Steelwork			1,158										
Cladding			379										
Precast decks		297											
Precast abutments		610											
Steel beams		586											
Concrete in-situ (RC40/50)	4,179	2,880	75,300	12,980									
Aggregates	62,705	1,092	41,990	6,500	1,079	3,207	1,533	1,332	1,311	252	1,688	90,048	
Reinforcement		165	1,114	2,350									
Kerbs	984		290	60									
Tarmac	62,705	480			385	1,293	555	514	528	94	635	20,160	
Pipes			1,100	300									
M&E fittings			437										
Manholes	191												
Precast pit units			2,351										
Fencing	1,612	27	220										160
Plants and Trees													3,170
Seeds													1,268
Total[tonnes]	***132,376***	***6,137***	***124,339***	***6,137***	***1,465***	***4,500***	***2,108***	***1,846***	***1,839***	***346***	***2,322***	***110,208***	***4,598***

Table C.5: Profiled Main SRFI Site Material Quantities for Buildings Elements [tonnes]

Buildings	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Steelwork			6,654	4,231	4,231	4,231	4,231	4,231	4,231	4,231	36,268
Cladding			1,416	947	947	947	947	947	947	947	8,044
Precast walls			925	738	738	738	738	738	738	738	6,093
Concrete in-situ (RC28/30)			45,772	32,459	32,459	32,459	32,459	32,459	32,459	32,459	272,983
Concrete in-situ (RC32/40)			45,772	32,459	32,459	32,459	32,459	32,459	32,459	32,459	272,983
Aggregates			86,104	62,583	62,583	62,583	62,583	62,583	62,583	62,583	524,183
Ceilings/Plasterboard			95	61	61	61	61	61	61	61	520
Kerbs			264	207	207	207	207	207	207	207	1,712
Tarmac			4,424	3,894	3,894	3,894	3,894	3,894	3,894	3,894	31,685
Pipes			660	595	595	595	595	595	595	595	4,823
Manholes			137	123	123	123	123	123	123	123	1,001
Concrete in-situ (GEN I)			251	227	227	227	227	227	227	227	1,838
Annual Sub-Total (LCA A1-A3)	***0***	***0***	***192,474***	***138,523***	***138,523***	***138,523***	***138,523***	***138,523***	***138,523***	***138,523***	***1,162,133***
M&E fittings			2,321	1,552	1,552	1,552	1,552	1,552	1,552	1,552	13,184
Reinforcement			541	397	397	397	397	397	397	397	3,319
Backfill			8,690	7,829	7,829	7,829	7,829	7,829	7,829	7,829	63,492
Fittings			33	30	30	30	30	30	30	30	242
Annual Sub-Total [Excluded]	***0***	***0***	***192,474***	***138,523***	***138,523***	***138,523***	***138,523***	***138,523***	***138,523***	***138,523***	***1,162,133***

Table C.6: Profiled Main SRFI Site Material Quantities for Infrastructure Elements [tonnes]

Infrastructure	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
Steelwork	579	579									**1,158**
Cladding	190	190									**379**
Precast decks	149	149									**297**
Precast abutments	305	305									**610**
Steel beams	293	293									**586**
Concrete in-situ (RC40/50)	47,670	47,670									**95,339**
Aggregates	56,144	56,144									**112,287**
Kerbs	667	667									**1,334**
Tarmac	31,593	31,593									**63,185**
Pipes	700	700									**1,400**
Manholes	96	96									***191***
Precast pit units	1,176	1,176									***2,351***
Annual Total (LCA A1 – A3)	***139,559***	***139,559***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***279,117***
Reinforcement	1,815	1,815									***3,629***
Fencing	930	930							80	80	***2,019***
M&E fittings	219	219									***437***
Plants & Trees									1,585	1,585	***3,170***
Seeds									634	634	***1,268***
Annual Sub-total (excluded)	***2,963***	***2,963***	***0***	***0***	***0***	***0***	***0***	***0***	***2,299***	***2,299***	***10,523***

Appendix D: Profiled Private Car Emission Factors

Table D.1: High Growth across electric only (cars), thousands

Vehicle stock	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Electric	-	300	*740*	*1180*	*1620*	*2060*	2500	3600	4700	5800	6900	8000	*8850*	*9700*	*10550*	*11400*	*12250*	*13100*	*13950*	*14800*	*15650*	*16500*	*17350*	*18200*	*19050*	*19900*	*20750*	*21600*	*22450*	*23300*	*24150*	25000
Hydrogen	-	2	*37.6*	*73.2*	*108.8*	*144.4*	180	280	380	480	580	680	*856*	*1032*	*1208*	*1384*	*1560*	*1736*	*1912*	*2088*	*2264*	*2440*	*2616*	*2792*	*2968*	*3144*	*3320*	*3496*	*3672*	*3848*	*4024*	4200
Liquid fuel	-	30,000	*30,400*	*30,800*	*31,200*	*31,600*	32,000	32,000	32,000	32,000	32,000	32,000	*30,700*	*29,400*	*28,100*	*26,800*	*25,500*	*24,200*	*22,900*	*21,600*	*20,300*	*19,000*	*17,700*	*16,400*	*15,100*	*13,800*	*12,500*	*11,200*	*9,900*	*8,600*	*7,300*	6000
TOTAL	**-**	**30,302**	**31,178**	**32,053**	**32,929**	**33,804**	**34,680**	**35,880**	**37,080**	**38,280**	**39,480**	**40,680**	**40,406**	**40,132**	**39,858**	**39,584**	**39,310**	**39,036**	**38,762**	**38,488**	**38,214**	**37,940**	**37,666**	**37,392**	**37,118**	**36,844**	**36,570**	**36,296**	**36,022**	**35,748**	**35,474**	**35,200**

Table D.2: Proportions of vehicle stock (cars)

Vehicle stock	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Electric %	**0.99**	**0.99**	**2.22**	**3.47**	**4.71**	**5.96**	**7.21**	**9.78**	**12.27**	**14.76**	**17.25**	**19.67**	22.30	24.87	27.44	30.01	32.58	35.14	37.71	40.28	42.85	45.42	47.98	50.55	53.12	55.69	58.26	60.82	63.39	65.96	68.53	**71.02**
Hydrogen %	**0.01**	**0.01**	**0.10**	**0.20**	**0.31**	**0.41**	**0.52**	**0.73**	**0.96**	**1.19**	**1.42**	**1.67**	2.20	2.72	3.23	3.74	4.25	4.77	5.28	5.79	6.31	6.82	7.33	7.85	8.36	8.87	9.38	9.90	10.41	10.92	11.44	**11.93**
Liquid fuel %	**99.00**	**99.00**	**97.68**	**96.33**	**94.98**	**93.63**	**92.27**	**89.49**	**86.77**	**84.05**	**81.32**	**78.66**	75.49	72.41	69.33	66.25	63.17	60.09	57.01	53.93	50.84	47.76	44.68	41.60	38.52	35.44	32.36	29.28	26.20	23.12	20.04	**17.05**

Table D.3: Assumed Well-to-Wheel CO2 emissions of different vehicle types (cars)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
HEV	**105**	**105**	**102**	**99**	**96**	**93**	**90**	**87.2**	**84.4**	**81.6**	**78.8**	**76**	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	**76**
PHEV	**36**	**36**	**35**	**34**	**33**	**32**	**31**	**30**	**29**	**28**	**27**	**26**	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	**26**
ICE New	**117**	**117**	**113.8**	**110.6**	**107.4**	**104.2**	**101**	**98**	**95**	**92**	**89**	**86**	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	**86**
Average ICE	**140.4**	**140.4**	**137.70**	**133.83**	**129.95**	**126.08**	**122.21**	**118.58**	**114.95**	**111.32**	**107.69**	**104.06**	101.82	99.56	97.30	95.045	92.79	90.53	88.27	86	86	86	86	86	86	86	86	86	86	86	86	**86**
Hydrogen	**55**	**55**	**53**	**51**	**49**	**47**	**45**	**43**	**41**	**39**	**37**	**35**	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	**35**

Table D.4: Estimated Average gCO_2e emissions per km (cars)

Emissions [gCO_2e/km]	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Electric	**0.70**	**0.70**	**1.52**	**2.31**	**3.04**	**3.72**	**4.36**	**5.73**	**6.96**	**8.09**	**9.13**	**10.03**	11.38	12.69	13.99	15.30	16.61	17.92	19.23	20.54	21.85	23.16	24.47	25.78	27.09	28.40	29.71	31.02	32.33	33.64	34.95	**36.22**
Hydrogen	**0.00**	**0.00**	**0.05**	**0.10**	**0.15**	**0.19**	**0.23**	**0.32**	**0.40**	**0.47**	**0.53**	**0.59**	0.77	0.95	1.13	1.31	1.49	1.67	1.85	2.03	2.21	2.39	2.57	2.75	2.93	3.11	3.28	3.46	3.64	3.82	4.00	**4.18**
Liquid Fuel	**139.00**	**139.00**	**134.50**	**128.91**	**123.43**	**118.05**	**112.77**	**106.12**	**99.74**	**93.56**	**87.58**	**81.86**	76.86	72.09	67.46	62.97	58.61	54.40	50.32	46.38	43.73	41.08	38.43	35.78	33.13	30.48	27.83	25.18	22.53	19.88	17.23	**14.66**
Average	**139.70**	**139.70**	**136.07**	**131.32**	**126.62**	**121.97**	**117.36**	**112.16**	**107.09**	**102.11**	**97.23**	**92.47**	**89.01**	**85.73**	**82.59**	**79.58**	**76.72**	**73.99**	**71.40**	**68.95**	**67.79**	**66.63**	**65.47**	**64.31**	**63.15**	**61.98**	**60.82**	**59.66**	**58.50**	**57.34**	**56.18**	**55.06**

Appendix E: Profiled Freight Emissions

Table E.1 Profiled Road-only Emissions (2018 – 2028)

Road only Scenario	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
>33t Articulated Road load moved [tonne.km]	654.97	654.97	654.97	654.97	654.97	654.97	654.97	654.97	654.97	654.97	654.97
Annual Scope 1 Road only GHG Emissions [tCO_2e]	**46,499**	**45,671**	**44,854**	**44,131**	**43,444**	**42,815**	**42,198**	**41,592**	**40,999**	**40,419**	**39,851**
Aggregated Scope 1 Road only GHG Emissions [tCO_2e]	**-**	**45,671**	**90,525**	**134,656**	**178,100**	**220,915**	**263,113**	**304,705**	**345,704**	**386,123**	**425,973**
Annual Scope 3 Road-only GHG Emissions [tCO_2e]	**14,584**	**14,533**	**14,483**	**14,444**	**14,406**	**14,368**	**14,330**	**14,292**	**14,254**	**14,216**	**14,178**
Aggregated Scope 3 Road-only Emissions [tCO_2e]	**-**	**14,533**	**29,016**	**43,461**	**57,867**	**72,235**	**86,565**	**100,857**	**115,111**	**129,327**	**143,504**
Annual Total Road only GHG Emissions [tCO_2e]	61,083	60,204	59,336	58,576	57,850	57,184	56,528	55,884	55,253	54,634	54,028
Aggregated Total Road only GHG Emissions [tCO_2e]	-	60,204	119,541	178,116	235,967	293,150	349,678	405,562	460,815	515,450	569,478

Table E.2 Profiled Rail Central Emissions (2018 – 2028)

Rail Central Scenario	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
>33t Articulated Road load moved [million tonne.km]	654.97	654.97	654.97	654.97	629.65	514.54	419.66	333.24	196.27	85.50	**0**
Rail load moved [million tonne.km]	0	0	0	0	34.87	193.35	323.99	442.98	631.56	784.07	**901.79**
>33t Articulated Road GHG Emissions [tCO_2e]	46,499	45,671	44,854	44,131	41,764	33,635	27,038	21,161	12,286	5,276	0
Rail GHG Emissions [tCO_2e]	0	0	0	0	1,078	5,861	9,649	12,889	17,774	21,627	24,140
Annual Scope 1 & 2 SRFI GHG Emissions [tCO_2e]	**46,499**	**45,671**	**44,854**	**44,131**	**42,842**	**39,496**	**36,687**	**34,050**	**30,060**	**26,904**	**24,140**
Aggregated Scope 1 & 2 SRFI GHG Emissions [tCO_2e]	**46,499**	**92,169**	**137,023**	**181,154**	**223,997**	**263,493**	**300,179**	**334,229**	**364,289**	**391,193**	**415,333**
>33t Articulated Road GHG Emissions [tCO_2e]	14,584	14,533	14,483	14,444	13,849	11,288	9,182	7,271	4,271	1,856	0
Rail GHG Emissions [tCO_2e]	0	0	0	0	267	1,471	2,454	3,339	4,739	5,855	6,703
Annual Scope 3 SRFI GHG Emissions [tCO_2e]	**14,584**	**14,533**	**14,483**	**14,444**	**14,116**	**12,759**	**11,635**	**10,611**	**9,010**	**7,711**	**6,703**
Aggregated Scope 3 SRFI GHG Emissions [tCO_2e]	**-**	**14,533**	**29,016**	**43,461**	**57,576**	**70,335**	**81,971**	**92,581**	**101,591**	**109,302**	**116,004**
Annual Total SRFI GHG Emissions [tCO_2e]	61,083	60,204	59,336	58,576	56,958	52,255	48,322	44,661	39,070	34,615	30,842
Aggregated Total SRFI GHG Emissions [tCO_2e]	-	106,703	166,039	224,615	281,573	333,828	382,150	426,811	465,880	500,495	531,337

Table E.3 Profiled Net Central Emissions (2018 – 2028)

Net Rail Central Emissions	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
>33t Articulated Road GHG Emissions [tCO_2e]	0	0	0	0	-1,680	-9,180	-15,160	-20,431	-28,713	-35,142	-39,851
Rail GHG Emissions [tCO_2e]	0	0	0	0	1,078	5,861	9,649	12,889	17,774	21,627	24,140
Annual Scope 1 & 2 Net GHG Emissions [tCO_2e]	**0**	**0**	**0**	**0**	**-602**	**-3,319**	**-5,511**	**-7,542**	**-10,939**	**-13,515**	**-15,711**
Aggregated Scope 1 & 2 Net GHG Emissions [tCO_2e]	**0**	**0**	**0**	**0**	**-602**	**-3,921**	**-9,432**	**-16,974**	**-27,914**	**-41,428**	**-57,139**
>33t Articulated Road GHG Emissions [tCO_2e]	0	0	0	0	-557	-3,081	-5,148	-7,021	-9,983	-12,360	-14,178
Rail GHG Emissions [tCO_2e]	0	0	0	0	267	1,471	2,454	3,339	4,739	5,855	6,703
Annual Scope 3 Net GHG Emissions [tCO_2e]	**0**	**0**	**0**	**0**	**-290**	**-1,610**	**-2,695**	**-3,681**	**-5,244**	**-6,505**	**-7,475**
Aggregated Scope 3 Net GHG Emissions [tCO_2e]	**0**	**0**	**0**	**0**	**-290**	**-1,900**	**-4,595**	**-8,276**	**-13,520**	**-20,025**	**-27,500**
Annual Total Net GHG Emissions [tCO_2e]	0	0	0	0	-892	-4,929	-8,206	-11,224	-16,183	-20,019	-23,186
Aggregated Net SRFI GHG Emissions [tCO_2e]	-	0	0	0	-892	-5,821	-14,027	-25,250	-41,434	-61,453	-84,639

Table E.4 Profiled Road-only Emissions (2029 – 2038)

Road only Scenario	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
>33t Articulated Road load moved [tonne.km]	654.97	654.97	654.97	654.97	654.97	654.97	654.97	654.97	654.97	654.97
Annual Scope 1 Road only GHG Emissions [tCO_2e]	**39,295**	**38,752**	**42,412**	**41,651**	**40,781**	**39,803**	**38,716**	**37,521**	**36,217**	**34,804**
Aggregated Scope 1 Road only GHG Emissions [tCO_2e]	**39,295**	**78,048**	**120,460**	**162,111**	**202,892**	**242,695**	**281,411**	**318,932**	**355,149**	**389,953**
Annual Scope 3 Road-only GHG Emissions [tCO_2e]	**14,139**	**14,101**	**13,974**	**13,847**	**13,720**	**13,593**	**13,466**	**13,339**	**13,212**	**13,085**
Aggregated Scope 3 Road-only Emissions [tCO_2e]	**14,139**	**28,241**	**42,215**	**56,062**	**69,782**	**83,375**	**96,841**	**110,180**	**123,391**	**136,476**
Annual Total Road only GHG Emissions [tCO_2e]	53,435	52,854	56,386	55,498	54,501	53,396	52,182	50,860	49,429	47,889
Aggregated Total Road only GHG Emissions [tCO_2e]	53,435	106,289	162,675	218,173	272,674	326,070	378,252	429,112	478,540	526,429

Table E.5 Profiled Rail Central Emissions (2019 – 2038)

Rail Central Scenario	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
>33t Articulated Road load moved [million tonne.km]	0	0	0	0	0	0	0	0	0	0
Rail load moved [million tonne.km]	901.792	901.792	901.792	901.792	901.792	901.792	901.792	901.792	901.792	901.792
>33t Articulated Road GHG Emissions [tCO_2e]	0	0	0	0	0	0	0	0	0	0
Rail GHG Emissions [tCO_2e]	23,349	22,896	21,715	20,534	19,353	18,173	16,992	15,811	14,630	13,449
Annual Scope 1 & 2 SRFI GHG Emissions [tCO_2e]	**23,349**	**22,896**	**21,715**	**20,534**	**19,353**	**18,173**	**16,992**	**15,811**	**14,630**	**13,449**
Aggregated Scope 1 & 2 SRFI GHG Emissions [tCO_2e]	**23,349**	**46,244**	**67,959**	**88,493**	**107,847**	**126,019**	**143,011**	**158,822**	**173,452**	**186,902**
>33t Articulated Road GHG Emissions [tCO_2e]	0	0	0	0	0	0	0	0	0	0
Rail GHG Emissions [tCO_2e]	6,671	6,639	6,575	6,512	6,448	6,385	6,321	6,258	6,194	6,131
Annual Scope 3 SRFI GHG Emissions [tCO_2e]	**6,671**	**6,639**	**6,575**	**6,512**	**6,448**	**6,385**	**6,321**	**6,258**	**6,194**	**6,131**
Aggregated Scope 3 SRFI GHG Emissions [tCO_2e]	**6,671**	**13,310**	**19,885**	**26,397**	**32,845**	**39,230**	**45,552**	**51,809**	**58,003**	**64,134**
Annual Total SRFI GHG Emissions [tCO_2e]	30,020	29,535	28,290	27,046	25,802	24,557	23,313	22,069	20,824	19,580
Aggregated Total SRFI GHG Emissions [tCO_2e]	30,020	59,554	87,844	114,890	140,692	165,249	188,563	210,631	231,456	251,036

Table E.6 Profiled Net Central Emissions (2019 – 2038)

Net Rail Central Emissions	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
>33t Articulated Road GHG Emissions [tCO_2e]	-39,295	-38,752	-42,412	-41,651	-40,781	-39,803	-38,716	-37,521	-36,217	-34,804
Rail GHG Emissions [tCO_2e]	23,349	22,896	21,715	20,534	19,353	18,173	16,992	15,811	14,630	13,449
Annual Scope 1 & 2 Net GHG Emissions [tCO_2e]	**-15,947**	**-15,857**	**-20,697**	**-21,117**	**-21,428**	**-21,630**	**-21,724**	**-21,710**	**-21,587**	**-21,355**
Aggregated Scope 1 & 2 Net GHG Emissions [tCO_2e]	**-73,086**	**-88,943**	**-109,640**	**-130,756**	**-152,184**	**-173,815**	**-195,539**	**-217,249**	**-238,836**	**-260,191**
>33t Articulated Road GHG Emissions [tCO_2e]	-14,139	-14,101	-13,974	-13,847	-13,720	-13,593	-13,466	-13,339	-13,212	-13,085
Rail GHG Emissions [tCO_2e]	6,671	6,639	6,575	6,512	6,448	6,385	6,321	6,258	6,194	6,131
Annual Scope 3 Net GHG Emissions [tCO_2e]	**-7,469**	**-7,462**	**-7,399**	**-7,335**	**-7,272**	**-7,208**	**-7,145**	**-7,081**	**-7,017**	**-6,954**
Aggregated Scope 3 Net GHG Emissions [tCO_2e]	**-7,469**	**-14,931**	**-22,330**	**-29,665**	**-36,937**	**-44,145**	**-51,289**	**-58,370**	**-65,388**	**-72,342**
Annual Total Net GHG Emissions [tCO_2e]	-23,415	-23,319	-28,096	-28,452	-28,700	-28,839	-28,869	-28,791	-28,604	-28,309
Aggregated Net SRFI GHG Emissions [tCO_2e]	-23,415	-46,734	-74,830	-103,282	-131,982	-160,820	-189,689	-218,480	-247,084	-275,393

Appendix F: Part L BRUKL Calculations – Kelly Taylor

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Plot 510 Fit-Out 120 lm/cw LTG

As designed

Date: Fri May 25 14:52:19 2018

Administrative information

Building Details

Address: Plot 510, GLP Phase 2, Magna Park, Milton Keynes, MK17 8EW

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.4.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.4.3

BRUKL compliance check version: v5.4.b.0

Owner Details

Name: IDI Gazeley

Telephone number: 02079014455

Address: 6th Floor, 99 Bishopsgate, London, EC2M 3XD

Certifier details

Name: Gary Westwell

Telephone number: 01752332890

Address: 1 Ashleigh Way, PLYMOUTH, PL75JX

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	18.3
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	18.3
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	10.8
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.35	0.35	External Wall
Floor	0.25	0.08	0.25	Office Ground Floor
Roof	0.25	0.25	0.25	Roof-default
Windows***, roof windows, and rooflights	2.2	1.86	2.82	Office Curtain Wall 0.15m
Personnel doors	2.2	1.94	2.2	Warehouse Door
Vehicle access & similar large doors	1.5	1.49	1.49	Dock Door Lower 01
High usage entrance doors	3.5	1.49	1.49	Glazed Door Entrance

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]

$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	1

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	55118	55118
External area [m²]	128282	128282
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	1	3
Average conductance [W/K]	39695	44086
Average U-value [W/m²K]	0.31	0.34
Alpha value* [%]	1	1

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
100	**B8 Storage or Distribution**
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	2.6	10.76
Cooling	0.64	1.17
Auxiliary	6.43	9.44
Lighting	10.6	18.85
Hot water	4.78	4.53
Equipment*	37.36	37.36
TOTAL**	25.05	44.75

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0.02	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	20.66	51.37
Primary energy* [kWh/m²]	63.59	106.91
Total emissions [kg/m²]	10.8	18.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name: **Shell and Core**

Plot 410 Fit Out

As designed

Date: Fri May 25 16:45:46 2018

Administrative information

Building Details

Address: Plot 410, Magna Park, Milton Keynes, Milton Keynes,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.4.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.4.3

BRUKL compliance check version: v5.4.b.0

Owner Details

Name: Gazeley

Telephone number: 02079014455

Address: 6th Floor, 99 Bishopsgate, London, EC2M 3XD

Certifier details

Name: Gary Westwell

Telephone number: 01752332890

Address: 1 Ashleigh Way, PLYMOUTH, PL75JX

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	17.4
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	17.4
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	13.6
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.35	0.35	Office External Wall 0.4m
Floor	0.25	0.08	0.25	Office Ground Floor
Roof	0.25	0.25	0.25	Roof
Windows***, roof windows, and rooflights	2.2	1.88	1.91	Rooflights 10
Personnel doors	2.2	1.88	2.2	Warehouse Door
Vehicle access & similar large doors	1.5	1.5	2.2	Level Access Upper 0.9
High usage entrance doors	3.5	1.49	1.49	Glazed Door Entrance

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	2

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	29904	29904
External area [m²]	72110	72110
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	2	3
Average conductance [W/K]	22701	24257
Average U-value [W/m²K]	0.31	0.34
Alpha value* [%]	0.91	0.91

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
100	**B8 Storage or Distribution**
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	5.71	10.07
Cooling	0.39	0.75
Auxiliary	7.7	9.48
Lighting	13.66	17.93
Hot water	4.9	4.62
Equipment*	35.75	35.75
TOTAL**	32.36	42.85

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

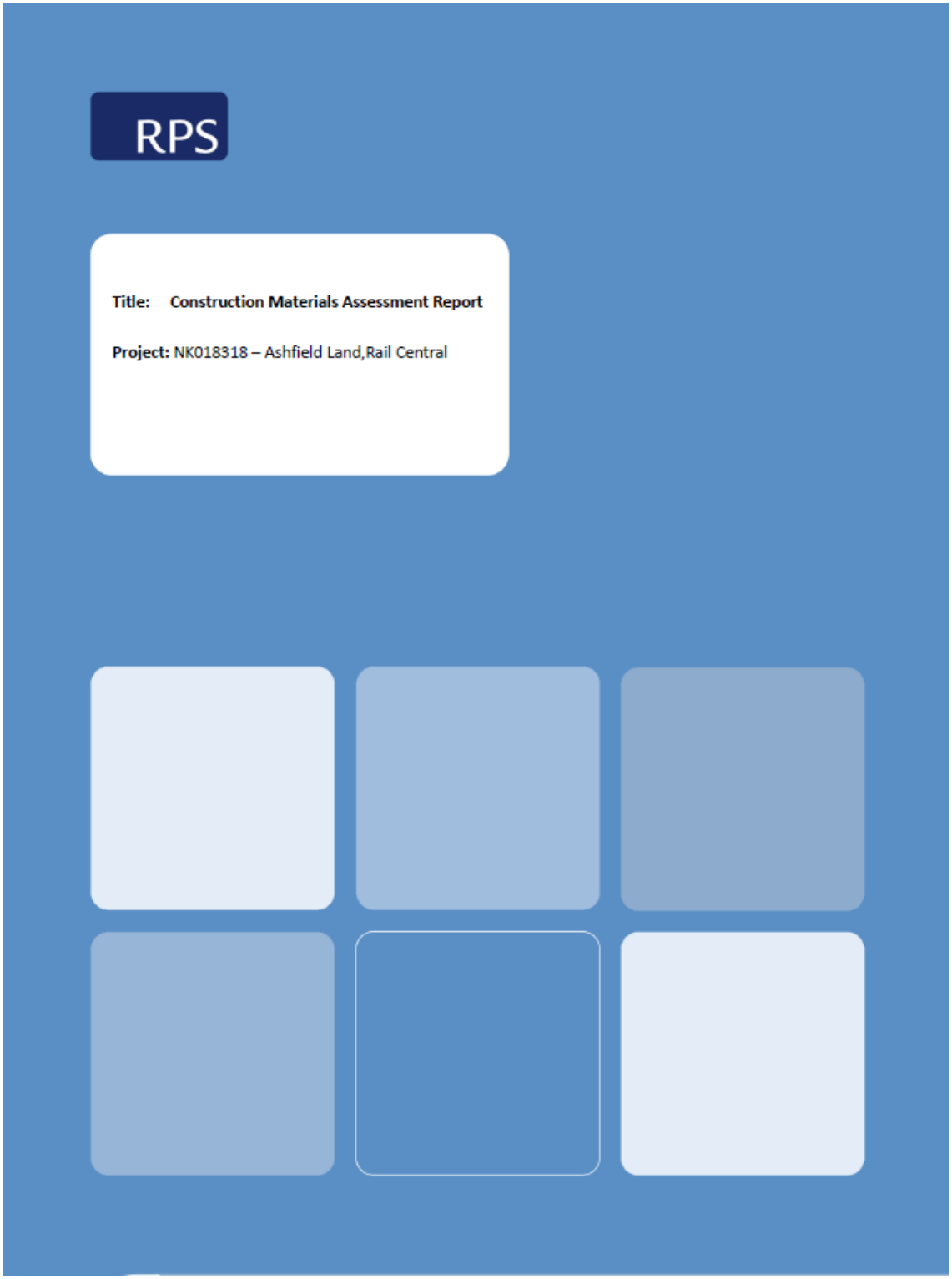
	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0.03	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	24.77	43.31
Primary energy* [kWh/m²]	79.74	102.3
Total emissions [kg/m²]	13.6	17.4

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

Appendix G: Main SRFI Site Materials Assessment Report – RPS



QUALITY MANAGEMENT

Prepared by:	Amir Alrikaby
Authorised by:	John Clayton
Date:	02 June 2016
Project Number/ Document Reference:	NK018318 – RPS-00-XX-RP-C-002

Revision History

Rev.	Date	Description	Author	Checked
A	18/07/17	Updated to suit latest master plan Includes temporary construction access	AA	JC

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1 INTRODUCTION 4
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APPENDIX 12

APPENDICES:

Michael Sparks Associates, Illustrative Masterplan, 30708-FE-96A

RPS, Construction Traffic Assessment Key Plan, RPS-00-XX-DR-C-SK0007/A

TPA, Temporary Construction Access Plan SK69,Rev-A

1 INTRODUCTION

1.1 Site Location

The Rail Central site lies approximately 5 miles south of Northampton town centre (National grid Reference 473077, 254830) and covers an area of approximately 260ha. Directly to the north of the site is the village of Milton Malsor, to the western boundary is the A43, to the east the Northampton loop rail line and to the south the west coast mainline. The Northampton / Towcester Road runs directly through the site from north to south. Further to the east of the site is the M1 motorway junction 15.

1.2 Project Description

The development outlined on Michael Sparks Associates drawing ref 30708-FE-96A consists of approximately 7.3M sqft of industrial warehousing with ancillary office accommodation and lorry park. A rail freight terminal and train maintenance facility adjacent to the Northampton loop line and express freight platform adjacent to the west coast mainline will also be provided. To facilitate access for the development, a new grade separated junction on the A43 and site access road will be constructed along with an underpass beneath the Northampton Road.

1.4 Scope

The main purpose of this exercise is to assess the number of vehicles delivering construction materials to the site in order to understand the impact of the construction traffic on the operation of the existing highway network. Quantities of construction materials have been estimated for six key aspects as follows:

1. Estate Roads
2. Bridges to form split level highway access on A43 Road
3. Buildings (Zone 1 to Zone 5)
4. Landscaping
5. Intermodal (Zone 6)
6. Express Freight Platform (Zone 7)

2 MATERIAL QUANTITIES ASSUMPTIONS

In order to quantify materials of different aspects of the project, several assumptions have been made to determine volumes/tonnage of construction materials as the following:

2.1 Buildings (Zone1 to Zone5)

- Construction thickness is : 200mm Concrete cast in-situ ground floor slab on top of 250mm unbound granular mixture type-1
- Construction thickness of service yard hardstanding is : 190mm concrete cast in-situ on top of 260mm unbound granular mixture type-1
- Construction thickness of carparks: 25mm surface course,75mm dense binder course on top of 150mm unbound granular mixture type-1
- Building: 15m clear internal height
- Precast concrete loading docks
- Composite cladding to walls and roof

2.2 Estate Roads

Construction thickness of all estate roads shown on RPS drawing (RPS-00-XX-DR-C-SK0007/A) as the following:

- Surface Course : 40mm
- Binder Course : 60mm
- Base Course : 250mm
- Foundation (Sub-Base): 420mm

2.3 It is assumed that all construction materials will be brought to site via road transport. Depending on the phasing of the development and the timing of the construction of the rail freight terminal, it is possible that some of construction materials could be delivered by rail, for example, aggregates and possibly cement (see 2.5 below)

2.4 Vehicle type

Three types of transporting vehicles have been assumed as shown in the following table:

Vehicle Type		Max Payload (t)
Articulated trailer	A	30
Concrete truck mixer	C	15
Tipper	T	20

2.5 Concrete Works

It is assumed that all concrete will be delivered to site via concrete mixer vehicles; however it is possible that an on-site batching plant will be proposed during construction works. This will however still require delivery of aggregate and cement. The traffic impact in terms of road delivery is likely to be reduced, because the aggregate and cement would be delivered by tippers and cement trucks respectively, which have bigger payload capacities than concrete mixer trucks.

2.6 Earthworks

It is assumed all top soil will be retained on site for Landscaping/ bunding purposes. It is also assumed that all other earthworks will re-use any remaining material, i.e. there will be no net import/export of soil during the earthworks exercise.

2.7 list of exclusions

This report currently excludes:

- Contractors Plant/Machinery
- Car journeys of construction workers
- Offsite Highway Improvements

3 MATERIAL USAGE

3.1 The total weight of the construction materials which will be transported to the rail central site is estimated to be **1.5 million** tonnes during the construction phase.

3.2 Table 3.1 illustrates the breakdown of the above tonnages for the key aspects in addition to the transport mode and the assumed payload for each type of materials.

Table:1	Material Quantities for Rail Central-Ashfield Land

1- Estate Roads &Temporary Construction Access	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Aggregate	62705	ROAD	100	20	T	3136
Tarmac	62705	ROAD	100	20	T	3136
Kerbs	984	ROAD	100	25	A	40
Fencing	1612	ROAD	100	6	A	269
Road Manholes/Gullies	191	ROAD	100	20	A	10
Pipes	810	ROAD	100	*28	A	30
Concrete In-Situ	4179	ROAD	100	15	C	279
Total Roads	**133186**					**6900**

** Maximum No of pipes is 65 per load, based on 28t load*

2-Bridges on A43 Road & to Northampton Road	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Aggregate	1092	ROAD	100	20	T	55
Concrete	2880	ROAD	100	15	C	192
Steel Beams	586	ROAD	100	20	A	30
Reinforcement	165	ROAD	100	30	A	6
Precast abutments	610	ROAD	100	30	A	21
Precast Decks	297	ROAD	100	6	A	50
Tarmac	480	ROAD	100	20	T	24
Fencing	27	ROAD	100	6	A	5
Total bridges	**6137**					**383**

4-Buildings						
Zone 1	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Steelwork	6670	ROAD	100	20	A	334
Claddings	1497	ROAD	100	6	A	250
Precast walls	1035	ROAD	100	30	A	35
M&E fittings	2453	ROAD	100	20	A	123
Concrete In-Situ	101025	ROAD	100	15	C	6735
Aggregates	96160	ROAD	100	20	T	4808
Reinforcement	614	ROAD	100	30	A	21
Ceilings/Plasterboard	96	ROAD	100	6	A	16
Kerbs	323	ROAD	100	25	A	13
Tarmac of carparks	5297	ROAD	100	20	T	265
Drainage						
Pipes	1113	ROAD	100	**28	A	44
Backfill of trenches	14652	ROAD	100	20	T	733
Manholes	231	ROAD	100	20	A	12
Concrete In-Situ	424	ROAD	100	15	C	29
Fittings	56	ROAD	100	25	A	3
Total Zone 1	**231646**					**13421**

Zone 2	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Steelwork	4982	ROAD	100	20	A	249
Claddings	1120	ROAD	100	6	A	187
Precast walls	774	ROAD	100	30	A	26
M&E fittings	1836	ROAD	100	20	A	92
Concrete In-Situ	76715	ROAD	100	15	C	5115
Aggregates	74768	ROAD	100	20	T	3739
Reinforcement	470	ROAD	100	30	A	16
Ceilings/Plasterboard	72	ROAD	100	6	A	12
Kerbs	344	ROAD	100	25	A	14
Tarmac of carparks	5346	ROAD	100	20	T	268
Drainage						
Pipes	1113	ROAD	100	**28	A	44
Backfill of trenches	14652	ROAD	100	20	T	733
Manholes	231	ROAD	100	20	A	12
Concrete In-Situ	424	ROAD	100	15	C	29
Fittings	56	ROAD	100	25	A	3
Total Zone 2	**182903**					**10539**

Zone-3	Weight (t)	Transport Mode	% by Road	Payload (t)	Viehicle	No of Vehicles
Steelwork	6685	ROAD	100	20	A	335
Claddings	1523	ROAD	100	6	A	254
Precast walls	1673	ROAD	100	30	A	56
M&E fittings	2496	ROAD	100	20	A	125
Concrete In-Situ	113731	ROAD	100	15	C	7583
Aggregates	111716	ROAD	100	20	T	5586
Reinforcement	726	ROAD	100	30	A	25
Ceilings/Plasterboard	96	ROAD	100	6	A	16
Kerbs	307	ROAD	100	25	A	13
Tarmac of carparks	7038	ROAD	100	20	T	352
Drainage						
Pipes	742	ROAD	100	**28	A	29
Backfill of trenches	9768	ROAD	100	20	T	489
Manholes	154	ROAD	100	20	A	8
Concrete In-Situ	283	ROAD	100	15	C	19
Fittings	37	ROAD	100	25	A	2
Total Zone 3	**256975**					**14892**

Zone-4	Weight (t)	Transport Mode	% by Road	Payload (t)	Viehicle	No of Vehicles
Steelwork	6712	ROAD	100	20	A	336
Claddings	1517	ROAD	100	6	A	253
Precast walls	1051	ROAD	100	30	A	36
M&E fittings	2486	ROAD	100	20	A	125
Concrete In-Situ	100140	ROAD	100	15	C	6676
Aggregates	96357	ROAD	100	20	T	4818
Reinforcement	597	ROAD	100	30	A	20
Ceilings/Plasterboard	96	ROAD	100	6	A	16
Kerbs	293	ROAD	100	25	A	12
Tarmac of carparks	6545	ROAD	100	20	T	328
Drainage						
Pipes	742	ROAD	100	**28	A	29
Backfill of trenches	9768	ROAD	100	20	T	489
Manholes	154	ROAD	100	20	A	8
Concrete In-Situ	283	ROAD	100	15	C	19
Fittings	37	ROAD	100	25	A	2
Total Zone 4	**226778**					**13167**

Zone-5	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Steelwork	11219	ROAD	100	20	A	561
Claddings	2387	ROAD	100	6	A	398
Precast walls	1560	ROAD	100	30	A	52
M&E fittings	3913	ROAD	100	20	A	196
Concrete In-Situ	154355	ROAD	100	15	C	10291
Aggregates	145182	ROAD	100	20	T	7260
Reinforcement	912	ROAD	100	30	A	31
Ceilings/Plasterboard	160	ROAD	100	6	A	27
Kerbs	445	ROAD	100	25	A	18
Tarmac of carparks	7459	ROAD	100	20	T	373
Drainage						
Pipes	1113	ROAD	100	**28	A	44
Backfill of trenches	14652	ROAD	100	20	T	733
Manholes	231	ROAD	100	20	A	12
Concrete In-Situ	424	ROAD	100	15	C	29
Fittings	56	ROAD	100	25	A	3
Total Zone 5	**344068**					**20028**

*** Maximum No of pipes is 37 per load,based on 28t load*

5-Landscaping	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Plants and trees	3170	ROAD	100	20	A	159
Fencing/Stacks	160	ROAD	100	10	A	16
Seeds	1268	ROAD	100	20	A	63
Total Landscaping	**4598**					**238**

6-Intermodal (Zone 6)	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Aggregate	41990	ROAD	100	20	T	2100
Kerbs	290	ROAD	100	25	A	12
Fencing	220	ROAD	100	6	A	37
Pipes	1100	ROAD	100	**28	A	44
In-Situ Concrete	75300	ROAD	100	15	C	5020
Reinforcement	1114	ROAD	100	30	A	38
Steelwork of Depot	1158	ROAD	100	30	A	39
Cladding of Depot	379	ROAD	100	6	A	64
M&E fittings	437	ROAD	100	20	A	22
Precast Pit Units-Depot	2351	ROAD	100	25	A	95
Total Rail Terminal	**124339**					**7471**

Maximum payload of kerbs is 25t based on 38t Trailer

*** Maximum No of pipes is 37 per load, based on 28t load*

7-Express Freight Platform (Zone 7)	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Aggregate	6500	ROAD	100	20	T	325
Kerbs	60	ROAD	100	25	A	3
Pipes	300	ROAD	100	28	A	11
In-Situ Concrete	12980	ROAD	100	15	C	866
Reinforcement	2350	ROAD	100	25	A	94
Total Rail Terminal	**22190**					**1299**

Summary						
	Weight (t)	Transport Mode	% by Road	Payload (t)	Vehicle	No of Vehicles
Roads/Temporary Access	133186	ROAD	100	Varies	Varies	6900
Bridges on A43 Road/Underpass	6137	ROAD	100	Varies	Varies	383
Buildings (Zone 1 to 5)	1242370	ROAD	100	Varies	Varies	72047
Landscaping	4598	ROAD	100	Varies	Varies	238
Intermodal(Zone-6)	124339	ROAD	100	Varies	Varies	7471
Express Freight Platform	22190	ROAD	100	Varies	Varies	1299
Total=	**1532820**					**88338**

APPENDIX

Appendices

Michael Sparks Associates, Illustrative Masterplan, 30708-FE-96A

RPS, Construction Traffic Assessment Key Plan, RPS-00-XX-DR-C-SK0007/A

TPA, Temporary Construction Access Plan SK69, Rev-A

NOTES:

SUBJECT TO STATUTORY CONSENTS

BASED ON MK SURVEYING TOPOGRAPHICAL SURVEY DRAWING REF: 2223, DATED JULY 2016, AND ORDNANCE SURVEY INFORMATION.

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N

LEGEND

NEW RAILWAY ARRANGEMENT.
BASED ON: INTERMODALITY'S PROPOSED RAIL LAYOUT. (DRAWING: INT SC DI 57.)

LANDSCAPE STRATEGY.
BASED ON: BARRY CHINN'S ILLUSTRATIVE LANDSCAPE MASTERPLAN. DRAWING NO:1-16-20C. DATED: 24-02-17

REV	DATE	NOTE	DRW	CHK
A	16-06-17	Rail layout updated	PF	MS

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ASHFIELD LAND

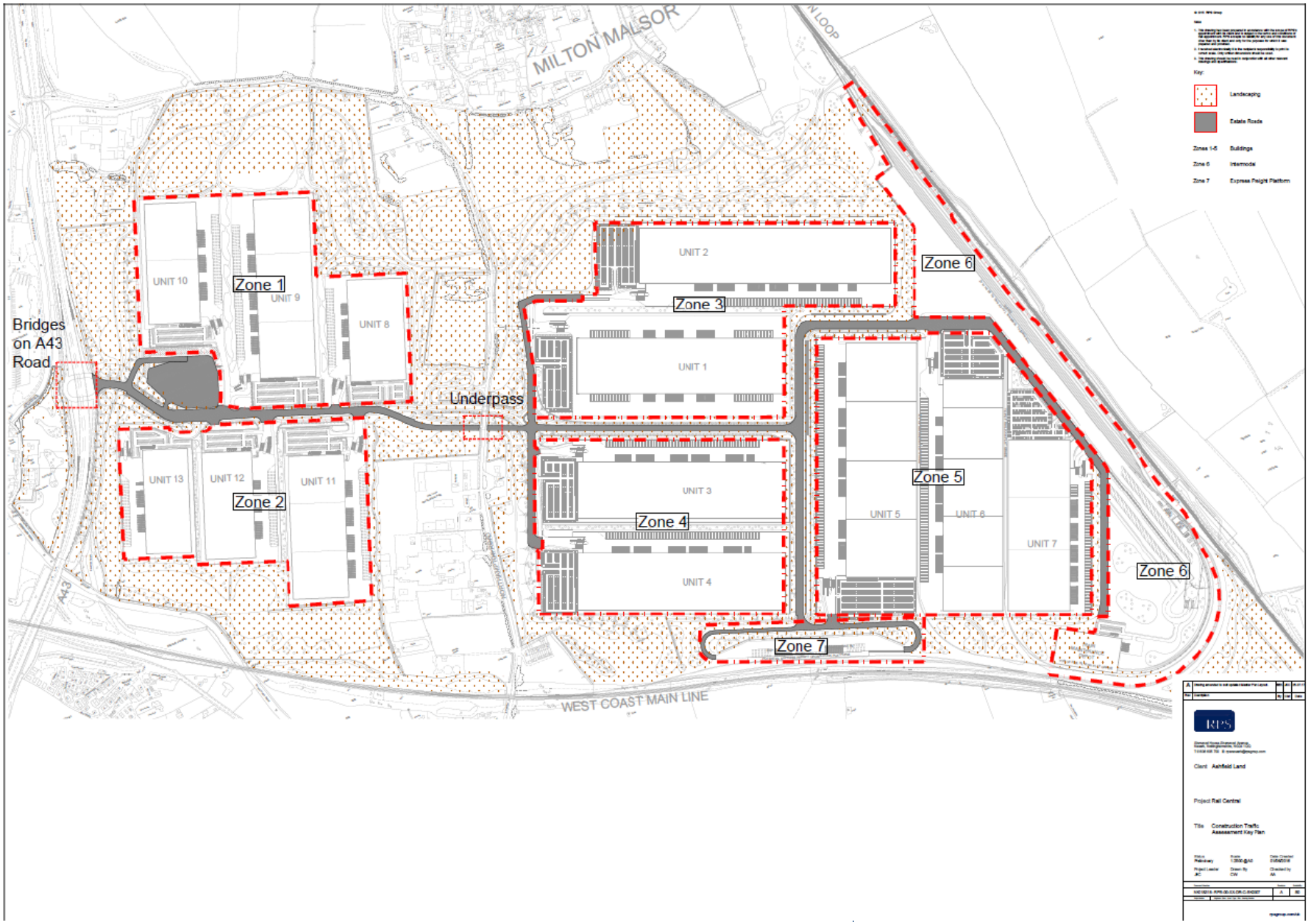
TITLE
RAIL CENTRAL

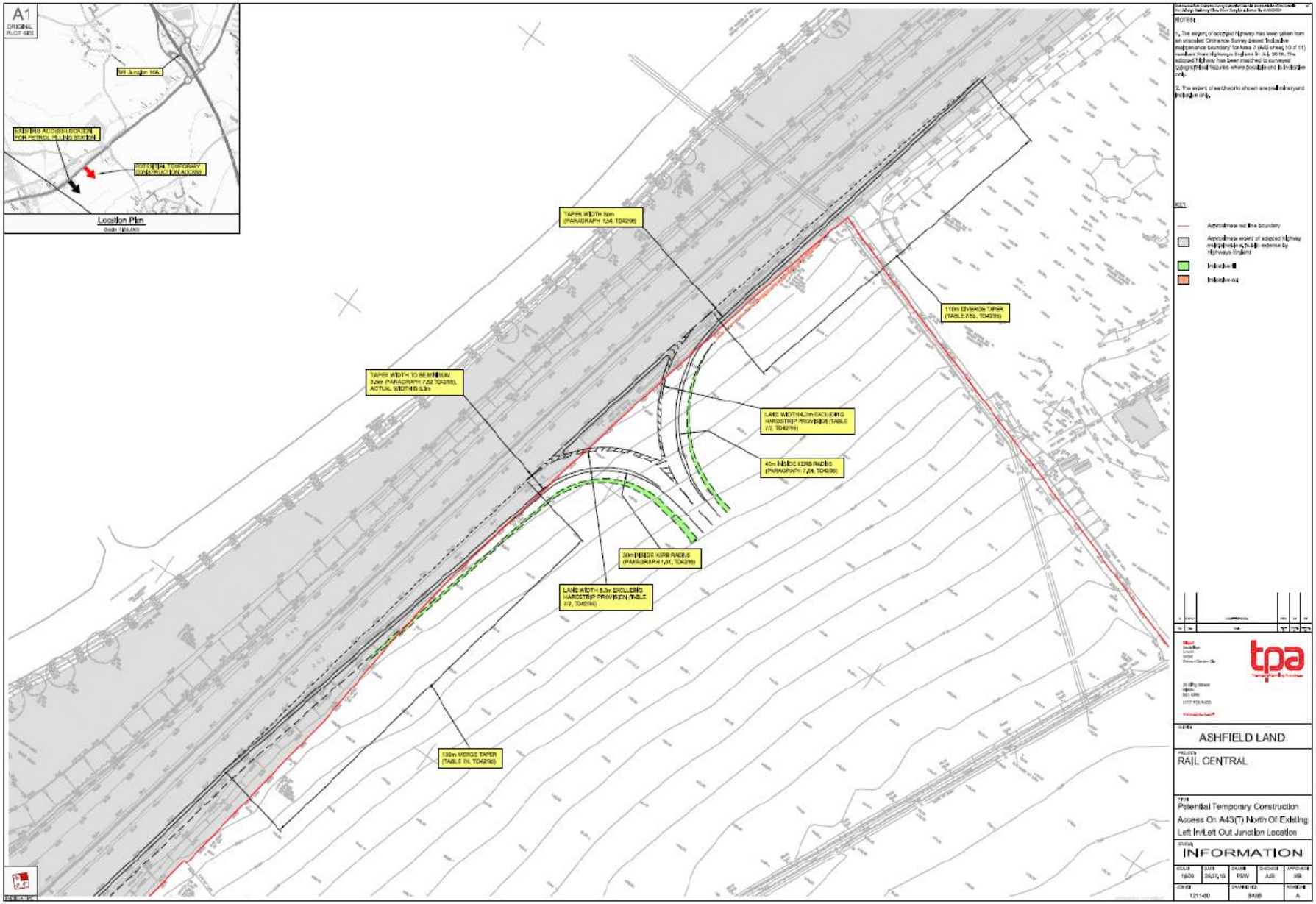
DRAWING
ILLUSTRATIVE COLOUR MASTERPLAN

CLIENT
ASHFIELD LAND

DATE	SCALE	DRAWN
JUNE 2017	1:5000@A1	PF
	STATUS	CHECKED
	FEASIBILITY	MS/GZ

DRAWING NUMBER
30708-FE-96A


MILTON MALSOR
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Zone 6
Zone 7
Zone 6
Bridges on A43 Road
Underpass
UNIT 1
UNIT 2
UNIT 3
UNIT 4
UNIT 5
UNIT 6
UNIT 7
UNIT 8
UNIT 9
UNIT 10
UNIT 11
UNIT 12
UNIT 13
A43
WEST COAST MAIN LINE
Landscaping
Estate Roads
Zones 1-5 Buildings
Zone 6 Intermodal
Zone 7 Express Freight Platform
RPS
Client Ashfield Land
Project Rail Central
Title Construction Traffic Assessment Key Plan


A1
ORIGINAL PLOT SIZE
M1 Junction 15A
EXISTING ACCESS LOCATION FOR PETROL FILLING STATION
POTENTIAL TEMPORARY CONSTRUCTION ACCESS
Location Plan
Scale 1:20,000
TAPER WIDTH 5pm (PARAGRAPH 7.24, TD42/95)
110m DIVERGE TAPER (TABLE 7.1a, TD42/95)
TAPER WIDTH TO BE MINIMUM 3.2m (PARAGRAPH 7.52 TD42/95), ACTUAL WIDTHS 5.2m
LANE WIDTH 4.7m EXCLUDING HARDSTRIP PROVISION (TABLE 7.1, TD42/95)
40m INSIDE KERB RADIUS (PARAGRAPH 7.24, TD42/95)
30m INSIDE KERB RADIUS (PARAGRAPH 7.91, TD42/95)
LANE WIDTH 5.3m EXCLUDING HARDSTRIP PROVISION (TABLE 7.2, TD42/95)
130m MERGE TAPER (TABLE 7.1d, TD42/95)
NOTES
1. The extent of adopted highway has been taken from an unscaled Ordnance Survey based Indicative maintenance boundary for Area 7 (M42 sheet 10 of 11) received from Highways England in July 2015. The adopted highway has been matched to surveyed topographical features where possible and is indicative only.
2. The extent of earthworks shown are preliminary and indicative only.
KEY
Approximate red line boundary
Approximate extent of adopted highway maintainable at public expense by Highways England
Indicative fill
Indicative cut
tpa
ASHFIELD LAND
RAIL CENTRAL
Potential Temporary Construction Access On A43(T) North Of Existing Left In/Left Out Junction Location
INFORMATION
1:500
26.07.16
PBW
AJS
MB
121480
SK09
A

Appendix H: Minor Highway Works Materials - TPA

ASHFIELD LAND LTD
Rail Central

Job number: 1211-80

Technical Note Highway Works Description

Transport Planning Associates

Junction Four – A5076 / A5123 / Upton Way

The proposed highway mitigation measures for the A5076 / A5123 / Upton Way roundabout are shown as follows:

- extension to the offside right turn lane on the Upton Way approach;
- reconfiguration of the road markings on the Danes Camp Way approach;
- reconfiguration of the road markings on the circulatory carriageway;
- additional offside lane on the A5123 approach;
- additional lane on the circulatory carriageway; and
- additional lane on the Upton Way exit.

Physical Works:

Carriageway Resurfacing (including road markings)	4,393.50	sqm
Carriageway Construction (including road markings, drainage, ducting and street lighting)	1,605.89	sqm
Traffic Signal Equipment	3	node
Site Clearance		
Preliminaries		

Junction Six – A5076 / Hunsbury Hill Avenue / Hunsbarrow Road / Hunsbury Hill Road

The proposed highway mitigation measures for the A5076 / Hunsbury Hill Avenue / Hunsbarrow Road / Hunsbury Hill Road roundabout are shown as follows:

- provision of signal control on both arms of the A5076 Danes Camp Way approaches and two corresponding traffic signals on the circulatory carriageway;
- provision of an additional nearside lane on both of the A5076 Danes Camp Way approaches;
- provision of an additional merge lane on both of the A5076 Danes Camp Way exits;
- lengthening of the nearside lane on the Hunsbarrow Road approach; and
- reconfiguration of the road markings to provide extra connecters on the circulatory carriageway and entry arms;

Physical Works:

Carriageway Resurfacing (including road markings)	5,269.23	sqm
Carriageway Construction (including road markings, drainage, ducting and street lighting)	2,769.04	sqm
Earthworks/Re-grade (including drainage & ducting)	3,738.90	sqm
Traffic Signal Equipment	2	node
Site Clearance		
Preliminaries		

Junction Seven – Towcester Road / A5076 / A5123 / Tesco

The proposed highway mitigation measures for the Towcester Road / A5076 / A5123 / Tesco roundabout as follows:

- provision of an additional lane and merge on Towcester Road south exit;
- provision of an additional offside lane on the A5076 Danes Camp Way approach;
- signalisation of the Towcester Road north approach and corresponding traffic signals on the circulatory carriageway;
- lengthening of the nearside lane on the Towcester Road north approach;
- provision of local widening on the circulatory carriageway;
- lengthening of the off side lane on the Mere Way approach;
- provision of a merge lane on the Mere Way exit; and
- provision of a merge lane on the Towcester Road south exit.

Physical Works:

Carriageway Resurfacing (including road markings)	4,932.10	sqm
Carriageway Construction (including road markings, drainage, ducting and street lighting)	2,311.21	sqm
Earthworks/Re-grade (including drainage & ducting)	735.23	sqm
Traffic Signal Equipment	3	node
Site Clearance		
Preliminaries		

Junction Fourteen – Tove Roundabout

The proposed highway mitigation measures for the A43 Tove Roundabout are shown as follows:

- reconfiguration of the roundabout and an increase in the size of the central island;
- lengthening of an existing lane and the provision of an additional lane on A43 south approach;
- reconfiguration and widening of the Towcester Road approach to accommodate an additional give way lane;
- lengthening of an existing lane and provision of an additional lane on the A5 (north) approach;
- widening of the circulatory carriageway between the A5 (north) and the A5 (south) to provide an additional lane; and
- provision of a merge lane on the A5 north exit.

Physical Works:

Carriageway Resurfacing (including road markings)	5,981.04	sqm
Carriageway Construction (including road markings, drainage, ducting and street lighting)	5,342.21	sqm
Footway/Island Construction (including drainage & ducting)	1,464.86	sqm
Verge	963.39	sqm
Earthworks/Re-grade (including drainage & ducting)	3,232.54	sqm
Traffic Signal Equipment	5	node
Site Clearance		
Preliminaries		

Junction Fifteen – Abthorpe Roundabout

The proposed highway mitigation measures for the A43 Tove Roundabout are shown as follows:

- provision of two additional offside lanes on the A43 north approach;
- realignment of the existing lanes on the Brackley Road approach;
- realignment of the A43 exit; and
- reconfiguration of the road markings on the circulatory carriageway.

Physical Works:

Carriageway Resurfacing (including road markings)	7,401.64	sqm
Carriageway Construction (including road markings, drainage, ducting and street lighting)	1,140.48	sqm
Footway/Island Construction (including drainage & ducting)	1,513.22	sqm
Earthworks/Re-grade (including drainage & ducting)	1,948.30	sqm
Traffic Signal Equipment	2	node
Site Clearance		
Preliminaries		

Junction Nineteen – A5076 / Telford Way / Walter Tull Way / Duston Mill Lane

The proposed highway mitigation measures for the A5076 / Telford Way / Walter Tull Way / Duston Mill Lane roundabout are shown as follows:

- provision of an additional nearside lane on the A5076 Upton Way north approach;
- realignment of the eastern approach;
- provision of a merge lane on the A5076 Upton Way south exit;
- provision of an additional nearside lane on the A5076 Upton Way south approach;
- realignment of the Telford Lane approach and exit;
- provision of a merge lane on the A5076 Upton Way north arm; and
- widening of the circulatory carriageway to accommodate three lanes on the east and west sections of the circulatory and two lanes on the north and south sections of the circulatory.

Physical Works:

Carriageway Resurfacing (including road markings)	4,210.54	sqm
Carriageway Construction (including road markings, drainage, ducting and street lighting)	2,031.28	sqm
Footway/Island Construction (including drainage & ducting)	319.82	sqm
Verge	102.97	sqm
Earthworks/Re-grade (including drainage & ducting)		sqm
Traffic Signal Equipment		node
Site Clearance		
Preliminaries		

Junction Twenty – A5076 / High Street / Duston Mill

The proposed highway mitigation measures for the A5076 / High Street / Duston Mill roundabout are shown as follows:

- provision of an additional nearside lane on the A5076 Upton Way north approach;
- provision of a merge lane on the A5076 Upton Way south exit;
- provision of an additional nearside lane on the A5076 Upton Way south approach;
- provision of a merge lane on the A5076 Upton Way north exit; and
- widening of the circulatory carriageway to accommodate three lanes on the east and west sections of the circulatory and two lanes on the north and south sections of the circulatory.

Physical Works:

Carriageway Resurfacing (including road markings)	4,447.25	sqm
Carriageway Construction (including road markings, drainage, ducting and street lighting)	2,078.25	sqm
Footway/Island Construction (including drainage & ducting)	808.91	sqm
Verge	135.94	sqm
Site Clearance		
Preliminaries		

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The Rail Central Rail Freight Interchange

Appendix 21.2 Rail & Road Freight Emission Factors

Document Information

Document No.	6.1.21.2
Drawing Number	RC-ALG-APP- 6.1.21.2
Regulation Number	Reg 5(2)(a)
Date	04/09/18
Author	Rebecca Beeson, Associate Director

Turley

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4.	Rail Freight Emission Factor Adjustments	13
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Executive Summary

1. This assessment has reviewed the source of the NS PNN statement that rail freight displaces 70% of road freight tonne for tonne and concludes that this is a slight misinterpretation of out of date data.

2. Using current data and emission factors, rail freight per tonne.km results in 58% fewer GHG emissions than road freight assuming an appropriate vehicle class (>33t articulated HGV) is displaced. At Rail Central, when considering origin and destination points, the reduction in emission from rail to road freight is estimated to be 22%.

3. To assess the impact of decarbonisation of road and rail freight to the end of the short-term operational period (2038), potential emission reduction opportunities up to 2038 for both rail freight and the equivalent road freight anticipated to be displaced by rail, have been identified. Assumptions on take-up and efficiencies delivered have been made based on available literature and a profile of future emission factors has been developed for rail freight and freight moved by articulated HGVs greater than 33 tonnes.

4. Emissions are predicted to reduce for both rail and road over the period, but as the opportunities to reduce GHG emissions in large HGVs are more limited, rail emissions reduce at a faster rate. The differential over time therefore increases, resulting in greater savings for rail freight compared with a road only comparator in the future.

5. It is estimated that by 2028, the transfer of freight from road to rail at Rail Central could result in a reduction of 73,561 tonnes CO_2e and by 2038, it is estimated that 346,047 tonnes CO_2e could be displaced.

6. This is the equivalent of a circa 14% reduction during the construction phase, before the site is fully operational, and a 56% reduction during the short-term operational phase.

7. By 2050, it is anticipated that a total of 756,356 tonnes CO2e could be displaced, equivalent to 0.03% of the total UK Carbon Budget between 2018 and 2050.

8. By the end of the long-term operational phase in 2088, a total of 2,062,411 could be displaced – a significant quantum of emissions.

1. Introduction

1.1 This assessment has been carried out to support the assessment of greenhouse gases associated with freight for the Chapter 23 and Appendix 23.1 of the PEIR for the Proposed Development of Rail Central.

1.2 The displacement of road freight to rail is consistently identified as an important method for reducing GHG emissions, particularly for large container loads being transported over long distances. However, often quoted emission reductions are based on 2008 data that fails to consider a number of factors:

- Emission factors applied in 2008 were based on crude data from the National Atmospheric Emissions Inventory (NAEI) and DfT transport statistics; since 2008, methods for assessing emissions from road and rail have improved and are now considered more accurate.

- The distance travelled by rail is likely to be longer than comparator distance travelled by road; this is due to the transhipment leg between the rail heads and the ultimate origin and destination but is not taken into account in a simple tonne.km comparison.

- Emissions for road and rail freight are reducing over time, but by different amounts; thus, altering the emissions differential.

1.3 There is an urgent need to reduce greenhouse gas emissions and the UK has set legally binding carbon budgets to deliver against short-, medium-, and long-term reduction targets. As a result, emissions have reduced significantly over the last decade, and are expected to continue reducing into the future. In the context of estimating future GHG emissions, this is important to recognise and take into account.

1.4 To achieve emission reductions on the scale required, efforts are required to both reduce the level of emission generating activity and to reduce the emission content of activities. This assessment has drawn upon currently available reports and research to identify potential emission reduction scenarios for road and rail freight to develop a set of emission factors for road and rail freight movements at Rail Central up to 2038.

2. Modal Shift

2.1 MDS Intermodal1 have provided an estimate of the quantity of road freight that will be displaced by rail at full operation; this is based on the GB Rail Freight Model, assuming 335 operating days per annum.

2.2 Rail freight is assigned to specific routes on the national railway network, thereby allowing the distance over which the forecast rail traffics move to be established; this results in 72.9million unit-km per annum, with one unit representing a single container load.

2.3 Distance travelled by road is calculated in a similar way, with and without the displacement by rail freight; this results in 210,605,000 HGV-kms travelled with the SRFI in place and 263,550,000 HGV-kms if all transport is via road. This results in a shift of 52,945,000 HGV-kms from road to rail.

2.4 BEIS guidance[2] states that:

"For comparison with other freight transport modes (e.g. road vs. rail), the user may require CO_2 factors in tonne km (tkm) units."

and that:

"The average tonne freight lifted figures are derived from the tkm and vehicle km (vkm) figures given for each class of HGV in Tables RFS0119 and RFS0109, respectively (DfT, 2016). Dividing the tkm by the vkm figures gives the average tonnes freight lifted by each HGV class."

2.5 Assuming that the average load displaced by rail freight is intermodal in origin, an average unit load of 10.98 tonnes is applied, derived from DfT Port Statistics and including empty units.

2.6 The movement of this load would otherwise have taken place by road, so the same tonnage is also applied to the distance shifted from road to rail to assess the counterfactual:

- Rail: 72,900,000 unit.km x 10.98 = 772,740,000 tonne.km
- Road: 52,945,000 HGV.km x 10.98 = 561,217,000 tonne.km

2.7 In the SRFI scenario, total tonne.km by road and rail equate to 211.5 million tonne.km, which is an additional 8% compared with the road only comparator. As the tonnage moved is the same in both scenarios, this also represents an 8% increase in overall distance travelled, which is in line with assumptions applied elsewhere, such as the 10% additional distance assumed by Arup3 . This takes into account the transhipment leg between the rail heads and the ultimate origin and destination of the freight. The approach adopted here is more

[1] MDS Intermodal 2017 'Mode Shift and Greenhouse Gas Emissions Benefits at Rail Central'. MDS Intermodal.
[2] BEIS 2017 '2017 Government GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors', UK Government.
[3] Arup 2017 'Future Potential for Modal Shift in the UK Rail Freight Market'. Arup.

accurate as it is based on likely origin and destination data specific to the location of the Proposed Development.

2.8 The quantity of freight transferred to rail is assumed to be directly proportional to the quantity of warehouse space completed and operational in a given year. This is the basis for profiling freight movements by mode and corresponding emissions during the construction phase when the SRFI is not yet fully operational.

2.9 Under the SRFI scenario, it is appropriate to apply an emission factor for articulated vehicles >33t, based on the assumption that rail is most likely to displace heavier long-haul freight journeys. Emissions are proportional to load, so specific emission factor for the load assumed (10.98 tonnes) must be calculated.

2.10 For the remaining freight, average articulated HGV emission factors would be applicable; this would take into account that the remainder of the freight not displaced by rail is likely to be more regional with a different payload profile. However, given that this proportion remains the same in both road-only and SRFI scenarios, it is unnecessary to calculate this figure.

3. Emission Factors

3.1 The National Policy Statement for National Networks[4],published in 2014, states that:

'Tonne for tonne, rail freight produces 70% less CO_2 than rail freight'

This is based on the document *Delivering a Sustainable Transport System: The Logistics Perspective,* published by DfT in 2008[5].

3.2 The 2008 DfT report states that:

'Rail produces around 0.05kg of CO_2 per tonne km compared to around 0.17kg of CO_2 per tonne km for road transport'.

This is based on DfT analysis of NAEI emission data and traffic statistics (*Figure 2.4 CO_2* within the document sets out the intensity of road and rail transport).

3.3 This simplistic assessment fails to consider a number of factors, which are considered further below:

- Only direct carbon dioxide (CO_2) emissions are considered, with the impact of other GHGs and indirect upstream impacts associated with the production of fuels excluded.
- A tonne for tonne comparison does not consider that the distance travelled by rail is likely to be longer than the comparator distance travelled by road; this is due to the transhipment leg between the rail heads and the ultimate origin and destination. In Arup's work looking at the future potential for modal shift[6] , this was assumed to result in an additional 10% of tonne.km, but this figure is entirely dependent on origin/ destination data relative to an individual SRFI.
- The displacement of road freight to rail freight in the context of an SRFI is likely to focus on long-haul container freight. It is assumed that this requires heavier articulated vehicles (>33t), and the profile of these vehicles in terms of emissions and emission reduction potential is different to other vehicles. An average HGV or average articulated HGV freight figure would therefore be an unsuitable comparator assumption to apply.
- Similarly, the emissions profile of rail freight will vary depending on a number of factors, although BEIS[7] identifies: "*Traffic-, route- and freight-specific factors are not currently available, but would present a more appropriate means of comparing modes (e.g. for bulk aggregates, intermodal, other types of freight)*.". This is particularly relevant to this assessment, as emission factors for rail freight increased per tonne.km in 2017, thought by the Office of Road and Rail (ORR) to be as a result

[4] DfT 2014 'National Policy Statement for National Networks', UK Government.
[5] DfT 2008 'Delivering a Sustainable Transport System: The Logistics Perspective'. UK Government
[6] Arup 2017 'Future Potential for Modal Shift in the UK Rail Freight Market'. Arup.
[7] BEIS 2017 '2017 Government GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors' , UK Government.

of the reduction in movements of bulk coal across the freight network, and an increase in container freight which tends to be less efficient in terms of tonnes per km travelled[8].

Background

3.4 In 2008, emissions associated with road and rail freight were crudely estimated and in the intervening years, significantly more data is now available, improving the accuracy of the figures over time. The annual GHG Methodology papers that support BEIS emission factors for company reporting (formerly Defra) set out the sources of data used and associated assumptions. Adjusting that data to take into account future scenarios (for example, an increase in the use of electric traction) allows us to estimate potential future emission factors.

Baseline Emission Factors: Road

3.5 In order to make adjustments to current emission factors to take into account future scenarios, current BEIS emission factors[9] have been deconstructed based on their source data and the BEIS methodology detailing how each emission factor has been calculated[10] .

3.6 For the purposes of this assessment, it is assumed that rail freight displaces the largest vehicle class, which is articulated vehicles over 33t. The following data from DfT[11] relates to this vehicle type and was used to calculated BEIS 2018 emission factors (2016 data):

- 111,987 million tonne km moved (RFS0119)
- 845 million tonnes lifted (RFS0119)
- 9,904 million vehicle km (RFS0119)
- 7.9 miles per gallon (RFS0141)
- 0.62 loading factor (RFS0117)

[Note that these figures have been restated following a change in DfT methodology for calculating the domestic aspect of the 'Road Fright Statistics' series; the original figures were used to calculate 2017 emission factors, and no changes in emission factor methodology have been published in 2018].

3.7 The above figures result in an average load of 11.30725 tonnes; this is greater than the 10.98 tonnes load assumed in the calculation of tonne.km associated with the Proposed Development, which means that an average emission factor cannot be applied.

3.8 The Methodology Paper for Emission Factors states that for the 2017 GHG Conversion Factors, DfT data is combined with test data from the European ARTEMIS project showing how fuel efficiency, and therefore CO_2 emissions, varies with vehicle load.

[8] ORR 2017 'Rail Infrastructure, Assets and Environmental', UK Government.

[9] BEIS 2018 'Greenhouse gas reporting: conversion factors 2018', UK Government.

[10] BEIS 2017 '2017 Government GHG Conversion Factors for Company Reporting: Methodology Paper ofr Emission Factors' , UK Government.

[11] DfT 2017 'Domestic road freight activity (RFS01)', UK Government.

3.9 The miles per gallon figure from table RFS0141 is converted to gCO2e per km using the standard fuel conversion factor for diesel.

3.10 From analysis of ARTEMIS data, the methodology states that it was possible to derive the change in CO_2 emissions for a vehicle completely empty (0% load) or fully laden (100% load) on a weight basis compared with the emissions at half-load (50% load). The data show the effect of load is symmetrical and largely independent to f the Euro mission classification of the HGV and type of drive cycle. An articulated HGV with a gross vehicle weight greater than 33 tonne emits 25% more CO_2 per km when fully laden and 25% less CO_2 per km when empty relative to emissions at half-load.

3.11 All other GHG emissions (e.g. NOx and CH_4) are assumed to change in proportion with CO_2 and figures therefore represent CO_2e emissions; similarly, Well-to-Tank (WTT) emissions are assumed to be proportional to CO_2e emissions.

3.12 Based on the DfT source data identified above and current (2018) diesel and WTT diesel emission factors, emission factors per tonne.km relative to a load of 10.98 tonnes can be calculated and are set out in **Table 3.1**.

Table 3.1: Tonne.km emission factors calculated from first principles

Loading Factor	0%	50%	60.21%	62%	100%
Tonnage	0	9.12	10.98	11.3	18.24
Diesel [$kgCO_2e$/km]	0.6646	0.8862	0.9314	0.9993	1.1077
Diesel [$kgCO_2e$/tonne.km]	-	0.09872	0.0848	0.0831	0.0607
WTT Diesel [$kgCO_2e$/km]	0.1565	0.2086	0.2193	0.2211	0.2608
WTT Diesel [$kgCO_2e$/tonne.km]	-	0.0229	0.0200	0.0196	0.0143

3.13 **Table 3.2** illustrates that the tonne.km emission factors calculated from first principles compare well with those published for 50%, 100% and average laden vehicles; the small difference likely to be as a result of rounding in the figures provided by BEIS.

Table 3.2: 2018 published emission factors and % difference in calculated figures

Loading Factor	50%	Average (62%)	100%
Diesel [$kgCO_2e$/tonne.km]	0.09774	0.94395	1.11078
% difference	0.57%	0.49%	0.27%

WTT Diesel [$kgCO_2e$/tonne.km]	0.02326	0.01986	0.01449
% difference	1.64%	1.52%	1.32%

3.14 The baseline emission factors for the transportation of freight displaced by the SRFI are therefore as follows:

- Diesel [$kgCO_2e$/tonne.km] = 0.0848
- WTT Diesel [$kgCO_2e$/tonne.km] = 0.0200

Baseline Emission Factors: Rail

3.15 In 2008 DEFRA[12] set out the methodology for assessing emission factors for rail freight. This explains that the value for rail freight is provisional and based on available information on fuel consumption and CO_2 emissions by diesel freight trains in the UK in 2005 produced by the UK Greenhouse Gas Inventory on the basis of average fuel consumption rates of diesel locomotives and estimated freight train km and DfT statistics on the total tonne km rail freight moved in *2005: Transport Statistics Great Britain (Table 4.1)*.

3.16 Freight trains are hauled by electric and diesel locomotives, but specific rail freight energy use data was not available nationally and the 2008 factors assume haulage only by diesel locomotives. The resulting emission factor was 21.0 gCO_2 per tonne km; this is significantly different to the figure calculated by DfT in 2008, which stated 0.17kg CO_2 per tonne.km.

3.17 The methodology was updated the following year[13], when the CO_2 value for rail freight was based on available information on CO_2 emissions by diesel freight trains in the UK in 2007 produced by the Office of Road and Rail (ORR). This resulted in an emission factor of 0.0285 $kgCO_2$ per tonne.km, or 0.0319 $kgCO_2e$ per tonne.km.

3.18 These emission factors were in place until 2012, when they were updated to include data from ORR on both diesel and electric transportation of rail freight; relating to 2011, diesel accounted for 93% of rail freight movements, with an overall rail freight emission factor of 0.0276$kgCO_2$ or 0.03063$kgCO_2e$ per tonne.km. Indirect emissions were also assessed, accounting for a further 0.00571$kgCO_2e$ per tonne.km.

3.19 This methodology has been applied to the calculation of rail emissions ever since, with emission factors updated annually based on emissions data from the previous year.

3.20 Direct emission factors for freight include Scope 1 and 2 emissions associated with fuel and electricity, and indirect emission factors include the upstream Scope 3 emissions associated with each fuel, when combined resulting in total 'well-to-wheel' emissions factors; emissions are compared on a tonne.km basis.

[12] Defra 2008 'Guidelines to Defra's GHG Conversion Factors: Methodology Paper for Transport Emission Factors'. UK Government.

[13] Defra 2009 'Guidelines to Defra/ DECC's GHG Conversion Factors for Company Reporting'. UK Government.

3.21 The current BEIS Methodology states that: *"Data provided by the Office of the Rail Regulator's (ORR) Table 2.100 Sustainable development: Estimate of normalised passenger and freight CO_2e emissions for 2014-2016 (ORR, 2016) has been used to update the rail freight emission factors for the 2017 GHG Conversion factors".*

Note that the ORR was renamed the Office of Rail and Road in 2015 and is referred to as such elsewhere in this document.

3.22 As no methodology has been published to support the 2018 emission factors, it is assumed that there have been no changes in methodology since 2017. ORR *Table 2.100 Sustainable development: Estimates of normalised passenger and freight CO_2e emissions* includes no new data and covers the period up to 2016-17.

3.23 ORR publish details of their methodology[14] for calculating the emission factors published in Table 2.100. This states that:

- Freight operators provide the ORR with their total traction electricity (kWh) and diesel usage (litres) consumption (*Table 2.101: Estimates of passenger and freight energy consumption and CO_2e emissions (by traction type)*.
- Energy consumption data is then converted into CO_2e using standard conversion factors from Defra (now BEIS).
- Prior to conversion, electricity consumption is uprated assuming 1.5% of electricity generated is lost during transmission.
- In some instances, actual consumption data is not provided by operators. In these cases, an estimate of CO_2e is made based on the number of train kilometres each operator runs by working out the average CO_2e emissions per train km for the operators who have provided data and applying this factor to the train kilometres for operators that require estimation.
- To calculate the normalised output, the total CO_2e emission for freight operators are normalised by net tonne kilometres sourced from the dataset published in the Rail Freight Usage Statistics (*Table13.25: Freight train kilometres by operator* and Table *13.7: Freight moved*)

3.24 The addition of 1.5% of the reported electricity consumption to consider electricity lost during transmission would otherwise be accounted for under Scope 3 emission factors and does not correspond with BEIS methodologies; emission factors for losses during transport and distribution are around 9% of Scope 2 electricity emission factors.

3.25 The emissions per net freight tonne.km published by ORR are not those that are reported by BEIS; a comparison of ORR and BIES emission factors is provided in **Table 3.3**.

[14] ORR 2017 'Rail Infrastructure, Assets and Environmental: Quality & Methodology Report', UK Government.

Table 3.3: ORR and BEIS Rail Freight Emission Factors [tonne.km]

Emission Factor	2014/15	2015/16	2016/17	2017/18
BEIS Direct [$kgCO_2e$/tonne.km]	0.02601	0.02950	0.03394	0.03351
BEIS Indirect [$kgCO_2e$/tonne.km]	0.00596	0.00601	0.00774	0.00756
Total BEIS [$kgCO_2e$/tonne.km]	0.03197	0.03551	0.04168	0.04107
ORR [$kgCO_2e$/tonne.km]	0.0293	0.0337	0.0332	N/A

3.26 Using the source data in ORR Table 2.101, the emission factors applied to electricity and diesel consumption can be calculated from first principles and are presented in **Table 3.4** alongside the equivalent emission factors reported by BEIS.

Table 3.4: ORR and BEIS Electricity and Diesel Emission Factors

Emission Factor	2014/15	2015/16	2016/17	2017/18
BEIS Direct Electricity [$kgCO_2e$/kWh]	*0.46219*	*0.41205*	*0.35156*	*0.28307*
BEIS Indirect Electricity [$kgCO_2e$/kWh]	*0.11273*	*0.10475*	*0.09416*	*0.06969*
BEIS Total Electricity [$kgCO_2e$/litre]	0.57492	0.5168	0.44572	0.35276
ORR Electricity [$kgCO_2e$/kWh]	0.50178	0.46923	0.41833	-
BEIS Direct Diesel [$kgCO_2e$/litre]	*2.67614*	*2.61163*	*2.67193*	*2.68779*
BEIS Indirect Diesel [$kgCO_2e$/kWh]	*0.5796*	*0.55266*	*0.62566*	*0.62564*
BEIS Total Diesel [$kgCO_2e$/litre]	3.25574	3.16429	3.29759	3.31343
ORR Diesel [$kgCO_2e$/litre]	2.96416	2.90883	2.96583	-

3.27 Whilst ORR state that the DEFRA (now BEIS) factors are applied to electricity and diesel consumption figures, it is apparent that there are significant discrepancies compared with the emission factors reported by BEIS. The source data from ORR relating to the quantity of fuel and electricity consumed is therefore used as the basis for assessing emission factors for freight, with BEIS emission factors applied to this data.

3.28 By applying BEIS emission factors to the electricity and diesel quantities provided in Table 2.101, a direct emission factor of 0.03277 $kgCO_2e$/rail freight tonne.km is calculated for 2017, reducing to 0.03273 in 2018; this compares

with the 0.0339 $kgCO_2e$/ rail freight tonne.km reported by BEIS in 2017 and 0.03351 $kgCO_2e$/ rail freight tonne.km reported in 2018. The difference in 2017 figures equates to circa 2%, which is not considered significant; to allow adjustments to be made in future assumptions, the calculated figures are adopted for estimating baseline freight emission factors.

3.29 Indirect emissions associated with rail freight are reported at 0.00774 $kgCO_2e$ per tonne.km in 2017; this compares with a factor of 0.00771 $kgCO_2e$ per tonne.km when calculated from first principles, reducing to 0.00756 $kgCO_2e$ per tonne.km in 2018.

3.30 BEIS emission factors for electricity are changing rapidly, and the BEIS 2018 reported electricity emission factors relate to 2016 emissions; projected emission factors (**Ref 11**) relate to the year in which they occur, so to tie these two sets of emission factors together, projected emission factors for 2018 have been applied to calculate baseline emissions.

3.31 Whilst indirect emissions are also changing, there is no published data on the level to which reductions are expected; as a result, 2018 BEIS emission factors have been applied for all future years.

3.32 Baseline rail freight tonne.km figures are therefore taken as:

- Direct: 0.0325 $kgCO_2e$/tonne.km
- Indirect: 0.0077 $kgCO_2e$/tonne.km
- Total: 0.0402 $kgCO_2e$/tonne.km

3.33 It is noted that Arup[15] have assumed that electric traction produces zero carbon (i.e. CO_2e) emissions, based on the fact that power generation for electric locomotives is included under the EU Emissions Trading Scheme (EU ETS)and therefore already internalized and accounted for at the point of generation. If this approach were to be adopted in this assessment, then energy generated in power stations would also be excluded, as many power stations are also included in the EU ETS. For consistency with the ES methodology adopted in relation to other emission sources, and for completeness, this approach has not been applied and electric traction emissions are calculated based on the electricity consumed to generate the required level of electric traction as reported in 2016/17 figures. This is consistent with the BEIS GHG reporting methodology[16] and provides a worst-case assessment scenario.

3.34 Without data to allow the assessment of a rail tonne.km figure specific to container freight, it should be noted that current and future estimates of emissions may significantly under-estimate the emissions associated with rail freight; this is recognised as a limitation of this assessment.

3.35 As the purpose of this assessment is to support the GHG assessment for the Rail Central ES, a worst-case scenario would be reduced emissions across the HGV network with corresponding higher emissions in the rail sector.

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[15] Arup 2017 'Future Potential for Modal Shift in the UK Rail Freight Market'. Arup.

[16] BEIS 2017 '2017 Government GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors', UK Government.

3.36 The approach taken in this assessment is therefore to adjust the calculated current emission factors to take into account anticipated likely changes in efficiency appropriate to each mode. The Rail section summarises the adjustments made to baseline emission factors to take into account anticipated future scenarios.

4. Rail Freight Emission Factor Adjustments

Background

4.1 This section reviews the likely measures and anticipated levels of uptake for measures that have the potential to reduce rail freight emissions up to 2050. The assumptions set out in this section are used to inform the adjustments made to the baseline emission factors for rail freight reported in Section 3 of this report up to 2050; calculations and adjusted emission factors are provided in **Appendix B** and are used to profile emissions associated with modal shift at the Proposed Development in **Appendix A**.

Electrification & Rolling Stock

4.2 Although 34% of the rail network is electrified, only 5% of freight is currently transported using electric traction[17]. Even on routes where the majority of the track is electrified (such as the West Coast Mainline), there are still lengths of track (this includes current gaps on key corridors from Felixstowe and the new Thames Gateway development to the Midlands, North West and North East, along with the privately owned intermodal terminals not currently electrified) that are not and the practicalities of transferring from electric to diesel for part of the route mean that for many journeys, diesel trains are the preferred option.

4.3 Whilst bi-mode trains, which can switch between diesel and electric traction along the same route do exist, there are currently only 10 (2%) of such locomotives in operation amongst four of the five major freight operators18 (purchased between 2015 and 2017 and operated by Direct Rail Services). Similarly, electric locomotives currently comprise circa 10% of these freight fleets.

4.4 Rolling stock requires significant investment and as a result tends to be operational for long periods of time; the average age of rolling stock owned by four of the five major freight operators is 32 years19. In addition, the period between putting out a tender for new rolling stock and that rolling stock becoming operational can be several years, so there is a lag in any in bi-mode operation in the freight sector becoming an operational reality. Indeed, Government announcements to date relating to the cancellation of funding for electrification projects only cite passenger use of bi-mode trains, where Government have a greater influence on rolling stock due to franchising arrangements, and as a result, a much higher proportion of journeys are electrified.

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[17] ORR 2017 'Rail Infrastructure, Assets and Environmental', UK Government.

[18] *This includes GB Railfreight, Direct Rail Services, Freightliner and Colas Rail, but excludes DB Cargo UK who do not publish this information. DB Cargo UK are the largest operator, but inherited a large fleet from British Rail. It is known that circa 250 locomotives were replaced in 1996, but no further purchases are known.*

[19] *Based on rolling stock data for GB Railfreight, Direct Rail Services, Freightliner and Colas Rail, assessed in Appendix E.*

4.5 Any further switches to electric traction will require significant investment in infrastructure, which at present is unlikely given the cancellation of a number of electrification projects in 2017[20].

4.6 Whilst Government has recently announced that it would like to phase out diesel trains entirely by 2040[21], potentially through the use of hydrogen technology and battery storage, it is not yet understood what this will entail, particularly for freight which is not governed by franchise arrangements.

4.7 Although a pilot of a hydrogen powered passenger train is planned by 2020, Rail Freight Group Executive Director Maggie Simpson sounded a note of caution, saying that whilst battery and hydrogen "*may show promise for lightweight passenger trains, their application for heavy duty freight is at best unproven, and setting an arbitrary deadline of 2040 could well therefore be counterproductive, damaging the case for investment*".[22]

4.8 The Applicant has committed to the electrification of the rail line within the Main SRFI Site, though this is dependent on consultation with Network Rail; as this is outside the control of the Applicant and would require wider electrification to make a meaningful reduction in GHG emissions, this is noted, but has not been included in any assumptions.

4.9 Whilst a linear relationship from 95% diesel traction in 2017, to 0% diesel traction in 2040, would result in 17% of traction being delivered by non-diesel sources by 2020, and 41% by 2030, we have assumed that for the reasons stated above, there will be slower initial uptake of alternative traction methods. Given that no new infrastructure is currently planned, in the short-term this would rely on increased uptake of electric or bi-mode trains. As procurement takes time, we have assumed that the current proportion of diesel traction remains until 2020. Between 2020 and 2030, we have assumed that electric traction increases linearly to 30%, delivered through an increased uptake in bi-mode trains. Between 2030 and 2040, we have assumed that despite recent announcements, a proportion of freight will remain on diesel traction (20%) and that alternatives are likely to include battery storage and hydrogen technologies.

4.10 Future emission factors for grid electricity consider decarbonisation and the input of low carbon and renewable energy sources into the overall fuel mix; this results in an emission factor of 0.05495 $kgCO_2e/kWh$ in 2035 compared with 0.20497 $kgCO_2e/kWh$ in 2018. Whilst hydrogen and other alternatives may have lower emissions, this is likely to be balanced out by older locomotives that continue to run, so it is reasonable to assume that the use of electric traction as the alternative to diesel throughout. This also presents a worst-case view of overall emissions, which is consistent with the ES approach.

Freight Efficiency

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[20] The Rt Hon Chris Grayling MP 2017 'Written Statement to Parliament: Rail update: bi-mode train technology', UK Government.

[21] The Rt Hon Jo Johnson MP 2018 'Speech: Lets raise our ambitions for a cleaner, greener railway', UK Government.

[22] Railway Gazette 2018 'Hydrogen train to be tested in the UK by 2020'. Available at: http://www.railwaygazette.com/news/traction-rolling-stock/single-view/view/hydrogen-train-to-be-tested-in-the-uk-by-2020.html Railway Gazette.

4.11 Freight emissions from rail are likely to increase over time on a tonne.km basis due to the shift in transportation of bulk materials such as coal, to the transportation of less efficient container freight. This trend is likely to continue as container freight becomes a more significant component of the overall freight mix and given that the modal shift at Rail Central assumes the displacement of container freight movements, current rail freight emissions are likely to be an under-estimate.

4.12 Given that BEIS does not have sufficient data to provide a breakdown of tonne.km by freight type, it would be inappropriate and disproportionate for this assessment to consider this further. However, to take this into account in the future, it is assumed that whilst there may be efficiency improvements on a tonne.km basis for road freight, no such improvements occur for rail freight.

5. Road Freight Emission Factor Adjustments

Background

5.1 This section reviews the likely measures and anticipated levels of uptake for measures that have the potential to reduce road freight emissions (specific to the type of vehicle being displaced by rail) up to 2050. The assumptions set out in this section are used to inform the adjustments made to the baseline emission factors for road freight reported in Section 3 of this report up to 2050; calculations and adjusted emission factors are provided in **Appendix C** and are used to profile emissions associated with modal shift at the Proposed Development in **Appendix A**.

5.2 There are two categories of emission reduction from road freight: improvements in efficiency; and improvements in emissions associated with fuels used.

5.3 There have been numerous studies and reports over the past several years investigating the opportunities for reductions in road freight emissions, and the purpose of this document is not to repeat that content, but to identify reasonable assumptions relating to how emissions associated with road freight transport could change in the short- to medium-term (up to 2038).

5.4 The following reports have provided the primary basis for our road freight assumptions:

- Freight Carbon Review 2017 Moving Britain Forward[23]
- Committee on Climate Change (CCC) Sectoral Scenarios for the Fifth Carbon Budget Technical Report[24]
- Centre for Sustainable Road Freight (SRF) An Assessment of the potential for demand-side fuel savings in the Heavy Goods Vehicle (HGV) Sector[25]
- Element Energy Low Carbon Transport Roadmaps[26]

5.5 The 2017 Freight Carbon Review identifies several areas where the road freight sector can deliver reduced GHG emissions. These include:

- Efficient driving and in-cab technologies: Eco-driving techniques, maintenance procedures and vehicle checks designed to achieve greater fuel efficiency,
- Fleet design: Widely available technologies to reduce HGV fuel consumption including retrofit equipment such as aerodynamic devices and fairings and low rolling resistance tyres.
- Alternative fuels: LNG, CNG, biomethane and liquid biofuels are all considered suitable for use in the current generation of HGV engines.

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[23] DfT 2017 'Freight Carbon Review 2017 Moving Britain Ahead', UK Government

[24] The Committee on Climate Change 2015 'Sectorial scenarios for the Fifth Carbon Budget Technical Report', CCC.

[25] Centre for Sustainable Road Freight (SRF) 2015 'An Assessment of the potential for demand-side fuel savings in the Heavy Goods Vehicle (HGV) Sector'. CSRF and CCC.

[26] Element Energy 2015 'Transport Energy Infrastructure Roadmap'. Low CVP.

- Low and zero emission technologies: battery electric and hydrogen fuel cell technologies.

5.6 These are supported by a number of UK and EU policy and funding incentives, pilot schemes and research funds to accelerate uptake of new technologies.

5.7 EC plans to publish regulatory proposals on the monitoring and reporting of fuel consumption and CO_2 emissions from all new HGVs by 2018; it is anticipated that these proposals would help to inform purchasing behaviour bad potentially be used to set CO_2 emissions standards within the EU in the longer term. In the future it is possible that manufacturers selling new HGVs into the EU market will face regulatory limits on their fleet average CO_2 emissions in a similar way to that as seen for cars and vans.

Efficiency Measures

5.8 The CCC Sectoral Scenarios for the Fifth Carbon Budget and more recently, the Freight Carbon Review, set out a number of options for demand-side reduction and the potential savings that could result. This includes:

- Efficient driving and in-cab technologies
- Fleet design
- Use of higher capacity vehicles
- Collaboration and consolidation

5.9 A review of efficiency options for road transport to 2050 carried out by AEA[27] to inform the sectoral scenarios identified a range of potential measures, their likely uptake over time and the level of efficiency over a 2010 baseline that could be delivered. Where measures are identified in the Freight Carbon Review and can be quantified, this data has been used to profile the efficiency improvements expected over time using a linear interpolation between uptake years (typically by 2020 and 2030); the percentage improvement in efficiency over the 2010 baseline has been applied to miles per gallon fuel consumption data for 2010 sourced from DfT. This data forms the basis of BEIS GHG emission factors for freighting goods so is considered a reliable baseline source, consistent with other measures.

5.10 From DfT Table RFS0141, in 2010, average fuel efficiency for a >33t articulated HGV was 7.6 miles per gallon; this reduced to 7.9 miles per gallon by 2016, the most recent year for which data is available (and the basis of 2018 emission factors).

5.11 **Table 5.1** outlines the measures assumed, the resultant efficiency improvement and the anticipated level of uptake by 2030 and 2050. Linear interpolation has been applied to determine the level of annual uptake. This is then multiplied by the efficiency improvement to determine the overall reduction fuel consumed as a result of the measure. Measures are applied to all vehicles, irrespective of fuel type.

[27] AEA 2012 'A review of the efficiency and cost assumption for road transport vehicles to 2050', AEA.

Table 5.1: Assumed Uptake of Efficiency Measures

Measure	Uptake by 2030	Uptake by 2050	Efficiency Improvement
General powertrain improvements (2020 - 2030)	-	-	8.3% by 2030
Low rolling resistance tyres	36%	100%	5%
Aerodynamic improvements	21%	100%	13%
Automatic tyre pressure adjustment	33%	100%	3%
Fuel efficiency and use of telematics	67%	100%	3%
Longer/ heavier vehicles	72%	100%	14%

Fuels

5.12 As previously stated, it is assumed that the goods being transported by rail are those that would otherwise have been transported long-haul by road. The most suitable vehicles for this type of driving and distance are articulated HGVs with high payloads, so it is assumed that all vehicles displaced by rail are over 33t articulated vehicles.

5.13 This type of vehicle has more limited alternative vehicle fuel options than smaller vehicles. Based on transport roadmaps developed by Element Energy, it is assumed that that diesel is likely to remain a predominant fuel option in the short- to medium-term, with methane/ biomethane and methanol as potential fuel alternatives in the future. Other technologies, such as electric and hydrogen are not expected to play a part in reducing emissions for this vehicle class.

5.14 The roadmaps predict a quantum of each vehicle fuel type on the road at 2020, 2025, 2030 and 2050, and these have been applied using linear interpolation to estimate potential vehicle quantums during the intervening periods. In reality, trajectories may not be linear and will depend on a number of factors, such as the availability of fuelling infrastructure and vehicles; however, for the purposes of this assessment, this is considered acceptable.

Diesel

5.15 Diesel emissions are reduced through blending with biodiesel, although this can affect the vehicle engine and increase maintenance intervals; components may need to be added or replaced to facilitate the use of higher biodiesel blends[28]. The compatibility of heavy-duty vehicles with higher blends is much better than for lighter vehicles due to the type of fuel injection system applied.

5.16 An estimate of market share of heavy duty vehicles which are currently compatible with biodiesel blends and neat biodiesel is high and is presented in

[28] TNO (2013) *'Bringing biofuels on the market – Options to increase EU biofuels volumes beyond the current blending limits*', Website: https://ec.europa.eu/energy/sites/ener/files/documents/2013_11_bringing_biofuels_on_the_market.pdf accessed July 2018, The European Commission.

Table 5.2, where the number following the letter 'B' indicates the percentage of biofuel in the blend.

Table 5.2: Biodiesel Compatibility by Vehicle Market Share

	B7	B20	B30	B100
Estimated Market Share	100%	85%	80%	60%

[Source: Table 16 Bringing biofuels on the market - Options to increase EU biofuels volumes beyond the current blending limits]

5.17 The BEIS 2017 methodology for GHG emissions does not state the proportion of biodiesel in the 'average' forecourt diesel mix; it uses data based on forecourt sales, but we have not been able to source this information. Instead, Table RTFO 01 from the DfT in relation to the RTFO scheme for 2017/18 has been applied; this sets out the quantity of diesel and biodiesel supplied in the UK, of which biodiesel accounts for 2.87%. It should be noted that this covers all transport diesel and biodiesel and may not relate directly to the BEIS 'average' diesel emission factor, but this is not considered likely to result in a significant error.

5.18 The emission factor for diesel (100% mineral diesel) is 2.68779 $kgCO_2e$/litre, compared with diesel (average biofuel blend) of 2.62964 kgCO2e/litre; assuming a biodiesel proportion of 2.87% results in the emission factor for the biodiesel component of 0.5676 kCO2e/litre.

5.19 An assessment of the potential future proportion of renewable transport fuels has been made based on the recent consultation relating to the future of the Renewable Transport Fuel Obligation scheme[29]; this sets out that by 2032, 12.4% of transport fuels will be from recognised renewable sources, including biomethane, biodiesel, biogas and bio-methanol.

5.20 Under the scheme, emissions for fuels supported range from 14gCO_2e/MJ fuel for biodiesel produced from used cooking oil to 68gCO_2e/MJ fuel for biodiesel produced from palm oil. These compare with 70.267 gCO_2e/MJ calculated for 100% mineral diesel using the BEIS 2018 emission factors and fuel properties. As the proportion of biodiesel increases, it is assumed that the emissions associated with its production will also increase and that less preferable sources (such as palm oil) will have to be used to meet demand. The current biodiesel emission factor calculated above of 0.5676 $kgCO_2e$/litre is therefore increased over time (to 2032) to 1.1289 $kgCO_2e$/ litre; this correlates with the central estimate of savings against diesel for fuels supported by the RTFO scheme. Emission factors for diesel are adjusted so that biodiesel delivers 12.4% of total supply by 2032. By 2050, it is assumed that biodiesel equals 30% of the blend.

Gas

5.21 The most likely alternative to diesel in the short- to medium-term is gas, however, this requires dedicated vehicles, and result in different fuel behaviours. There are a number of research projects being undertaken to

[29] DfT 2017 'The Renewable Transport Fuel Obligations Order: Government Response to the consultation on amendments'. UK Government.

understand a number of factors including the efficiency loss of alternative fuels compared with diesel and in particular, the impacts of methane slip.

5.22 The Low Carbon Truck Trial results indicate that a Scope 1 ‘tank-to-wheel’ emission saving of 11% can be achieved with a dedicated gas vehicle with a 15% biomethane blend. If the biomethane were removed, there would be an increase in emissions due to the reduction in efficiency between spark ignition dedicated gas truck and diesel comparator trucks.

5.23 This is consistent with other studies, which indicate that emissions compared with diesel for a dedicated gas vehicle are between -4% and 2% (Scope 1) and between -10% to 2% (Scope 3).

5.24 Unlike with diesel, there is no issue in substituting 100% natural gas with biomethane.

5.25 For the purposes of this assessment, it is therefore assumed that a dedicated gas vehicle has the same emissions as a diesel vehicle. For simplicity, the proportion of biomethane is assumed to be the same as for biodiesel in 2016, increasing linearly to 50% by 2050.

5.26 The current BEIS Emission Factor for biomethane is recorded as 0.10473 $kgCO_2e$/ GJ; based on fuel properties for biomethane, this converts to 0.0000041 $kgCO_2e$/litre.

Summary

5.27 A weighted emission factor for each year up to 2050 is calculated based on the estimated proportion of each vehicle type and their relative calculated emission factors, taking into account the measures described in this section. A full breakdown of the impact of individual measures on an annual basis is included in **Appendix B**.

6. Assessment & Conclusions

6.1 A profile of emissions considering the measures described in this document is presented in **Appendix A**.

6.2 Assuming the quantities of freight moved by road and rail as assessed in **Paragraphs 2.7 and 2.8**, annual emissions at key points in time are outlined in **Table 6.1** based on the emission factors calculated.

Table 6.1: Comparison of Emissions by Road and Rail

	2018	2028	2038	2050
Road only Emissions	60,920	50,524	47,456	40,855
SRFI GHG Emissions	60,920	27,561	15,263	6,485
% Reduction as a result of road to rail	0%	45.45%	67.84%	84.13%

6.3 Aggregated freight emissions as a result of the Proposed Development are presented for the construction phase (2019 -2028), short-term operational phase (2028 - 2038), and part of the long-term operational phase (2039 -2050) in **Table 6.2**.

6.4 Whilst emission profiles have not been developed beyond 2050 for road and rail freight, no assessment of potential emission reduction is projected beyond 2050. However, an assessment of long-term operational emissions (2039 - 2088) is also made based on emission factors at 2050, assuming no further improvements in efficiency or reductions in emission factors beyond this date.

Table 6.2: Aggregated Freight Emissions as a Result of Rail Central

GHG Emissions [tCO_2e]	2019 - 2028	2028 - 2038	2039-2050	2039 - 2088
Road-only Comparator	544,892	486,969	531,065	2,083,550
SRFI	486,706	214,482	120,757	367,187
Net SRFI	-76,186	-272,487	-410,308	-1,716,364

Appendix A: Profiled Emissions

Table A.1 Profiled Road-only Construction Phase Operational Emissions (2018 – 2028)

Road only Scenario	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
>33t Articulated Road [million tonne.km]	581	581	581	581	581	581	581	581	581	581	581
Annual Scope 1 GHG Emissions [tCO_2e]	**49,311**	**47,827**	**46,569**	**45,618**	**44,720**	**43,873**	**43,073**	**42,319**	**41,607**	**40,935**	**40,301**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**-**	**47,827**	**94,396**	**140,013**	**184,733**	**228,606**	**271,679**	**313,998**	**355,605**	**396,540**	**436,840**
Annual Scope 3 GHG Emissions [tCO_2e]	**11,609**	**11,562**	**11,315**	**11,141**	**10,979**	**10,827**	**10,687**	**10,556**	**10,436**	**10,325**	**10,223**
Aggregated Scope 3 Emissions [tCO_2e]	**-**	**11,562**	**22,878**	**34,019**	**44,998**	**55,825**	**66,512**	**77,068**	**87,503**	**97,828**	**108,052**
Annual GHG Emissions [tCO_2e]	60,920	59,389	57,885	56,759	55,698	54,700	53,760	52,875	52,043	51,260	50,524
Aggregated GHG Emissions [tCO_2e]	-	59,389	117,274	174,033	229,731	284,431	338,191	391,066	443,108	494,368	544,892

Table A.2 Profiled Rail Central Construction Phase Operational Emissions (2018 – 2028)

SRFI Scenario (30%)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
>33t Articulated Road [million tonne.km]	581	581	581	549	530	491	432	353	255	137	0
Rail [million tonne.km]	0	0	0	44	71	125	206	315	450	613	802
>33t Articulated Road Scope 1 Emissions [tCO_2e]	49,311	47,827	46,569	43,119	40,761	37,026	31,990	25,715	18,259	9,673	0
Rail Scope 1 & 2 Emissions [tCO_2e]	0	0	0	1,398	2,209	3,817	6,184	9,211	12,743	16,996	21,598
Annual Scope 1 & 2 GHG Emissions [tCO_2e]	**49,311**	**47,827**	**46,569**	**44,517**	**42,970**	**40,843**	**38,174**	**34,926**	**31,002**	**26,670**	**21,598**
Aggregated Scope 1 & 2GHG Emissions [tCO_2e]	**-**	**47,827**	**94,396**	**138,912**	**181,882**	**222,726**	**260,899**	**295,825**	**326,827**	**353,497**	**375,095**
>33t Articulated Road Scope 3 Emissions [tCO_2e]	11,609	11,562	11,315	10,531	10,007	9,138	7,937	6,414	4,580	2,440	0
Rail Scope 3 Emissions [tCO_2e]	0	0	0	337	543	953	1,564	2,373	3,378	4,576	5,964
Annual Scope 3 GHG Emissions [tCO_2e]	**11,609**	**11,562**	**11,315**	**10,869**	**10,550**	**10,090**	**9,500**	**8,787**	**7,958**	**7,016**	**5,964**
Aggregated Scope 3 Emissions [tCO_2e]	**-**	**11,562**	**22,878**	**33,746**	**44,296**	**54,387**	**63,887**	**72,674**	**80,632**	**87,648**	**93,612**
Annual GHG Emissions [tCO_2e]	**60,920**	**59,389**	**57,885**	**55,385**	**53,520**	**50,934**	**47,674**	**43,714**	**38,960**	**33,685**	**27,561**
Aggregated GHG Emissions [tCO_2e]	**-**	**59,389**	**117,274**	**172,659**	**226,179**	**277,112**	**324,786**	**368,500**	**407,460**	**441,145**	**468,706**

Table A.3 Profiled Net Central Construction Phase Operational Emissions (2018 – 2028)

SRFI Scenario (30%)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
>33t Articulated Road [million tonne.km]	0	0	0	-32	-51	-91	-150	-228	-326	-444	-581
Rail [million tonne.km]	0	0	0	44	71	125	206	315	450	613	802
>33t Articulated Road tCO_2e	0	0	0	-2,499	-3,959	-6,846	-11,084	-16,604	-23,347	-31,262	-40,301
Rail tCO_2e	0	0	0	1,398	2,209	3,817	6,184	9,211	12,743	16,996	21,598
Annual Scope 1 GHG Emissions [tCO_2e]	**0**	**0**	**0**	**-1,101**	**-1,750**	**-3,029**	**-4,900**	**-7,393**	**-10,605**	**-14,265**	**-18,703**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**-**	**0**	**0**	**-1,101**	**-2,851**	**-5,880**	**-10,780**	**-18,173**	**-28,777**	**-43,043**	**-61,746**
>33t Articulated Road Scope 3 Emissions [tCO_2e]	0	0	0	-610	-972	-1,690	-2,750	-4,142	-5,856	-7,885	-10,223
Rail Scope 3 Emissions [tCO_2e]	0	0	0	337	543	953	1,564	2,373	3,378	4,576	5,964
Annual Scope 3 GHG Emissions [tCO_2e]	**0**	**0**	**0**	**-273**	**-429**	**-737**	**-1,186**	**-1,769**	**-2,478**	**-3,309**	**-4,260**
Aggregated Scope 3 Emissions [tCO_2e]	**-**	**0**	**0**	**-273**	**-702**	**-1,439**	**-2,625**	**-1,769**	**-4,246**	**-7,556**	**-11,815**
Annual GHG Emissions [tCO_2e]	**0**	**0**	**0**	**-1,374**	**-2,179**	**-3,766**	**-6,086**	**-9,161**	**-13,083**	**-17,574**	**-22,963**
Aggregated GHG Emissions [tCO_2e]	**-**	**0**	**0**	**-1,374**	**-3,553**	**-7,319**	**-13,405**	**-19,941**	**-33,024**	**-50,598**	**-73,561**

Table A.4 Profiled Road-only Short-term Operational Phase Emissions (2029 – 2038)

Road only Scenario	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
>33t Articulated Road [million tonne.km]	581	581	581	581	581	581	581	581	581	581
Annual Scope 1 GHG Emissions [tCO_2e]	**39,702**	**39,136**	**39,082**	**39,017**	**38,634**	**38,230**	**37,784**	**37,293**	**36,758**	**36,178**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**39,702**	**78,838**	**117,920**	**156,937**	**195,571**	**233,801**	**271,585**	**308,879**	**345,637**	**381,815**
Annual Scope 3 GHG Emissions [tCO_2e]	**10,131**	**10,047**	**10,120**	**10,205**	**10,336**	**10,486**	**10,656**	**10,844**	**11,051**	**11,277**
Aggregated Scope 3 Emissions [tCO_2e]	**10,131**	**20,178**	**30,298**	**40,503**	**50,839**	**61,325**	**71,981**	**82,825**	**93,876**	**105,153**
Annual GHG Emissions [tCO_2e]	**49,833**	**49,183**	**49,202**	**49,222**	**48,971**	**48,717**	**48,439**	**48,137**	**47,810**	**47,456**
Aggregated GHG Emissions [tCO_2e]	**49,833**	**99,016**	**148,218**	**197,439**	**246,410**	**295,127**	**343,566**	**391,703**	**439,513**	**486,969**

Table A.5 Profiled Rail Central Short-term Operational Phase Emissions (2019 – 2038)

Rail Central Scenario	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Rail [million tonne.km]	802	802	802	802	802	802	802	802	802	802
Annual Scope 1 & 2 GHG Emissions [tCO_2e]	**20,890**	**20,483**	**19,258**	**17,788**	**16,579**	**15,224**	**13,717**	**12,509**	**11,161**	**9,809**
Aggregated Scope 1 & 2GHG Emissions [tCO_2e]	**20,890**	**41,373**	**60,631**	**78,419**	**94,998**	**110,223**	**123,940**	**136,449**	**147,610**	**157,418**
Annual Scope 3 GHG Emissions [tCO_2e]	**5,935**	**5,907**	**5,851**	**5,794**	**5,737**	**5,681**	**5,624**	**5,568**	**5,511**	**5,455**
Aggregated Scope 3 Emissions [tCO_2e]	5,935	11,842	17,693	23,487	29,224	34,905	40,530	46,098	51,609	57,064
Annual GHG Emissions [tCO_2e]	**26,825**	**26,390**	**25,109**	**23,582**	**22,317**	**20,905**	**19,342**	**18,077**	**16,672**	**15,263**
Aggregated GHG Emissions [tCO_2e]	**26,825**	**53,215**	**78,324**	**101,906**	**124,223**	**145,128**	**164,470**	**182,547**	**199,219**	**214,482**

Table A.6 Profiled Net Central Short-term Operational Phase Emissions (2019 – 2038)

Net Rail Central Emissions	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Annual Scope 1 GHG Emissions [tCO_2e]	**-18,812**	**-18,653**	**-19,824**	**-21,229**	**-22,055**	**-23,006**	**-24,066**	**-24,784**	**-25,598**	**-26,370**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**-18,812**	**-37,465**	**-57,289**	**-78,518**	**-100,573**	**-123,579**	**-147,645**	**-172,430**	**-198,027**	**-224,397**
Annual Scope 3 GHG Emissions [tCO_2e]	**-4,195**	**-4,140**	**-4,270**	**-4,411**	**-4,599**	**-4,805**	**-5,031**	**-5,276**	**-5,540**	**-5,823**
Aggregated Scope 3 Emissions [tCO_2e]	**-4,195**	**-8,335**	**-12,605**	**-17,016**	**-21,614**	**-26,420**	**-31,451**	**-36,727**	**-42,267**	**-48,089**
Annual GHG Emissions [tCO_2e]	**-23,007**	**-22,793**	**-24,093**	**-25,640**	**-26,654**	**-27,812**	**-29,098**	**-30,060**	**-31,138**	**-32,192**
Aggregated GHG Emissions [tCO_2e]	**-23,007**	**-45,801**	**-69,894**	**-95,533**	**-122,187**	**-149,999**	**-179,096**	**-209,157**	**-240,294**	**-272,487**

Table A.7a Profiled Road-only Long-term Operational Phase Emissions (2039 – 2050)

Road only Scenario	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
>33t Articulated Road [million tonne.km]	581	581	581	581	581	581	581	581	581	581	581	581
Annual Scope 1 GHG Emissions [tCO_2e]	**35,552**	**34,879**	**34,158**	**33,388**	**32,570**	**31,702**	**30,783**	**29,813**	**28,792**	**27,718**	**26,591**	**25,434**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**35,552**	**70,430**	**104,588**	**137,976**	**170,546**	**202,248**	**233,031**	**262,845**	**291,637**	**319,355**	**345,947**	**371,381**
Annual Scope 3 GHG Emissions [tCO_2e]	**11,522**	**11,786**	**12,068**	**12,368**	**12,687**	**13,024**	**13,379**	**13,753**	**14,144**	**14,553**	**14,980**	**15,421**
Aggregated Scope 3 Emissions [tCO_2e]	**116,676**	**128,461**	**140,529**	**152,897**	**165,584**	**178,608**	**191,988**	**205,740**	**219,884**	**234,437**	**249,417**	**264,838**
Annual GHG Emissions [tCO_2e]	47,074	46,664	46,225	45,757	45,257	44,726	44,162	43,566	42,936	42,271	41,571	40,855
Aggregated GHG Emissions [tCO_2e]	**47,074**	**93,738**	**139,964**	**185,720**	**230,977**	**275,703**	**319,866**	**363,432**	**406,368**	**448,639**	**490,210**	**531,065**

Table A.8a Profiled Rail Central Long-term Operational Phase Emissions (2039 – 2050)

SRFI Scenario (30%)	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Rail [million tonne.km]	802	802	802	802	802	802	802	802	802	802	802	802
Annual Scope 1 & 2 GHG Emissions [tCO_2e]	**8,674**	**7,493**	**6,904**	**6,310**	**5,710**	**5,105**	**4,496**	**3,881**	**3,261**	**2,635**	**2,005**	**1,369**
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	**166,092**	**173,585**	**180,489**	**186,799**	**192,509**	**197,614**	**202,110**	**205,991**	**209,251**	**211,886**	**213,891**	**215,260**
Annual Scope 3 GHG Emissions [tCO_2e]	**5,398**	**5,342**	**5,319**	**5,297**	**5,274**	**5,251**	**5,229**	**5,206**	**5,184**	**5,161**	**5,138**	**5,116**
Aggregated Scope 3 Emissions [tCO_2e]	**154,324**	**159,666**	**164,985**	**170,282**	**175,556**	**180,807**	**186,036**	**191,242**	**196,425**	**201,586**	**206,725**	**211,840**
Annual GHG Emissions [tCO_2e]	14,072	12,835	12,223	11,606	10,984	10,357	9,724	9,087	8,444	7,796	7,143	6,485
Aggregated GHG Emissions [tCO_2e]	**14,072**	**26,907**	**39,130**	**50,736**	**61,721**	**72,077**	**81,802**	**90,889**	**99,333**	**107,129**	**114,272**	**120,757**

Table A.9a Profiled Net Rail Central Long-term Operational Phase Emissions (2039 – 2050)

SRFI Scenario (30%)	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Annual Scope 1 GHG Emissions [tCO_2e]	**-26,878**	**-27,386**	**-27,254**	**-27,079**	**-26,860**	**-26,596**	**-26,288**	**-25,933**	**-25,531**	**-25,083**	**-24,587**	**-24,065**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**130,540**	**103,155**	**75,901**	**48,822**	**21,962**	**-4,634**	**-30,922**	**-56,854**	**-82,386**	**-107,469**	**-132,055**	**-156,120**
Annual Scope 3 GHG Emissions [tCO_2e]	**-6,124**	**-6,444**	**-6,749**	**-7,072**	**-7,413**	**-7,773**	**-8,151**	**-8,546**	**-8,960**	**-9,392**	**-9,842**	**-10,305**
Aggregated Scope 3 Emissions [tCO_2e]	**-6,124**	**-12,568**	**-19,316**	**-26,388**	**-33,801**	**-41,574**	**-49,724**	**-58,271**	**-67,231**	**-76,623**	**-86,465**	**-96,770**
Annual GHG Emissions [tCO2e]	-33,002	-33,829	-34,002	-34,150	-34,273	-34,369	-34,438	-34,479	-34,492	-34,475	-34,428	-34,370
Aggregated GHG Emissions [tCO_2e]	**-33,002**	**-66,831**	**-100,833**	**-134,984**	**-169,257**	**-203,626**	**-238,064**	**-272,543**	**-307,035**	**-341,510**	**-375,938**	**-410,308**

Table A.7b Profiled Road-only Long-term Operational Phase Emissions (2051 – 2069)

Road only Scenario	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
>33t Articulated Road [million tonne.km]	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581
Annual Scope 1 GHG Emissions [tCO_2e]	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**25,434**	**50,868**	**76,302**	**101,736**	**127,169**	**152,603**	**178,037**	**203,471**	**228,905**	**254,339**	**279,773**	**305,207**	**330,641**	**356,075**	**381,508**	**406,942**	**432,376**	**457,810**	**483,244**
Annual Scope 3 GHG Emissions [tCO_2e]	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**
Aggregated Scope 3 Emissions [tCO_2e]	**280,259**	**295,680**	**311,101**	**326,522**	**341,943**	**357,364**	**372,785**	**388,206**	**403,627**	**419,048**	**434,469**	**449,890**	**465,311**	**480,732**	**496,153**	**511,574**	**526,995**	**542,416**	**557,837**
Annual GHG Emissions [tCO_2e]	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855
Aggregated GHG Emissions [tCO_2e]	571,920	612,775	653,630	694,485	735,340	776,194	817,049	857,904	898,759	939,614	980,469	1,021,324	1,062,179	1,103,033	1,143,888	1,184,743	1,225,598	1,266,453	1,307,308

Table A.8b Profiled Rail Central Long-term Operational Phase Emissions (2051 – 2069)

SRFI Scenario (30%)	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Rail [million tonne.km]	802	802	802	802	802	802	802	802	802	802	802	802	802	802	802	802	802	802	802
Annual Scope 1 & 2 GHG Emissions [tCO_2e]	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	**216,630**	**217,999**	**219,368**	**220,738**	**222,107**	**223,476**	**224,845**	**226,215**	**227,584**	**228,953**	**230,323**	**231,692**	**233,061**	**234,430**	**235,800**	**237,169**	**238,538**	**239,907**	**241,277**
Annual Scope 3 GHG Emissions [tCO_2e]	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**
Aggregated Scope 3 Emissions [tCO_2e]	**216,630**	**217,999**	**219,368**	**220,738**	**222,107**	**223,476**	**224,845**	**226,215**	**227,584**	**228,953**	**230,323**	**231,692**	**233,061**	**234,430**	**235,800**	**237,169**	**238,538**	**239,907**	**241,277**
Annual GHG Emissions [tCO_2e]	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485
Aggregated GHG Emissions [tCO_2e]	127,242	133,727	140,212	146,697	153,182	159,667	166,152	172,637	179,122	185,607	192,092	198,577	205,062	211,547	218,032	224,517	231,002	237,487	243,972

Table A.9b Profiled Net Rail Central Long-term Operational Phase Emissions (2051 – 2069)

SRFI Scenario (30%)	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Annual Scope 1 GHG Emissions [tCO_2e]	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**-155,165**	**-165,470**	**-175,775**	**-186,080**	**-196,386**	**-206,691**	**-216,996**	**-227,301**	**-237,607**	**-247,912**	**-258,217**	**-268,522**	**-278,828**	**-289,133**	**-299,438**	**-309,744**	**-320,049**	**-330,354**	**-340,659**
Annual Scope 3 GHG Emissions [tCO_2e]	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**
Aggregated Scope 3 Emissions [tCO_2e]	**-155,165**	**-165,470**	**-175,775**	**-186,080**	**-196,386**	**-206,691**	**-216,996**	**-227,301**	**-237,607**	**-247,912**	**-258,217**	**-268,522**	**-278,828**	**-289,133**	**-299,438**	**-309,744**	**-320,049**	**-330,354**	**-340,659**
Annual GHG Emissions [tCO2e]	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370
Aggregated GHG Emissions [tCO_2e]	-444,678	-479,048	-513,418	-547,788	-582,158	-616,527	-650,897	-685,267	-719,637	-754,007	-788,377	-822,747	-857,117	-891,486	-925,856	-960,226	-994,596	-1,028,966	-1,063,336

Table A.7c Profiled Road-only Long-term Operational Phase Emissions (2070 – 2088)

Road only Scenario	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088
>33t Articulated Road [million tonne.km]	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581
Annual Scope 1 GHG Emissions [tCO_2e]	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**	**25,434**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**880,058**	**905,492**	**930,926**	**956,360**	**981,794**	**1,007,228**	**1,032,662**	**1,058,096**	**1,083,530**	**1,108,963**	**1,134,397**	**1,159,831**	**1,185,265**	**1,210,699**	**1,236,133**	**1,261,567**	**1,287,001**	**1,312,435**	**1,337,869**
Annual Scope 3 GHG Emissions [tCO_2e]	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**	**15,421**
Aggregated Scope 3 Emissions [tCO_2e]	**573,258**	**588,679**	**604,100**	**619,521**	**634,942**	**650,363**	**665,784**	**681,205**	**696,626**	**712,046**	**727,467**	**742,888**	**758,309**	**773,730**	**789,151**	**804,572**	**819,993**	**835,414**	**850,835**
Annual GHG Emissions [tCO_2e]	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855	40,855
Aggregated GHG Emissions [tCO_2e]	1,348,163	1,389,018	1,429,872	1,470,727	1,511,582	1,552,437	1,593,292	1,634,147	1,675,002	1,715,857	1,756,711	1,797,566	1,838,421	1,879,276	1,920,131	1,960,986	2,001,841	2,042,696	2,083,550

Table A.8c Profiled Rail Central Long-term Operational Phase Emissions (2070 – 2088)

SRFI Scenario (30%)	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088
Rail [million tonne.km]	802	802	802	802	802	802	802	802	802	802	802	802	802						
Annual Scope 1 & 2 GHG Emissions [tCO_2e]	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**	**1,369**
Aggregated Scope 1 & 2 GHG Emissions [tCO_2e]	**242,646**	**244,015**	**245,385**	**246,754**	**248,123**	**249,492**	**250,862**	**252,231**	**253,600**	**254,969**	**256,339**	**257,708**	**259,077**	**260,447**	**261,816**	**263,185**	**264,554**	**265,924**	**267,293**
Annual Scope 3 GHG Emissions [tCO_2e]	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**	**5,116**
Aggregated Scope 3 Emissions [tCO_2e]	**222,293**	**227,409**	**232,525**	**237,640**	**242,756**	**247,872**	**252,987**	**258,103**	**263,219**	**268,335**	**273,450**	**278,566**	**283,682**	**288,797**	**293,913**	**299,029**	**304,145**	**309,260**	**314,376**
Annual GHG Emissions [tCO_2e]	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485	6,485
Aggregated GHG Emissions [tCO_2e]	250,457	256,942	263,427	269,912	276,397	282,882	289,367	295,852	302,337	308,822	315,307	321,792	328,277	334,762	341,247	347,732	354,217	360,702	367,187

Table A.9c Profiled Net Rail Central Long-term Operational Phase Emissions (2070 – 2088)

SRFI Scenario (30%)	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088
Annual Scope 1 GHG Emissions [tCO_2e]	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**	**-24,065**
Aggregated Scope 1 GHG Emissions [tCO_2e]	**-794,831**	**-818,895**	**-842,960**	**-867,025**	**-891,089**	**-915,154**	**-939,218**	**-963,283**	**-987,348**	**-1,011,412**	**-1,035,477**	**-1,059,541**	**-1,083,606**	**-1,107,671**	**-1,131,735**	**-1,155,800**	**-1,179,865**	**-1,203,929**	**-1,227,994**
Annual Scope 3 GHG Emissions [tCO_2e]	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**	**-10,305**
Aggregated Scope 3 Emissions [tCO_2e]	**-350,965**	**-361,270**	**-371,575**	**-381,880**	**-392,186**	**-402,491**	**-412,796**	**-423,101**	**-433,407**	**-443,712**	**-454,017**	**-464,322**	**-474,628**	**-484,933**	**-495,238**	**-505,543**	**-515,849**	**-526,154**	**-536,459**
Annual GHG Emissions [tCO2e]	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370	-34,370
Aggregated GHG Emissions [tCO_2e]	-1,097,706	-1,132,076	-1,166,446	-1,200,815	-1,235,185	-1,269,555	-1,303,925	-1,338,295	-1,372,665	-1,407,035	-1,441,405	-1,475,774	-1,510,144	-1,544,514	-1,578,884	-1,613,254	-1,647,624	-1,681,994	-1,716,364

Appendix B: Profiled Emission Factors - Road

Table B.1: Baseline Emission Factor Calculation Data and Sources

	>33t Articulated HGV	Data	Source
[1]	Annual Goods Moved [tonne.km]	111,987,000,000	DfT Table RFS0119
[2]	Annual Distance Travelled [vehicle.km]	9,904,000,000	DfT Table RFS0119
[3]	Fuel Efficiency [miles per gallon]	7.9	DfT Table RFS0141
[4]	Average Loading Factor	0.62	DfT Table RFS0117
[5]	Mile to km Conversion	1.6096	Standard conversion
[6]	Gallon to Litres Conversion	4.561	Standard conversion
[7]	Km per litre	2.7966	Calculation ({[3] x [5]}/[6])
[8]	Average tonnes per load	11.31	Calculation ([1]/[2])
[9]	$kgCO_2e$ per litre diesel (average load factor)	2.62694	BEIS 2018 Emission Factors
[10]	$kgCO_2e$ per litre WTT diesel (average load factor)	0.61846	BEIS 2018 Emission Factors

Table B.2: Baseline Emission Factor Calculations

[11]	Loading Factor [LF]	0.00	0.50	0.60	0.62	1.00	Source
BEIS 2018 Emission Factors							
[12]	$kgCO_2e$ diesel per tonne.km	-	0.0977	-	0.0835	0.0609	BEIS 2018 Emission Factors
[13]	$kgCO_2e$ WTT diesel per km	-	0.0233	-	0.0199	0.0145	BEIS 2018 Emission Factors
Emission Factors Calculated from 1st Principles							
[14]	Tonnes per load	0.00	9.12	10.98	11.31	18.24	Calculation: LF 0.62 = [8]; LF 1.00 = [8]/[4]; LF 0.50 = 0.5 * LF 1.00
[15]	$kgCO_2e$ diesel per km	0.6646	0.8862	0.9314	0.9393	1.1077	Calculation : LF 0.62 = [12]/[7]; LF (other) = ([LF 0.62 [15]]/(0.5*[4] + 0.75))*(0.5*LF (other) +0.75)
[16]	$kgCO_2e$ diesel per tonne.km	-	0.0972	0.0848	0.0831	0.0607	Calculation : [14]/[15]
[17]	$kgCO_2e$ WTT diesel per km	0.1565	0.2086	0.2193	0.2211	0.2608	Calculation : LF 0.62 = [13]/[7]; LF (other) = ([LF 0.62 [17]]/(0.5*[4] + 0.75))*(0.5*LF (other) +0.75)
[18]	kgCO2e WTT diesel per tonne.km	-	0.0229	0.0200	0.0196	0.0143	Calculation : [16]/[17]
Comparison between BEIS and Calculated							
[19]	Difference between BEIS and Calculated	-	0.57%	-	0.49%	0.27%	Calculation
[20]	Difference between BEIS and Calculated	-	1.64%	-	1.52%	1.32%	Calculation

Table B3: Vehicle Stocks, Efficiency Improvement Measures & Resulting Emission Factors (2018 – 2028)

Vehicle Stocks	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Total HGVs	504,864	507,836	**510,807**	513,778	516,750	519,721	522,692	**525,664**	528,635	531,607	534,578
% HGV > 18t*	146,411	147,272	**148,134**	148,996	149,857	150,719	151,581	**152,443**	153,304	154,166	155,028
% Diesel (some dual fuel)	95%	94%	**92%**	91%	90%	88%	87%	**86%**	85%	84%	82%
Diesel (including dual)	139,383	137,847	**136,283**	135,288	134,272	133,236	132,178	**131,101**	130,002	128,883	127,743
Natural Gas > 18t	2,400	3,200	**4,000**	5,600	7,200	8,800	10,400	**12,000**	14,400	16,800	19,200
Niche/ other fuels	4,628	6,225	**7,851**	8,108	8,385	8,683	9,002	**9,342**	8,902	8,483	8,085
Existing Diesel Articulated >33t											
General Powertrain Improvements											
Efficiency improvement (from 2020)	0.00%	0.00%	0.00%	0.83%	1.66%	2.49%	3.32%	4.15%	4.98%	5.81%	6.64%
Fuel efficiency - Low rolling resistance tyres											
Uptake	14.40%	16.20%	18.00%	19.80%	21.60%	23.40%	25.20%	27.00%	28.80%	30.60%	32.40%
% increase in fuel efficiency per uptake (from 2010)	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
% increase in fuel efficiency	0.72%	0.81%	0.90%	0.99%	1.08%	1.17%	1.26%	1.35%	1.44%	1.53%	1.62%
Fuel Efficiency - Aerodynamic trailers/ bodies*											
Uptake	11.00%	11.83%	12.67%	13.50%	14.33%	15.17%	16.00%	16.83%	17.67%	18.50%	19.33%
% increase in fuel efficiency per uptake (from 2010)	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%
% increase in fuel efficiency	1.43%	1.54%	1.65%	1.75%	1.86%	1.97%	2.08%	2.19%	2.30%	2.40%	2.51%
Fuel Efficiency - Automatic tyre pressure adjustment											
Uptake	13.20%	14.85%	16.50%	18.15%	19.80%	21.45%	23.10%	24.75%	26.40%	28.05%	29.70%
% increase in fuel efficiency per uptake (from 2010)	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
% increase in fuel efficiency	0.40%	0.45%	0.50%	0.54%	0.59%	0.64%	0.69%	0.74%	0.79%	0.84%	0.89%
Fuel Efficiency - Fuel efficiency and use of telematics											
Uptake	26.80%	34.55%	37.50%	40.45%	43.40%	46.35%	49.30%	52.25%	55.20%	58.15%	61.10%
% increase in fuel efficiency per uptake (from 2010)	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
% increase in fuel efficiency	0.80%	1.04%	1.12%	1.21%	1.30%	1.39%	1.48%	1.57%	1.66%	1.74%	1.83%
Total increase in Fuel Efficiency											
Total increase in Fuel Efficiency (from 2010)	3.35%	3.83%	4.17%	5.33%	6.50%	7.67%	8.83%	10.00%	11.16%	12.33%	13.50%
Diesel average mpg (>33t artics)	7.90	7.94	7.96	8.05	8.14	8.23	8.32	8.41	8.50	8.59	8.68

Use of larger and longer vehicles	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Uptake	-	0.00%	0.00%	7.20%	14.40%	21.60%	28.80%	36.00%	43.20%	50.40%	57.60%
% change in load	-	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
% change in average load factor	-	0.00%	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	6.00%	7.01%	8.01%
Loading Factor (artics>33t)	0.602	0.602	0.620	0.626	0.632	0.639	0.645	0.651	0.657	0.663	0.670
Tonnes per load	10.98	10.98	11.31	11.42	11.53	11.65	11.76	11.87	11.99	12.10	12.21
Recalculated Emissions Factors (without biofuels)											
km per litre	2.7966	2.8096	2.8187	2.8503	2.8819	2.9134	2.9450	2.9765	3.0081	3.0397	3.0712
$kgCO_2e$ diesel per km	0.9393	0.9350	0.9320	0.9216	0.9115	0.9017	0.8920	0.8825	0.8733	0.8642	0.8553
$kgCO_2e$ WTT diesel per km	0.2211	0.2201	0.2194	0.2170	0.2146	0.2123	0.2100	0.2078	0.2056	0.2035	0.2014
tonnes (average load)	10.98	10.98	11.31	11.42	11.53	11.65	11.76	11.87	11.99	12.10	12.21
$kgCO_2e$ diesel per km	0.9314	0.9271	0.9320	0.9243	0.9169	0.9096	0.9024	0.8955	0.8886	0.8819	0.8754
$kgCO_2e$ WTT diesel per km	0.2193	0.2183	0.2194	0.2176	0.2159	0.2141	0.2125	0.2108	0.2092	0.2076	0.2061
Adjusted Direct Emission Factor [$kgCO_2e$ diesel per tonne.km]	0.0848	0.0844	0.0824	0.0809	0.0795	0.0781	0.0767	0.0754	0.0741	0.0729	0.0717
Adjusted Indirect Emission Factor [$kgCO_2e$ WTT diesel per tonne.km]	0.0200	0.0199	0.0194	0.0191	0.0187	0.0184	0.0181	0.0178	0.0175	0.0172	0.0169
Biodiesel Mix											
Uptake	2.87%	3.53%	4.21%	4.89%	5.58%	6.26%	6.94%	7.62%	8.30%	8.98%	9.66%
% increase in fuel efficiency per uptake	0.5676	0.6189	0.6590	0.6991	0.7392	0.7793	0.8194	0.8595	0.8996	0.9397	0.9798
% increase in fuel efficiency	0.0848	0.0821	0.0798	0.0780	0.0763	0.0746	0.0730	0.0715	0.0700	0.0686	0.0673
Natural Gas Articulated >33t (90% of diesel)											
Uptake	2.87%	3.53%	4.21%	4.89%	5.58%	6.26%	6.94%	7.62%	8.30%	8.98%	9.66%
% increase in fuel efficiency per uptake	0.0848	0.0842	0.0837	0.0831	0.0825	0.0819	0.0813	0.0807	0.0801	0.0795	0.0789
% increase in fuel efficiency	0.0200	0.0201	0.0202	0.0203	0.0203	0.0204	0.0205	0.0206	0.0207	0.0208	0.0209
Adjusted Scope 1 Emission Factor [$kgCO_2e$/tonne.km]	**0.0848**	**0.0823**	**0.0801**	**0.0785**	**0.0769**	**0.0755**	**0.0741**	**0.0728**	**0.0716**	**0.0704**	**0.0693**
Adjusted Scope 3 Emission Factor [$kgCO_2e$/ tonne.km]	**0.0200**	**0.0199**	**0.0195**	**0.0192**	**0.0189**	**0.0186**	**0.0184**	**0.0182**	**0.0180**	**0.0178**	**0.0176**

Table B.4: Vehicle Stocks, Efficiency Improvement Measures & Resulting Emission Factors (2029 – 2038)

Vehicle Stocks	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Total HGVs	537,549	**540,521**	543,492	546,463	549,435	552,406	555,378	558,349	561,320	564,292
% HGV > 18t*	155,889	**156,751**	157,613	158,474	159,336	160,198	161,060	161,921	162,783	163,645
% Diesel (some dual fuel)	81%	**80%**	76%	72%	68%	64%	60%	56%	52%	48%
Diesel (including dual)	126,582	**125,401**	119,786	114,102	108,349	102,527	96,636	90,676	84,647	78,549
Natural Gas > 18t	21,600	**24,000**	27,050	30,100	33,150	36,200	39,250	42,300	45,350	48,400
Niche/ other fuels	7,707	**7,350**	10,777	14,273	17,838	21,471	25,174	28,945	32,786	36,695
Existing Diesel Articulated >33t										
General Powertrain Improvements										
Efficiency improvement (from 2020)	7.47%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%
Fuel efficiency - Low rolling resistance tyres										
Uptake	34.20%	**36.00%**	39.20%	42.40%	45.60%	48.80%	52.00%	55.20%	58.40%	61.60%
% increase in fuel efficiency per uptake (from 2010)	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
% increase in fuel efficiency	1.71%	1.80%	1.96%	2.12%	2.28%	2.44%	2.60%	2.76%	2.92%	3.08%
Fuel Efficiency - Aerodynamic trailers/ bodies*										
Uptake	20.17%	**21.00%**	24.95%	28.90%	32.85%	36.80%	40.75%	44.70%	48.65%	52.60%
% increase in fuel efficiency per uptake (from 2010)	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%
% increase in fuel efficiency	2.62%	2.73%	3.24%	3.76%	4.27%	4.78%	5.30%	5.81%	6.32%	6.84%
Fuel Efficiency - Automatic tyre pressure adjustment										
Uptake	31.35%	**33.00%**	36.35%	39.70%	43.05%	46.40%	49.75%	53.10%	56.45%	59.80%
% increase in fuel efficiency per uptake (from 2010)	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
% increase in fuel efficiency	0.94%	0.99%	1.09%	1.19%	1.29%	1.39%	1.49%	1.59%	1.69%	1.79%
Fuel Efficiency - Fuel efficiency and use of telematics										
Uptake	64.05%	**67.00%**	68.65%	70.30%	71.95%	73.60%	75.25%	76.90%	78.55%	80.20%
% increase in fuel efficiency per uptake (from 2010)	3.00%	**3.00%**	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
% increase in fuel efficiency	1.92%	2.01%	2.06%	2.11%	2.16%	2.21%	2.26%	2.31%	2.36%	2.41%
Total increase in Fuel Efficiency										
Total increase in Fuel Efficiency (from 2010)	14.66%	15.83%	16.65%	17.48%	18.30%	19.12%	19.95%	20.77%	21.59%	22.42%
Diesel average mpg (>33t artics)	8.76	8.85	8.92	8.98	9.04	9.11	9.17	9.23	9.29	9.36

Use of larger and longer vehicles										
Uptake	64.80%	**72%**	72%	72%	72%	72%	72%	72%	72%	72%
% change in load	14%	**14%**	14%	14%	14%	14%	14%	14%	14%	14%
% change in average load factor	9.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%
Loading Factor (artics>33t)	0.676	0.682	0.682	0.682	0.682	0.682	0.682	0.682	0.682	0.682
Tonnes per load	12.33	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44
Recalculated Emissions Factors (without biofuels)										
km per litre	3.1028	3.1343	3.1566	3.1789	3.2012	3.2235	3.2458	3.2681	3.2903	3.3126
$kgCO_2e$ diesel per km	0.8466	0.8381	0.8322	0.8264	0.8206	0.8149	0.8093	0.8038	0.7984	0.7930
$kgCO_2e$ WTT diesel per km	0.1993	0.1973	0.1959	0.1946	0.1932	0.1919	0.1905	0.1892	0.1880	0.1867
tonnes (average load)	12.33	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44
$kgCO_2e$ diesel per km	0.8689	0.8626	0.8566	0.8505	0.8446	0.8388	0.8330	0.8274	0.8217	0.8162
$kgCO_2e$ WTT diesel per km	0.2046	0.2031	0.2017	0.2002	0.1989	0.1975	0.1961	0.1948	0.1935	0.1922
Adjusted Scope 1 Emission Factor [$kgCO_2e$/tonne.km]	0.0705	0.0694	0.0689	0.0684	0.0679	0.0674	0.0670	0.0665	0.0661	0.0656
Adjusted Scope 3 Emission Factor [$kgCO_2e$ / tonne.km]	0.0166	0.0163	0.0162	0.0161	0.0160	0.0159	0.0158	0.0157	0.0156	0.0154
Biodiesel Mix										
Uptake	10.34%	11.02%	11.70%	**12.40%**	13.47%	14.45%	15.42%	16.40%	17.38%	18.36%
% increase in fuel efficiency per uptake	1.0199	1.0600	1.1001	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289
% increase in fuel efficiency	0.0660	0.0647	0.0641	0.0635	0.0626	0.0618	0.0610	0.0602	0.0594	0.0586
Natural Gas Articulated >33t (90% of diesel)										
Uptake	10.34%	11.02%	11.70%	**12.40%**	14.53%	16.62%	18.71%	20.80%	22.89%	24.98%
% increase in fuel efficiency per uptake	0.0783	0.0777	0.0771	0.0765	0.0747	0.0728	0.0710	0.0692	0.0674	0.0656
% increase in fuel efficiency	0.0210	0.0211	0.0212	0.0213	0.0216	0.0219	0.0222	0.0225	0.0228	0.0230
Adjusted Scope 1 Emission Factor [$kgCO_2e$/tonne.km]	**0.0683**	**0.0673**	**0.0672**	**0.0671**	**0.0665**	**0.0658**	**0.0650**	**0.0642**	**0.0632**	**0.0622**
Adjusted Scope 3 Emission Factor [$kgCO_2e$/tonne.km]	**0.0174**	**0.0173**	**0.0174**	**0.0176**	**0.0178**	**0.0180**	**0.0183**	**0.0187**	**0.0190**	**0.0194**

Table B.5: Vehicle Stocks, Efficiency Improvement Measures & Resulting Emission Factors (2039 – 2050)

Vehicle Stocks	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
Total HGVs	567,263	570,234	573,206	576,177	579,149	582,120	585,091	588,063	591,034	594,006	596,977	**600,000**
% HGV > 18t*	164,506	165,368	166,230	167,091	167,953	168,815	169,677	170,538	171,400	172,262	173,123	**174,000**
% Diesel (some dual fuel)	44%	40%	36%	32%	28%	24%	20%	16%	12%	8%	4%	**0%**
Diesel (including dual)	72,383	66,147	59,843	53,469	47,027	40,516	33,935	27,286	20,568	13,781	6,925	**0**
Natural Gas > 18t	51,450	54,500	57,550	60,600	63,650	66,700	69,750	72,800	75,850	78,900	81,950	**85,000**
Niche/ other fuels	40,674	44,721	48,837	53,022	57,276	61,599	65,991	70,452	74,982	79,581	84,248	89,000
Existing Diesel Articulated >33t	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
General Powertrain Improvements												
Efficiency improvement (from 2020)	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%	8.30%
Fuel efficiency - Low rolling resistance tyres												
Uptake	64.80%	68.00%	71.20%	74.40%	77.60%	80.80%	84.00%	87.20%	90.40%	93.60%	96.80%	**100.00%**
% increase in fuel efficiency per uptake	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
% increase in fuel efficiency	3.24%	3.40%	3.56%	3.72%	3.88%	4.04%	4.20%	4.36%	4.52%	4.68%	4.84%	5.00%
Fuel Efficiency - Aerodynamic trailers/ bodies*												
Uptake	56.55%	60.50%	64.45%	68.40%	72.35%	76.30%	80.25%	84.20%	88.15%	92.10%	96.05%	**100.00%**
% increase in fuel efficiency per uptake	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%	13.00%
% increase in fuel efficiency	7.35%	7.87%	8.38%	8.89%	9.41%	9.92%	10.43%	10.95%	11.46%	11.97%	12.49%	13.00%
									Fuel Efficiency - Automatic tyre pressure adjustment			
Uptake	63.15%	66.50%	69.85%	73.20%	76.55%	79.90%	83.25%	86.60%	89.95%	93.30%	96.65%	100.00%
% increase in fuel efficiency per uptake	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
% increase in fuel efficiency	1.89%	2.00%	2.10%	2.20%	2.30%	2.40%	2.50%	2.60%	2.70%	2.80%	2.90%	3.00%
Fuel Efficiency - Fuel efficiency and use of telematics												
Uptake	81.85%	83.50%	85.15%	86.80%	88.45%	90.10%	91.75%	93.40%	95.05%	96.70%	98.35%	**100.00%**
% increase in fuel efficiency per uptake (from 2010)	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
% increase in fuel efficiency	2.46%	2.51%	2.55%	2.60%	2.65%	2.70%	2.75%	2.80%	2.85%	2.90%	2.95%	3.00%
Total increase in Fuel Efficiency												
Total increase in Fuel Efficiency (from 2010)	23.24%	24.07%	24.89%	25.71%	26.54%	27.36%	28.18%	29.01%	29.83%	30.65%	31.48%	32.30%
Diesel average mpg (>33t artics)	9.42	9.48	9.55	9.61	9.67	9.74	9.80	9.86	9.92	9.99	10.05	10.11

Use of larger and longer vehicles												
Uptake	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%
% change in load	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
% change in average load factor	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%	10.01%
Loading Factor (artics>33t)	0.682	0.682	0.682	0.682	0.682	0.682	0.682	0.682	0.682	0.682	0.682	0.682
Tonnes per load	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44
Recalculated Emissions Factors (without biofuels)												
km per litre	3.3349	3.3572	3.3795	3.4018	3.4240	3.4463	3.4686	3.4909	3.5132	3.5355	3.5577	3.5800
$kgCO_2e$ diesel per km	0.7877	0.7825	0.7773	0.7722	0.7672	0.7622	0.7573	0.7525	0.7477	0.7430	0.7384	0.7338
$kgCO_2e$ WTT diesel per km	0.1855	0.1842	0.1830	0.1818	0.1806	0.1795	0.1783	0.1772	0.1760	0.1749	0.1738	0.1728
tonnes (average load)	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44	12.44
$kgCO_2e$ diesel per km	0.8108	0.8054	0.8001	0.7948	0.7897	0.7846	0.7795	0.7745	0.7696	0.7648	0.7600	0.7553
$kgCO_2e$ WTT diesel per km	0.1909	0.1896	0.1884	0.1871	0.1859	0.1847	0.1835	0.1823	0.1812	0.1801	0.1789	0.1778
Adjusted Scope 1 EF [$kgCO_2e$/tonne.km]	0.0652	0.0647	0.0643	0.0639	0.0635	0.0631	0.0627	0.0623	0.0619	0.0615	0.0611	0.0607
Adjusted Scope 3 EF [$kgCO_2e$/tonne.km]	0.0153	0.0152	0.0151	0.0150	0.0149	0.0148	0.0148	0.0147	0.0146	0.0145	0.0144	0.0143
Biodiesel Mix	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
Uptake	19.33%	20.31%	21.29%	22.27%	23.25%	24.22%	25.20%	26.18%	27.16%	28.13%	29.11%	**30.00%**
% increase in fuel efficiency per uptake	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289	1.1289
% increase in fuel efficiency	0.0579	0.0571	0.0564	0.0556	0.0549	0.0542	0.0535	0.0528	0.0521	0.0515	0.0508	0.0502
Natural Gas Articulated >33t												
Uptake	27.07%	29.16%	31.24%	33.33%	35.42%	37.51%	39.60%	41.69%	43.78%	45.87%	47.96%	**50%**
% increase in fuel efficiency per uptake	0.0637	0.0619	0.0601	0.0583	0.0565	0.0546	0.0528	0.0510	0.0492	0.0474	0.0455	0.0438
% increase in fuel efficiency	0.0233	0.0236	0.0239	0.0242	0.0245	0.0248	0.0251	0.0254	0.0257	0.0260	0.0262	0.0265
Adjusted Scope 1 EF [$kgCO_2e$/tonne.km]	**0.0612**	**0.0600**	**0.0588**	**0.0574**	**0.0560**	**0.0545**	**0.0530**	**0.0513**	**0.0495**	**0.0477**	**0.0457**	**0.0438**
Adjusted Scope 3 EF [$kgCO_2e$/tonne.km]	**0.0198**	**0.0203**	**0.0208**	**0.0213**	**0.0218**	**0.0224**	**0.0230**	**0.0237**	**0.0243**	**0.0250**	**0.0258**	**0.0265**

Appendix C: Profiled Emission Factors - Rail

Table C.1: Impact of Increased Electric Traction on Emission Factors (2018 – 2028)

30% Electric by 2030 & 80% by 2040	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Electricity [million kWh]	58.40	58.40	58.40	87.60	116.80	146.00	175.20	204.40	233.60	262.80	292.00
Diesel non-forecourt [million litres]	203.90	203.90	203.90	198.53	193.17	187.80	182.44	177.07	171.71	166.34	160.97
Proportion Electric Traction	5%	5%	5%	8%	10%	13%	15%	17%	20%	23%	25%
Proportion Diesel Traction	95%	95%	95%	92%	90%	88%	85%	83%	80%	77%	75%
Freight distance [million km]	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98
Freight moved (million tonne.km)	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250
Calculated Emission Factors											
Electricity [ktCO$_2$e]	11.971	11.368	10.564	14.969	17.265	21.062	26.298	28.778	26.681	31.370	31.649
Non-forecourt diesel [ktCO$_2$e]	548.040	548.040	548.040	533.618	519.196	504.774	490.352	475.930	461.508	447.086	432.663
Total Scope 1 & 2 Emissions [ktCO$_2$e]	**560.011**	**559.408**	**558.604**	**548.587**	**536.461**	**525.836**	**516.650**	**504.708**	**488.189**	**478.456**	**464.312**
Emission Factor [kgCO$_2$e/tonne.km]	**0.0325**	**0.0324**	**0.0324**	**0.0318**	**0.0311**	**0.0305**	**0.0300**	**0.0293**	**0.0283**	**0.0277**	**0.0269**
WTT Diesel [ktCO$_2$e]	127.568	127.568	127.568	124.211	120.854	117.497	114.140	110.783	107.426	104.069	100.712
T&D Electricity [ktCO$_2$e]	1.920	1.920	1.920	2.879	3.839	4.799	5.759	6.719	7.678	8.638	9.598
WTT Electricity Generation [ktCO$_2$e]	3.273	3.273	3.273	4.910	6.547	8.183	9.820	11.457	13.093	14.730	16.367
WTT Electricity T&D [ktCO$_2$e]	0.306	0.306	0.306	0.459	0.612	0.765	0.918	1.071	1.224	1.377	1.530
Total Scope 3 Emissions [ktCO$_2$e]	**133.067**	**133.067**	**133.067**	**132.459**	**131.852**	**131.244**	**130.637**	**130.029**	**129.421**	**128.814**	**128.206**
Emission Factor [kgCO2e/tonne.km]	**0.0077**	**0.0077**	**0.0077**	**0.0077**	**0.0076**	**0.0076**	**0.0076**	**0.0075**	**0.0075**	**0.0075**	**0.0074**

Table C.2: Impact of Increased Electric Traction on Emission Factors (2028 – 2038)

30% Electric by 2030 & 80% by 2040	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Electricity [million kWh]	321.20	350.40	408.80	467.20	525.60	584.00	642.40	700.80	759.20	817.60
Diesel non-forecourt [million litres]	155.61	150.24	139.51	128.78	118.05	107.32	96.58	85.85	75.12	64.39
Proportion Electric Traction	27%	30%	35%	40%	45%	50%	55%	60%	65%	70%
Proportion Diesel Traction	73%	70%	65%	60%	55%	50%	45%	40%	35%	30%
Freight distance [million km]	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98
Freight moved (million tonne.km)	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250
Calculated Emission Factors										
Electricity [$ktCO_2e$]	30.856	36.525	42.612	48.699	54.787	60.874	66.962	73.049	79.136	85.224
Non-forecourt diesel [$ktCO_2e$]	418.241	403.819	374.975	346.131	317.287	288.442	259.598	230.754	201.910	173.065
Total Scope 1 & 2 Emissions [$ktCO_2e$]	**449.097**	**440.344**	**417.587**	**394.830**	**372.073**	**349.317**	**326.560**	**303.803**	**281.046**	**258.289**
Emission Factor [$kgCO_2e$/tonne.km]	**0.0260**	**0.0255**	**0.0242**	**0.0229**	**0.0216**	**0.0203**	**0.0189**	**0.0176**	**0.0163**	**0.0150**
WTT Diesel [$ktCO_2e$]	97.355	93.997	87.283	80.569	73.855	67.141	60.427	53.713	46.999	40.285
T&D Electricity [$ktCO_2e$]	10.558	11.518	13.437	15.357	17.276	19.196	21.116	23.035	24.955	26.875
WTT Electricity Generation [$ktCO_2e$]	18.003	19.640	22.913	26.187	29.460	32.733	36.007	39.280	42.553	45.826
WTT Electricity T&D [$ktCO_2e$]	1.683	1.836	2.142	2.448	2.754	3.060	3.366	3.672	3.978	4.284
Total Scope 3 Emissions [$ktCO_2e$]	**127.599**	**126.991**	**125.776**	**124.561**	**123.346**	**122.130**	**120.915**	**119.700**	**118.485**	**117.270**
Emission Factor [$kgCO_2e$/tonne.km]	**0.0074**	**0.0074**	**0.0073**	**0.0072**	**0.0072**	**0.0071**	**0.0070**	**0.0069**	**0.0069**	**0.0068**

Table C.1: Impact of Increased Electric Traction on Emission Factors (2039 – 2050)

30% Electric by 2030 & 80% by 2040	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Electricity [million kWh]	876.00	934.40	957.76	981.12	1,004.48	1,027.84	1,051.20	1,074.56	1,097.92	1,121.28	1,144.64	1,168.00
Diesel non-forecourt [million litres]	53.66	42.93	38.63	34.34	30.05	25.76	21.46	17.17	12.88	8.59	4.29	0.00
Proportion Electric Traction	75%	80%	82%	84%	86%	88%	90%	92%	94%	96%	98%	100%
Proportion Diesel Traction	25%	20%	18%	16%	14%	12%	10%	8%	6%	4%	2%	0%
Freight distance [million km]	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98	33.98
Freight moved (million tonne.km)	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250	17,250
Calculated Emission Factors												
Electricity [ktCO$_2$e]	91.311	97.399	99.834	102.269	104.704	107.139	109.574	112.009	114.444	116.878	119.313	121.748
Non-forecourt diesel [ktCO$_2$e]	144.221	115.377	103.839	92.302	80.764	69.226	57.688	46.151	34.613	23.075	11.538	0.000
Total Scope 1 & 2 Emissions [ktCO$_2$e]	**235.532**	**212.776**	**203.673**	**194.570**	**185.467**	**176.365**	**167.262**	**158.159**	**149.057**	**139.954**	**130.851**	**121.748**
Emission Factor [kgCO$_2$e/tonne.km]	**0.0137**	**0.0123**	**0.0118**	**0.0113**	**0.0108**	**0.0102**	**0.0097**	**0.0092**	**0.0086**	**0.0081**	**0.0076**	**0.0071**
WTT Diesel [ktCO$_2$e]	33.571	26.856	24.171	21.485	18.799	16.114	13.428	10.743	8.057	5.371	2.686	0.000
T&D Electricity [ktCO$_2$e]	28.794	30.714	31.482	32.249	33.017	33.785	34.553	35.321	36.089	36.856	37.624	38.392
WTT Electricity Generation [ktCO$_2$e]	49.100	52.373	53.682	54.992	56.301	57.610	58.920	60.229	61.538	62.848	64.157	65.466
WTT Electricity T&D [ktCO$_2$e]	4.590	4.896	5.019	5.141	5.263	5.386	5.508	5.631	5.753	5.876	5.998	6.120
Total Scope 3 Emissions [ktCO$_2$e]	**116.055**	**114.840**	**114.353**	**113.867**	**113.381**	**112.895**	**112.409**	**111.923**	**111.437**	**110.951**	**110.465**	**109.979**
Emission Factor [kgCO2e/tonne.km]	**0.0067**	**0.0067**	**0.0066**	**0.0066**	**0.0066**	**0.0065**	**0.0065**	**0.0065**	**0.0065**	**0.0064**	**0.0064**	**0.0064**

Appendix D: Profiled Emission Factors – Fuel & Electricity Inputs

Table D.1: Emission Factors for Fuel & Electricity Inputs (2018 – 2028)

Emission Factors	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
EEP 2017 [$kgCO_2e/kWh$]	0.2050	0.1947	0.1809	0.1709	0.1478	0.1443	0.1501	0.1408	0.1142	0.1194	0.1084
Applied Electricity [$kgCO_2e/kWh$]	0.2050	0.1947	0.1809	0.1709	0.1478	0.1443	0.1501	0.1408	0.1142	0.1194	0.1084
Diesel (100% mineral diesel) [$kgCO_2e/litre$]	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878
WTT Diesel (100% mineral diesel) [$kgCO_2e/litre$]	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256
T&D Electricity [$kgCO_2e/kWh$]	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329
WTT Electricity Generation [$kgCO_2e/kWh$]	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561
WTT Electricity T&D [$kgCO_2e/kWh$]	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Biomethane Scope 1 [$kgCO_2e$/ litre]	0.0848	0.0843	0.0837	0.0831	0.0825	0.0819	0.0813	0.0807	0.0801	0.0795	0.0789
Biomethane Scope 3 [$kgCO_2e$/ litre]	0.0200	0.0201	0.0202	0.0203	0.0204	0.0204	0.0205	0.0206	0.0207	0.0208	0.0209

Table D.1: Emission Factors for Fuel & Electricity Inputs (2018 – 2028)

Emission Factors	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
EEP 2017 [$kgCO_2e/kWh$]	0.0961	0.1042	0.0955	0.0777	0.0745	0.0665	0.0550	0.0545	0.0501	0.0462
Applied Electricity [$kgCO_2e/kWh$]	0.0961	0.1042	0.0955	0.0777	0.0745	0.0665	0.0550	0.0545	0.0501	0.0462
Diesel (100% mineral diesel) [$kgCO_2e/litre$]	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878
WTT Diesel (100% mineral diesel) [$kgCO_2e/litre$]	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256
T&D Electricity [$kgCO_2e/kWh$]	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329
WTT Electricity Generation [$kgCO_2e/kWh$]	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561
WTT Electricity T&D [$kgCO_2e/kWh$]	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Biomethane Scope 1 [$kgCO_2e/$ litre]	0.0783	0.0777	0.0771	0.0765	0.0747	0.0728	0.0710	0.0692	0.0674	0.0656
Biomethane Scope 3 [$kgCO_2e/$ litre]	0.0210	0.0211	0.0212	0.0213	0.0216	0.0219	0.0222	0.0225	0.0228	0.0230

Table D.1: Emission Factors for Fuel & Electricity Inputs (2039 – 2050

Emission Factors	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
EEP 2017 [kgCO_2e/kWh]	0.0482	0.0489	0.0465	0.0442	0.0418	0.0394	0.0371	0.0347	0.0323	0.0299	0.0276	0.0252
Applied Electricity [kgCO_2e/kWh]	0.0482	0.0489	0.0465	0.0442	0.0418	0.0394	0.0371	0.0347	0.0323	0.0299	0.0276	0.0252
Diesel (100% mineral diesel) [kgCO_2e/litre]	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878	2.6878
WTT Diesel (100% mineral diesel) [kgCO_2e/litre]	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256	0.6256
T&D Electricity [kgCO_2e/kWh]	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329
WTT Electricity Generation [kgCO_2e/kWh]	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561
WTT Electricity T&D [kgCO_2e/kWh]	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Biomethane Scope 1 [kgCO_2e/ litre]	0.0637	0.0619	0.0601	0.0583	0.0565	0.0546	0.0528	0.0510	0.0492	0.0474	0.0455	0.0438
Biomethane Scope 3 [kgCO_2e/ litre]	0.0233	0.0236	0.0239	0.0242	0.0245	0.0248	0.0251	0.0254	0.0257	0.0260	0.0262	0.0265

Appendix E: Rail Freight Operator Rolling Stock

Table E.1: GB Railfreight Rolling Stock

Class	Type	Built	Number	Age
Class 08	Shunter	1953	2	65
Class 09	Shunter	1959	2	59
Class 20	Diesel locomotive	1957-1968	11	56
Class 59	Diesel locomotive	1985	1	33
Class 66	Diesel locomotive	2000-2015	78	11
Class 73	Electro-diesel locomotive	1962, 1965-7	22	54
Class 92	Electric locomotive	1993-1996	16	24
Vanguard 0-6-0DH	Diesel locomotive	2011	2	7
Average Age	-	-	**64**	**39.7**

Table E.2: Colas Rolling Stock

Class	Type	Built	Number	Age
Class 37	Diesel locomotive	1960-1965	8	56
Class 56	Diesel locomotive	1976-84	7	38
Class 60	Diesel locomotive	1989	10	29
Class 66	Diesel locomotive	1998-2015	5	12
Class 67	Diesel locomotive	1999-2000	2	3
Class 70	Diesel locomotive	2014, 2016-17	17	3
Average Age	-	-	**49**	**22.9**

Table E.3: Direct Rail Services Rolling Stock

Class	Type	Built	Number	Age
Class 37	Diesel locomotive	1960 -1965	21	56
Class 57	Diesel locomotive	1998-2004	21	17
Class 66	Diesel locomotive	2002 -2008	19	13
Class 68	Diesel-electric	2013 – 2017	12	12
Class 88	Bi-mode	2015 -2017	10	3
Average Age	-	-	**83**	**23.5**

Table E.4: Freightliner Rolling Stock

Class	Type	Built	Number	Age
Class 47	Diesel locomotive	1953	1	65
Class 66	Diesel locomotive	1965	127	53
Class 70	Diesel locomotive	1999	19	19
Class 86	Electric locomotive	2009	16	9
Class 90	Electric locomotive	1987	10	31
Average Age	-	-	**173**	**44**

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Turley

The Rail Central Rail Freight Interchange

Appendix 21.3 Rail Central Climate Change Risk Assessment

Document Information

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Summary

1. This Technical Appendix presents the Climate Change Risk Assessment for the Proposed Development and sets out the potential climate change risks and effects which have been used to assist the Assessment of Effects in the Climate Change Adaptation section of ES Chapter 21 Climate Change.

2. In January 2012, government published the UK Climate Change Risk Assessment (UK CCRA 2012) (Ref 1) which sets out the main risks and opportunities arising from climate change over the coming years and provides a reference for key anticipated impacts and opportunities related to the natural environment, buildings and infrastructure, health and wellbeing, business and services, and agriculture and forestry. In 2017, an update to f the UK CCRA (UK CCRA 2017) was published providing greater detail on the potential risks and identifies a number of priority areas for further action (Ref 2).

3. This Appendix has been prepared under the following headings:

- **UK Climate Change Risk Assessment –** A summary of the UK CCRAs and risks and opportunities relevant to the Proposed Development.
- **Review of Climate Change Guidance –** A summary of climate change adaptation guidance in the UK relevant to the Proposed Development.
- **Baseline Climatic Conditions –**Baseline climatic conditions for the Proposed Development Area, drawing on historic climate data from the Met Office.
- **Future Climatic Conditions –** Predicted impacts of climate change for the East Midlands based on summary of data from the UKCP09 projections.
- **Summary of Anticipated Risks and Potential Effects –** A summary of the identified climate change risks and potential climate change effects relevant to the Proposed Development.
- **Assessment of Risk Methodology –** Setting out the methodology or assessing climate change risk and the need for assessment as part of the EC Chapter 21 Climate Change.
- **Project Risk Assessment –** Assessment of risk relevant to the identified effects for the Proposed Development.
- **Summary –** A summary of the effects to be considered in the Climate Change Adaptation assessment.

UK Climate Change Risk Assessments

4. The UK CCRAs set out the main risks and opportunities to the UK from climate change, providing an overview of main risks in and across sectors to help identify appropriate adaptation measures. First published in 2012 the UK CCRA was updated in 2017 to provide updated advice on climate change risks and opportunities in accordance with the requirement in the Climate Change Act to report regularly on UK progress on adaptation.

UK Climate Change Risk Assessment - 2012

5. The UK CCRA 2012 sets out the key potential risks and opportunities for a range of sectors including the Natural Environment, Buildings and Infrastructure, Health and Wellbeing, Business and Services, and Agriculture and Forestry. The key findings which relate to the Proposed Development are summarised below.

6. **The Natural Environment –** Effects of climate change could by significant by the 2050s, potentially having a negative effect on existing ecosystem pressures. Table 1 sets out key risks and opportunities and how these may relate to the Proposed Development.

Table 1: Natural Environment Risks and Opportunities

Risks	Opportunities
Increased prevalence of non-native species.	Increased habitat range for some generalist species.
Loss of climate space, with species unable to track climate change.	

7. **Buildings and Infrastructure –** Buildings and infrastructure will be affected by extreme weather events and long-term climate change, with challenges arising from higher temperatures and changing rainfall patterns. Table 2 sets out key risks and opportunities and how these may relate to the Proposed Development.

Table 2: Buildings and Infrastructure Risks and Opportunities

Risks	Opportunities
Energy	
Higher energy demand for cooling as a result of higher average and maximum temperatures	Reduced energy demand for heating as a result of warmer winters
Heat damage/disruption to energy infrastructure.	
Transport	

Road and railways at significant risk of flooding	
Water	
Supply-demand pressures as rainfall quantity is reduced.	
Buildings	
Damage to property due to flooding -	
Buildings affected by subsidence.	

8. **Business and Services –** The main risks and opportunities to the business sector as being related to flooding, heating and water resources; Table 3 sets out these key risks and opportunities and how these may relate to the Proposed Development.

Table 3: Business and Services Risks and Opportunities

Risks	Opportunities
Possible decrease in output for UK businesses due to an increase in supply chain disruption as a result of extreme events.	
Risk of monetary loss as a result of operational impacts of flooding.	
Variability in the availability of water during construction and operational stages of development.	
Potential loss of staff hours due to high internal building temperatures.	

UK Climate Change Risk Assessment – 2017

9. The UK CCRA 2017 provides a more focussed review of priority risks and opportunities in the UK identifying where more action is needed to strengthen policies to reduce long-term vulnerability to climate change.

10. The assessment sets out six areas of inter-related climate change risks for the UK which have high long-term risks and where more action is need; these include:

- Flooding and coastal change to communities, businesses and infrastructure.
- Risks to health, wellbeing and productivity from high temperatures.
- Risk of shortages in public water supply, and for agriculture, energy generation and industry.

- Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity.

- Risks to domestic and international food production and trade.

11. It also sets out the need for additional research focussing on new and emerging pests and diseases, and invasive and non-native species, affecting people, plants and animals.

12. The UK CCRA 2017 Synthesis Report (Ref 3) sets out the 'urgency categories' used to assess each of the 56 individual climate risks and opportunities considered in the Evidence Report. These include risks and opportunities in the Natural Environment (Ne), Infrastructure (In), People and the Built Environment (PB), and Business and Industry (Bu). In relation to the Proposed Development key risks and opportunities highlighted are set out in Table 4.

Table 4: UK Climate Change Risks and Opportunities

More Action Needed	Research Priority	Sustain Current Action	Watching Brief
Ne1 – Risks to species and habitats from changing climate space	Ne7 – Risks to freshwater supplies from high temperatures	In13 – Extreme heat risks to rail, road, ICT and energy infrastructure	In8 – Subsidence risks to buried surface infrastructure
Ne2 – Opportunities from new species colonisations	In11 – Risks to energy, transport and ICT from high winds and lighting	In14 – Benefits for infrastructure from reduced extreme cold events	
In1 – Risk of cascading infrastructure failures across interdependent networks	PB7 – Risks to building fabric from moisture, wind and driving rain	Bu3 – Risks to business operations from water scarcity	
In2 – Risks to infrastructure from river, surface/groundwater flooding	Bu5 – Employee productivity impacts in heatwaves and from severe weather infrastructure disruption		
In4 – Risks of sewer flooding due to heavy rainfall			
In9 – Risks to public water supplies from drought and low river flows			
PB1 – Risks to public health and wellbeing form high			

temperatures			
PB4 – Potential benefits to health and wellbeing from reduced cold			
PB5 – Risks to people, communities and buildings from flooding			
Bu1 – Risks to business sites from flooding			

The National Adaptation Programme - 2018

13. The second National Adaptation Programme was published in July 2018 (Ref 4) and sets out the government's response to the 2017 CCRA, showing the actions the government will be taking to address the risks and opportunities over the next 5 years.

14. The actions set out in the NAP responds to the six priority areas of climate change risks set out in the CCRA, key actions are focussed around:

- Flooding and coastal change risk, ensuring risks to communities, businesses and infrastructure are minimised, and new and existing development is resilient to the effects of climate change.
- Risks to the high temperatures are tackled with measures including delivering better green infrastructure and ensuring health systems adapt to protect people against the impacts of climate change.
- Risks of shortages of public water supply minimised through measures including restoration of natural processes within river systems, enhanced water storage capacity, and setting ambitious goals for reducing water leakage.
- Risks to natural capital are minimised through measures including building ecological resilience, linking habitat restoration with flood prevention and air quality improvements and protect sols and natural carbon stores.
- Risks to food production.
- Risks of new and emerging pests and diseases and invasive non-native species.

15. Alongside the risks set out in the CCRA the measures set out in the NAP provide additional support and guidance for local government in the preparation of plans to mitigate to and adapt to the impacts of climate change,

Review of Climate Change Guidance

16. This section provides a review of relevant guidance and evidence regarding potential impacts and risk associated with climate change relevant to the Proposed Development. Based on the UK CCRAs and knowledge of the Proposed Development, relevant areas of research have included; Biodiversity, Flood risk, and Infrastructure (e.g. rail and road).

Biodiversity

Biodiversity and Climate Change – A Summary of Impacts in the UK (Ref 5)

17. The 2010 report on Biodiversity and Climate Change sets out evidence about interactions between climate change and biodiversity and was published by the Joint Nature Conservation Committee (JNCC); the JNCC is a statutory advisor to the UK Government and its work contributes to maintaining and enriching biological diversity, conserving geological features and sustaining natural features.

18. The summary report includes details on the impacts of climate change on terrestrial and freshwater biodiversity and marine and coastal ecosystems.

19. In terms of terrestrial and freshwater ecosystems, one of the primary observed impacts of climate change in the UK has been a northward movement of species which prefer warmer climates and a retreat of northerly species. This is having both a positive and negative impact on species, widening areas for some and narrowing of others. By way of an example, a review of data on bird distribution notes that the northern margins of many species have moved further north. In addition, there is increasing evidence that the rise in UK temperature is impacting on natural events, for example many plants are now flowering earlier in the year. This can extend breeding periods but also has the potential to impact on a mismatch between natural systems in place, resulting in increased species competition.

20. **Summary –** The report concludes that diverse biological communities are more likely to adapt to climate change.

Assessment of Climate Change Impacts on UK Natural Assets (Ref 6)

21. The report forms part of a four- project series commissioned by the Committee on Climate Change (CCC) to support the evidence base for the UK CCRAs. It includes an aggregate assessment of climate change impacts on goods and benefits provided by the UK's natural assets.

22. Modelling of native British species finds that many species groups can expect to see their climate space significantly expanded, colonising new areas, potentially benefitting from the projected changes in climate. In theory, a warmer climate could result in richer and more diverse wildlife; however this relies on habitat strength and biodiversity.

23. While some species are anticipated to experience a growth in climate space others are expected to experience shrinking areas, this is particularly the case for mosses which favour wet and cold conditions. Mossy habitats such as peat bogs provide a significant carbon capture and store in the UK; erosion of these habitats through a northward shift could lead to a significant CO_2 release.

24. The report concludes that while in theory there may be potential benefits of a changing climate, there is also the potential for negative impact. To mitigate the impact of climate change, action is needed to restore degraded habitats so UK species have the best chance of adapting to climate change.

25. **Summary -** A review of current evidence indicates that the impacts of climate change are already being felt by UK species; further changes are anticipated as a result of climate change, including the expansion of species climate space and colonisation of new areas providing a potential benefit. Conversely, a warming climate is also anticipated to cause shrinkage of other habitats and species climate space. Ensuring habitats are of a high quality with good biodiversity will help with climate change adaptation.

Flood Risk

Flood Risk Assessments: Climate Change Allowances (Ref 7)

26. Government guidance on flood risk assessments includes guidelines on the application of climate change allowances in the assessment of flood risk and provision of drainage and flood risk management systems. This includes allowances for changes to peak river flows and peak rainfall intensity which have the potential to impact on fluvial and surface water flooding.

Climate Change Risk Assessment 2017 – Projections of Future Flood Risk in the UK, 2015 (Ref 8)

27. This report prepared in 2015 forms part of the evidence base for the 2017 UK Climate Change Risk Assessment and sets out the assessment of future flood risk considering different climate change scenarios, and population growth.

28. The report states that in the future, all forms of flooding will increase and key impacts of future flooding include an increased risk of flooding to residential homes, protected habitats and social infrastructure.

29. In terms of national infrastructure, these assets will be subject to significant increase in risk with the number of sites exposed to the highest chance of flooding increasing by 30%. In particular, local actions to protect assets such as electricity substations are likely to be effective to 2050, but further action is needed to protect against anticipated climatic changes from the 2080s.

30. At this stage, it is anticipated that current levels of adaptation will offset a proportion of the projected increase in risk, but is currently not sufficient, and under extreme climate change

scenarios will do little to prevent significant risk. In this context, action is needed to improve resilience and the assessment identifies a number of recommendations, including a need to improve the linkage between adaptation and investment planning.

31. **Summary -** It is anticipated that climate change will have a significant effect on flood risk and should be a key consideration for new development. Current adaptation measures and assessment methods as set out by government currently provide a mechanism for incorporating climate change adaptation measures in new development, however long-term changes will need to be taken into account in the design of key infrastructure.

Rail Infrastructure

Climate Change Adaptation Report (Ref 9)

32. The Climate Change Adaptation Report prepared in 2015 by Network Rail sets out the climate change risks relevant to rail infrastructure. It identifies measures and programmes required to adapt to and mitigate the impacts of climate change.

33. Key rail infrastructure related risks identified which may be applicable to the Proposed Development are set out in Table 5.

Table 5: Rail Infrastructure Risks

Climate Impact	Rail Infrastructure Asset	Effect
Temperature changes (high/low)	Track	Buckles and breaks resulting in a derailment risk Reduced opportunities for track maintenance
Temperature changes (high/low)	Switches and crossings	Frozen or snow blocked points Failure of point operating systems
High temperatures	Overhead line equipment	Sag of overhead lines and risk of dewirement
High temperature	Lineside equipment	Failure of temperature controls and overheating of electronic equipment
Increase in rainfall and flooding	All	Closure of lines due to track flooding Failure of lineside equipment due to flooding Scour of embankment material
Increased rainfall	Earthworks	Landslip and earthwork failure and risk to rolling stock and staff
Decreased rainfall	Earthworks	Desiccation of embankments resulting in track geometry faults and failures in

		lineside equipment
Lightning	Lineside equipment	Asset failures as a result of lightning strikes and electrical surges

34. **Summary –** The potential impacts of climate change on the rail network could lead to severe damage to foundations and cause the movement of rails; major operational loss due to overheating; or damage to infrastructure and lineside equipment. In response to these risks, Network Rail includes the consideration of climate change in its asset management model and where appropriate includes consideration of climate change in design processes.

Road Infrastructure

Climate Adaptation Risk Assessment Progress Update – 2016 (Ref 10)

35. Prepared in 2016, the Progress Update published by Highways England builds on a 2011 Risk Assessment which provided an initial assessment of the climate change risks and vulnerabilities to highways in England. Key climate change vulnerabilities relevant to the Proposed Development include:

- the design of existing and new foundations;
- surface water drainage; and
- attenuation

36. The latest adaptation plans set out actions to respond to the identified vulnerabilities ranging from 'do minimum' (i.e. it is considered there is sufficient resilience in place to address the risk) to 'develop contingency plans' and 'retro-fit solutions'(which includes pre-planned responses to climate change or adaptation measures applied to existing assets outside of normal cycles).

37. The 2016 update sets out progress against addressing the vulnerabilities identified. In relation to Rail Central, this includes:

- The design of foundations – *Development of Future Proof Designs, Interim advice on pavement foundations* will be updated – In progress.
- The design and construction of surfaces – Monitoring and feedback from surfacing contractors – Ongoing

38. **Summary –** Highways England has identified a wide range of risks associated with the impacts of climate change and has put in place an action plan for dealing with the highlighted risks including those associated with the design of new infrastructure elements such as those incorporated at the Proposed Development.

Baseline Climatic Conditions

Current Climate Conditions

39. The existing climate for the Proposed Development, covering All Development within Order Limits, is set out in Table 6; this sets out average climate data for Northampton Moulton Park climate station (Ref 11) from 1981 to 2010.

Table 6: Baseline Climate Data

Month	Max. temp (°C) (°C)	Min. temp(°C) (°C)	Days of air frost (days)	Sunshine (hours)	Rainfall (mm)	Days of rainfall >= 1 mm (days)
Jan	6.8	1.1	10.9	55.7	54	11.4
Feb	7.1	0.9	11.1	77.9	41.1	9.4
Mar	10	2.7	6.3	108.2	44.1	9.8
Apr	12.8	4	3	151.4	49.4	10
May	16.2	6.8	0.2	189.9	54.4	9.6
Jun	19.2	9.7	0	173.8	54.9	9.4
Jul	21.7	11.9	0	199.3	49.2	8.1
Aug	21.5	11.8	0	185.2	54.5	8.5
Sep	18.4	9.8	0	134	57.6	8.9
Oct	14.1	7	0.8	109.6	63.9	10.2
Nov	9.7	3.7	4.5	64.4	60	10.8
Dec	7	1.5	10.6	49.5	55.3	10.8
Annual	13.7	5.9	47.3	1498.9	638.1	116.9

Historic Weather Events

40. In addition to the historic climate data for locations across the UK, the Met Office includes details of past weather events (Ref 12) setting out a summary of the event and impacts. A short review of events from the last ten years (2007 – 2017) has been undertaken to review the potential impacts of extreme weather to help identify potential risks from future climate change events. Particular attention has been paid to events which reflect the anticipated climate changes and impacts on the East Midlands.

Hot Spell June 2017

41. The UK experienced a spell of hot, sunny weather in June 2017 with temperatures across some locations in the UK reaching 30-32 degrees. This resulted in some speed restrictions on rail lines to avoid buckling, and an increased risk of air pollution for congested areas such as the East Midlands.

Exceptional Warmth, December 2015

42. December 2015 was the warmest December on record across the UK with temperatures 7-9 degrees higher than might be expected at this time of year. This led to an increase in monthly rainfall of nearly 200%. Further storms during December led to flooding across parts of Lancashire, North Manchester and Yorkshire.

Winter Storms, January to February 2014

43. The UK experienced a spell of extreme weather from late January to mid-February with a succession of storms. The storms resulted in major flooding problems affecting much of the River Thames and large swathed of the River Severn floodplain. As well as flooding to properties and businesses, transport infrastructure was also affected.

Hot Dry Spell July 2013

44. From 3 – 23 July the UK experienced a prolonged period of hot, dry weather with daily maximum temperatures exceeding 28 degrees. This resulted in little or no rainfall for 19 days. When this period broke, a number of storms resulted in flash flooding, with lightning affecting trains and tram services in parts of Manchester, Birmingham and Edinburgh.

Exceptionally Wet Weather, November 2012

45. A series of heavy rainfall events in 2012 resulted in one of the wettest weeks in England in the last 50 years with areas of South West England, the Midlands and North East England experiencing >150% of the average monthly rainfall resulting in flooding.

46. The review of historic weather events highlights the risks of increased temperatures which can effect rail lines and air quality, and extended periods of rain which can cause flooding leading to significant damage to infrastructure. With climate change anticipated to increase temperatures and winter rainfall, these events highlight potential climate change risks to the Proposed Development.

Future Climatic Baseline

47. The Future Baseline and Climate Change Adaptation section within the ES are been based on data sourced from the UKCP09 website, which is the source of the climate projections data for the UK. The UKCP09 website (Ref 13) is managed by the Environment Agency working with the Met Office.

48. The UKCP09 website allows users to access information on plausible changes in 21st century climate for the United Kingdom. UKCP09 provides future climate projections for land and marine regions as well as observed (past) climate data for the UK.

49. UKCP09 was produced in 2009, funded by a number of agencies led by Defra. It is based on sophisticated scientific methods provided by the Met Office, with input from over 30 contributing organisations. UKCP09 can be used to help organisations assess potential impacts of the projected future climate and to explore adaptation options to address those impacts.

50. UKCP09 provides climate projections for the UK for three different future greenhouse gas emissions scenarios: a low emissions scenario, a medium emissions scenario and a high emissions scenario. All three scenarios are based on the scenarios presented by the Intergovernmental Panel on Climate Change (IPCC) Emission Scenarios Report (Ref 14).

51. The UKCP09 Climate Projections Report (Ref 15) states these three scenarios all assume very rapid economic growth, global population that peaks mid-century and then declines, and the rapid introduction of new and more efficient technologies. The High scenario assumes a high use of fossil fuels, the Medium scenario assumes a high use of non-fossil energy sources and the Medium Scenario assumes an intermediate case. UKCP09 treats all three emission scenarios as equally plausible.

52. The projections are averaged over each of seven future overlapping 30-year time periods, stepped forward by a decade, starting with 2010 – 2039. These future time periods are referred to by their middle decade, starting from the 2020s (2010 – 2039) and ending with the 2080s (2070 – 2099); all changes are expressed relative to a modelled 30-year baseline period of 1961 – 1990.

53. The projections for these three periods are set out under the low, medium and high emissions scenario and include results for a range of probability levels. The 50% probability level change is known as the central estimate. It is not the most likely outcome, it simply shows that half of the climate scenarios used to construct the probability distribution fell below that figure and half fell above it. At the 10% probability level, only 10% of the climate model runs fall at or below that level, at the 90% probability level, only 10% of the climate model runs fall at or above that level. The 10% and 90% levels therefore represent potential low and high changes in future climate.

54. The National Policy Statement for National Networks (NPS NN) (Ref 16) includes guidance on the assessment of climate change and states that:

"*Where transport infrastructure has safety-critical elements and the design life of the asset is 60 years or greater, the applicant should apply the UK Climate Projections 2009 (UKCP09) high emissions scenario (high impact, low likelihood) against the 2080 projections at the 50% probability level.*"

55. As noted in Paragraph52 the low, medium and high emissions scenarios are considered to be equally plausible, therefore the 'high' scenario does not represent 'high impact, low likelihood as stated in the NPS NN, it simply represents a high emissions scenario.

56. The NPS NN promotes the use of the 50% probability level, the central estimate. The central estimate is not the most likely outcome, it simply shows that half of the climate scenarios used to construct the probability distribution fell below that figure and half fell above it. If, for example, the central estimate for temperature rise for 2050 was 3ºC then the evidence suggest that temperatures are as likely to increase by less than 3ºC as they are to increase by more.

57. In this context, given the strategic nature of the Proposed Development on the national rail network and its anticipated life of 60 years, it is considered appropriate to follow government guidance and use the high emissions scenario, 2080 projections.

Project Assessment Timeframe

58. The consideration of potential climate change impacts is undertaken in accordance with defined and agreed timeframes for construction and operation. Table 7 details the anticipated project construction and operational timescales.

Table 7: Project and UKCPO9 timeframes

Timeframe	Construction	First Occupation	Short term Operation	Long Term Operation
Project Timeframe	2019-2029	2021	2029-2039	2039-2089
Corresponding UKCPO9 Timeframe	2020	2020	2050	2080

59. Given the scale and nature of the Proposed Development, professional judgement has been used to confirm the most suitable climate change projections to be used for the assessment is the high emissions scenario for East Midlands and that the worst-case assessment would be to consider the impacts at 2080, which can be considered as the long-term operation of the development.

Future Climate Predictions – Temperature and Rainfall

60. Table 8 summarises the UKCP09 dataset for East Midlands for the 2020s (Ref 17), 2050s (Ref 18) and 2080s (Ref 19) high emissions scenario in line with the construction and long-term operation phases of the Proposed Development covering all Works within Order Limits, setting out the 10%, 50% and 90% probability levels.

61. The future baseline climatic conditions cover the whole of the Proposed Development site and are relevant to all of the Proposed Development components.

Table 8: UKCP09 East Midlands Climate Change projections as obtained from the UKCP09 website (10%, 50% and 90% probability levels)

Timeframe	2020s	2050s	2080s
Temperature	Increase in winter mean temperature of 0.5C, 1.3C and 2.2C	Increase in winter mean temperature of 1.4C, 2.5C and 3.8C	Increase in winter mean temperature of 2C, 3.6C and 5.6C
	Increase in summer mean temperature of 0.4C, 1.4C and 2.4C	Increase in summer mean temperature of 1.3C, 2.8C and 4.7C	Increase in summer mean temperature of 2.3C, 4.4C and 7.3C
	Increase in summer mean daily maximum temperature of 0.5C, 1.8C and 3.4C	Increase in summer mean daily maximum temperature of 1.6C, 3.8C and 6.6C	Increase in summer mean daily maximum temperature of 2.7C, 6C and 10.3C
	Increase in summer mean daily minimum temperature of 0.6C, 1.5C and 2.7C	Increase in summer mean daily minimum temperature of 1.5C, 3.1C and 5.2C	Increase in summer mean daily minimum temperature of 2.5C, 4.9C and 8.2C
Rainfall	Change in annual mean precipitation of -5%, 0% and 6%	Change in annual mean precipitation of -6%, 0% and 6%	Change in annual mean precipitation of -7%, 1% and 9%
	Change in winter mean precipitation of -2%, 6% and 16%	Change in winter mean precipitation of 3%, 16% and 33%	Change in winter mean precipitation of 6%, 25% and 54%
	Change in summer mean precipitation of -20%, -4% and 15%	Change in summer mean precipitation of –38%, -17% and 7%	Change in summer mean precipitation of –50%, -25% and 4%

Future Climate Variance

62. Figures 1 to 4 demonstrate the variance in the climate change predictions for four of the key impacts anticipated to affect the Proposed Development using the baseline climatic data as the starting point, showing how the climate for the East Midlands is expected to change over time under the 10%, 50% (central estimate) and 90% probability scenarios.

Increase in Winter Rainfall

63. Figure 1 illustrates the predicted increase in winter rainfall between 2020 and 2080.

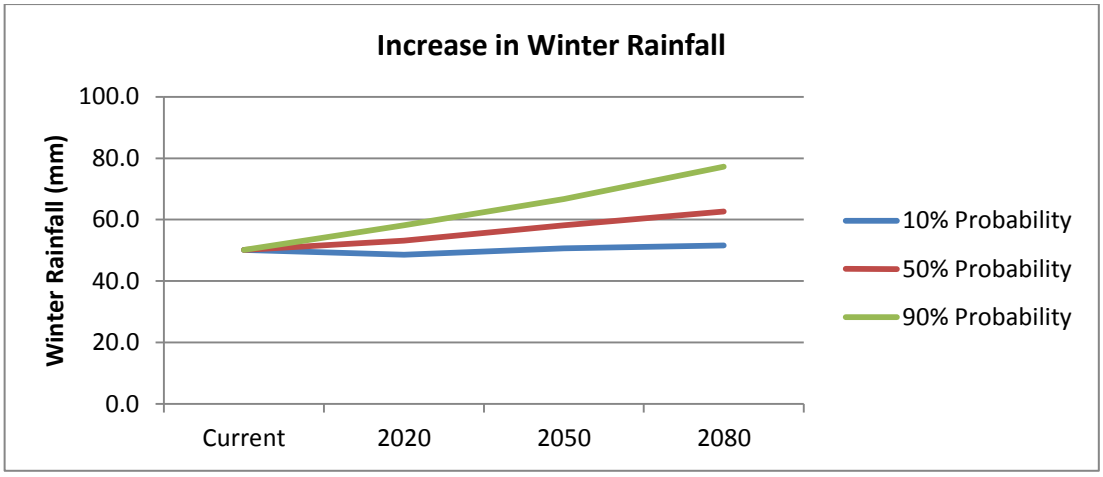

Figure 1: Increase in Winter Rainfall

Increase in Summer Mean Temperature

64. Figure 2 shows the predicted rise in summer mean temperature between 2020 and 2080 .

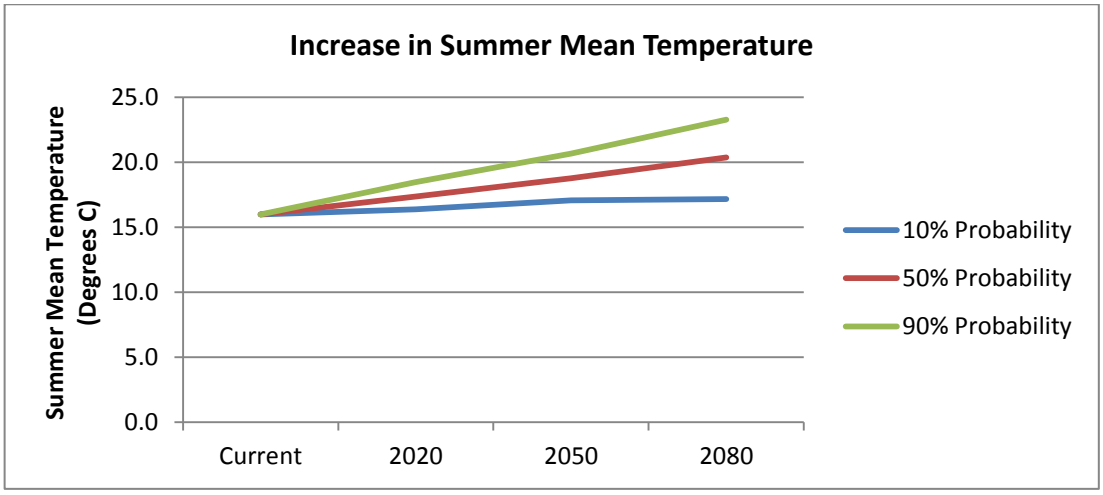

Figure 2: Increase in Summer Mean Temperature

Increase in Winter Mean Temperature

65. Figure 3 shows the predicted rise in winter mean temperature between 2020 and 2080.

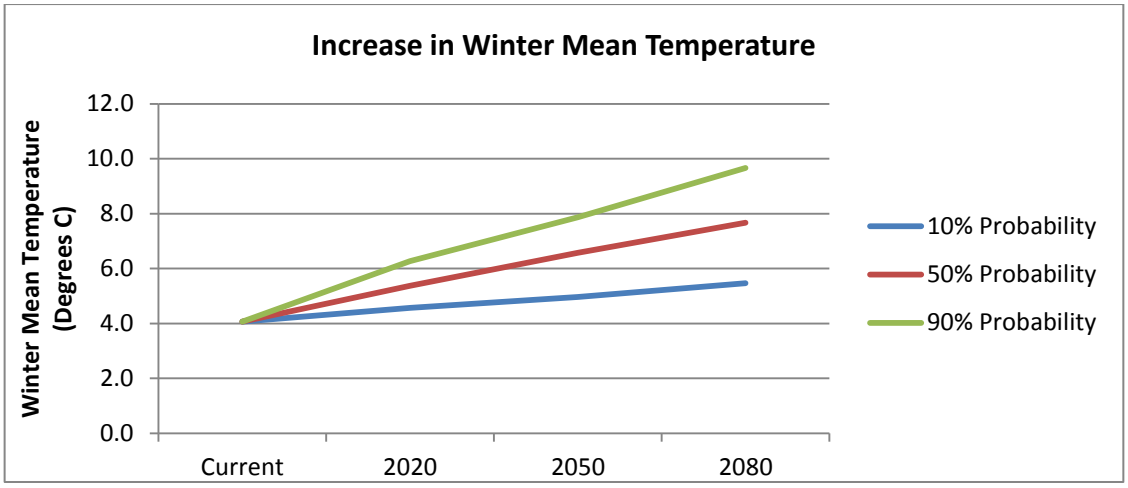

Figure 3: Increase in Winter Mean Temperature

Decrease in Summer Rainfall

66. Figure 4 shows the predicted fall in summer rainfall between 2020 and 2080.

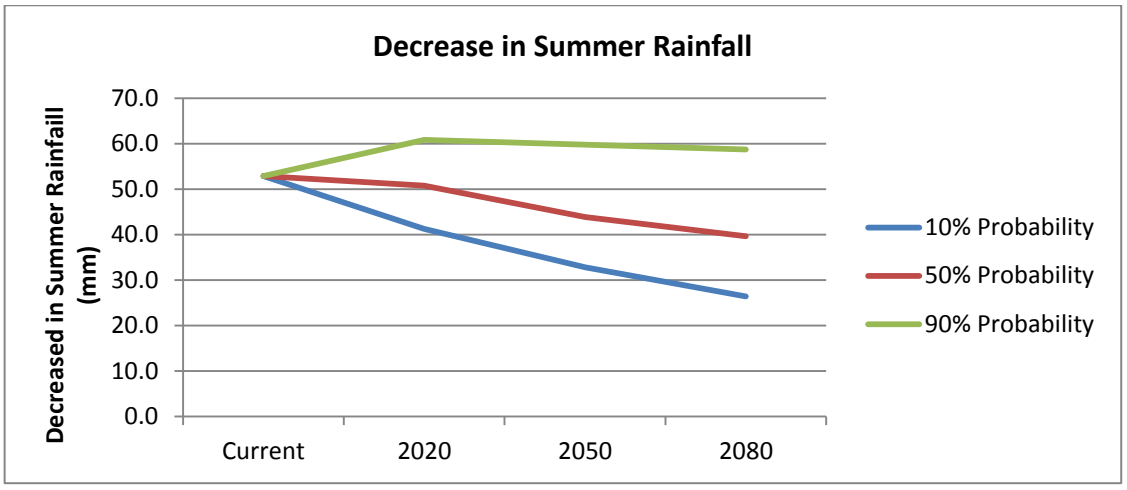

Figure 4: Decrease in Summer Rainfall

67. These figures demonstrate potential future climatic effects for the East Midlands. Generally it is expected there will be an increase in annual temperatures, increase in winter rainfall and decrease in summer rainfall; however, there is a wide range of variance in these predictions. It is possible that the impacts of climate change may be significantly higher or lower than the 50% probability scenario highlighted for use by the NPS NN.

Future Climate Predictions- Wind, Storms, Lightning, Snow and Fog

68. In addition to the summary of findings set out in Table 8, Table 9 presents the UKCP09 climate change predictions of potential changes relating to wind, storms, lightning, snow and fog where possible for the period up to 2080.

69. For each of the climate variables below, where available the change described is specific to the period up to 2080 and is based on the high emissions scenario and 90% probability which describe the worst case scenario where changes are unlikely to be greater than.

Table 9: Climate Change Predictions - Wind, Storms, Lightning, Snow and Fog

Climate Variable	Estimated potential changes at 2080
Wind (Ref 18)	Minor increase in wind speed of between 0.2m/s in winter and 0.2m/s in summer.
Storms (Ref 19)	There is no consistent signal of change in either storms or blocking near the UK. Such changes as are seen are relatively modest, and the potential for substantial change appears to be small. Data is not time specific.
Lightning (Ref 20)	Increase in lightning projected for all four seasons across the UK under the medium emission scenario (the only available data).
Snow (Ref 21)	Reduced snowfall; snow days projected to reduce by 80-90% in winter and 80-80% in Spring due to a shift from snow to rain.
Fog (Ref 22)	Reduced fog predicted across the UK by around 30% from Spring through to Autumn, with an increase in winter fog of approximately 60-70% under the medium emission scenario.

Summary of Climate Change Effects

70. Qualitatively, the future climate of the project location at 2050, and with increasing variability up to 2080, will likely include:

- an increase in mean average temperature of between 3.6C (2020s) and 1.3C (2080s) in winter and 1.4C (2020s) and 4.4C (2080s) in summer;
- more very hot days, particularly throughout the long-term operational phase, with an increase in daily maximum temperature of between 1.8C (2020s) and 6C (2080s) and daily minimum temperature of between 1.5C (2020s) and 4.9C (2080s);
- more intense downpours of rain, with an increase in winter rainfall of between 6% (2020s) and 25% (2080s), with reduced snowfall;
- an increase in dry spells, particularly in summer months, with summer rainfall dropping by between 4% (2020s) and 25% (2080s);
- minimal changes in wind speed;
- no consistent change in storm frequency;
- an Increase in lightning events; and
- reduced fog.

71. Given the nature of the Proposed Development a number of the potential impacts have been scoped out of the assessment which are summarised below.

72. **Wind and Storms -** Given the marginal projected difference in the 2080 (worst-case) scenario from the current baseline, no significant effects from climate change influenced wind or storms are anticipated.

73. **Lightning -** Although there is an anticipated increase in lightning events from the current baseline, these are predicted to be relatively rare, with the vast majority confined to the atmosphere with little or no impact upon the built environment. New buildings and structures include lightning protection as standard and it. It is therefore not considered appropriate necessary to assess the potential effects and impacts of lightning further.

74. **Fog -** The occurrence of fog is also thought likely to reduce generally as a result of climate change and as this is a phenomenon that currently does not appear to have any negative adverse impact on the built environment, it is not considered necessary to assess this further.

75. **Snowfall -** A significantly reduced occurrence of snowfall is likely to have a benefit on the Proposed Development in terms of reduced disruption due to a decrease in snow days; however, it is noted that the reduced snowfall will transfer to an increase in rainfall.

76. In this context, the following impacts have been identified and will be used in reviewing the potential climate change risks and effects related to the Proposed Development in the Climate Change Adaptation assessment within the ES Climate Change Chapter.

- Increase in winter mean temperature.
- Increase in summer mean and daily maximum temperature.
- Decrease in summer rainfall.
- Increase in winter rainfall.

77. The following section reviews the potential project risks associated with these impacts.

Anticipated Project Risks and Potential Effects

78. Following a review of the UK CCRAs, relevant guidance and the anticipated future climate within the East Midlands, the potential climate change risks and opportunities in Table 10 have been identified, highlighting the specific climate change effects to the Proposed Development. These form the basis for assessment of climate change effects in the Chapter 21, Climate Change.

Table 10: Summary of Anticipated Risks

Climate Change Impact	Risk/Effect	Opportunity
Increase in winter mean temperature	Risk to species and habitats from changing climate space	Opportunity for new species colonisation and increase in climate space
		Opportunity for improvement in health and wellbeing, i.e. during construction
		Opportunity for reduced energy use and therefore reduced GHG emissions
Increased summer mean and daily maximum temperature	Risk to species and habitats from changing climate space	Opportunity for new species colonisation and increase in climate space
	Increase in energy demand from additional cooling required in buildings	
	Damage to electrical infrastructure, i.e. substation overheating	
	Risk of overheating, impacting health and wellbeing	
	Risk of damage to rail infrastructure including rail and electrical equipment	
Decrease in summer rainfall	Risk to species and habitats from water restrictions	
	Risk to fresh water supplies	
	Risk to building and infrastructure foundations from ground movement	
Increase in winter rainfall	Risk of increase in flooding (fluvial and surface water) due to increased rainfall	

	Risk to building and infrastructure foundations from ground movement	

Rail Central Risk Assessment

This section sets out a review of the severity and nature of each potential effect/risk identified to determine the overall risk and potential likelihood of impact on the Proposed Development, and therefore whether it should be considered as part of the ES Climate Change Chapter.

Assessment of Risk Methodology

79. The following methodology has been used to determine the potential level of risk associated with the identified risks/effects. The criteria adopted for this assessment have been developed based on the application of professional judgement. The tables in this section provide a summary of how the level of climate change risk has been assessed with relation to the Proposed Development.

Severity of Risk

80. Table 11 sets out the definition for the severity of the risk posed. The identified risks have the potential to have impact on the Proposed Development through effects to the infrastructure including structural failure and damage, and during the operation of the development leading to a loss of operation.

Table 11: Severity of Impact

Severity of Impact	
High	Severe risk, i.e risk of structural failure to infrastructure such as roads, rail and buildings with operational/economic loss, or, risk of total loss of species or habitats
Moderate	Moderate risk, i.e. risk of structural damage to infrastructure, operational/economic loss, or loss of species or habitats
Low	Low risk, i.e. significant operational/economic loss/change to the site, a negative impact on site species
Very Low	Very Low risk i.e. minor operational loss/change to site operation.
Negligible	Increased site maintenance requirement

Nature of Risk

81. Table 12 sets out the definition for the nature of the impact posed. The identified risks are characterised by their nature, i.e. some are continual, others are seasonal, and others may have a short term daily effect.

Table 12: Nature of Impact

Nature of	

Impact	
Continual	Continual impact likely to have an effect all year and ongoing, for example increased winter and summer temperatures
Seasonal	Seasonal impacts, i.e. increased winter rainfall and decreased summer
Frequent	A frequent or short term continuous impact i.e. a long period of rainfall or increased temperature.
Infrequent	Infrequent impact from climate change, i.e. a rise in daily maximum temperature
Very infrequently	Occasional impact as a result of climate change.

Level of Risk

82. The level of risk posed by the identified risks has been assessed using Table 13, which defines the level of risk from Negligible to High; the higher the risk the greater potential impact posed to the proposed development.

Table 13: Level of Risk

	Severity of Impact				
Nature of Impact	High	Medium	Low	Very low	Negligible
Continual	Very High	High	Moderate	Low	Low
Seasonal	High	High	Moderate	Low	Low
Frequent	Moderate	Moderate	Moderate/Low	Low	Very low
Infrequent	Moderate	Moderate	Low	Very low	Very low
Very infrequently	Moderate	Low	Low	Very low	Negligible

83. At this stage it is considered that any risk which is assessed to be moderate or higher should be considered when assessing the effects of climate change on development.

Rail Central Climate Change Risk Assessment

84. Table 14 reviews the severity and nature of each risk identified above to determine the overall risk and potential likelihood of impact at Rail Central. Those with a moderate or higher risk are considered significant and will be considered in the assessment of climate change effects in the Climate Change Adaptation section of the ES Climate Change Chapter.

Table 14: Project Risk Assessment Summary

Climatic Effect	Risk	Severity of Impact	Nature of Impact	Risk Assessment
Increase in Winter Mean Temperature	Risk to landscape and mitigation species and habitats from changing climate space	Medium – Potential for the loss of species through climate space changes	Continual – Linked to a rise in summer temperature this risk is considered to be continual	High
Increased summer mean and daily maximum temperature	Risk to landscape and mitigation species and habitats from changing climate space	Medium – Potential for the loss of species through climate space changes	Continual – Linked to a rise in summer temperature this risk is considered to be continual	High
	Increase in energy demand from additional cooling required in buildings	Low – Likely to have minor change to operational energy	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short lived	Moderate
	Damage to electrical infrastructure, i.e. substation overheating	High – Potential damage to electrical equipment likely to be a severe impact	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short lived	High
	Risk of overheating impacting health and wellbeing	Medium – Likely to have minor impact on wellbeing	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short lived	High
	Risk of damage to rail infrastructure including rail and electrical equipment	High – Potential damage to electrical equipment likely to be a severe impact	Frequent/Seasonal – Linked to periods of extreme temperature, likely to be short lived	High
Decrease in summer rainfall	Risk to landscape and mitigation species and habitats from changing climate space	Medium – Potential for the loss of biodiversity /severe impact on habitats and species	Seasonal – Linked to increased summer rainfall and a decrease in rainfall over the same period	High
	Risk to fresh water supplies	Low – Likely to have minor impact on	Seasonal – Linked to increased summer rainfall and a decrease in	Moderate

		operation	rainfall over the same period	
	Risk to building and infrastructure foundations from ground movement	High – Potential damage to infrastructure and have a severe impact	Seasonal – Linked to periods of extreme temperature and reduction in summer rainfall	High
Increase in winter rainfall	Risk of increase in flooding (fluvial and surface water) due to increased rainfall	High – Potential damage to infrastructure and have a severe impact	Seasonal – Increase in winter rainfall also linked to an increase in winter temperature	High
	Risk to building and infrastructure foundations from ground movement	High – Potential damage to infrastructure and have a severe impact	Seasonal – Linked to an increase in winter temperature and saturated ground	High

85. In addition to the project risks identified above and number of opportunities were identified during this assessment that have the potential to provide benefits to the Proposed Development and should also be considered in the assessment of effects within the Climate Change EIA chapter.

Table 15: Climate Change Opportunities

Climate Change Impact	Opportunity
Increase in winter mean temperature	Opportunity for new species colonisation and increase in climate space
	Opportunity for improvement in health and wellbeing
	Opportunity for reduced energy use and therefore reduced GHG emissions
	Reduced risks from cold weather on construction and operational phases
Increased summer mean and daily maximum temperature	Opportunity for new species colonisation and increase in climate space

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Rail Central
Northamptonshire

The Rail Central Rail Freight Interchange

Northampton Gateway Examination

Written Representation of Ashfield Land Management Limited and Gazeley GLP Northampton s.a.r.l.

Appendix 11 - Rail Central Alternative Sites Assessment

Northampton Gateway PINS Reference Number
TR050006

6 November 2018

Rail Central
Northamptonshire

The Rail Central Rail Freight Interchange and Highway Order 201[x]

Alternative Sites Assessment

PINS Reference Number:
TR050004

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September 2018

Version 1.0

Planning Act 2008 | Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

The Rail Central Rail Freight Interchange and Highway Order 201[x]

Document 7.3: Alternative Site Assessment

Ashfield Land Management Limited and
Gazeley GLP Northampton s.à.r.l.

Regulation: 5(2)(q)

Turley

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1. Introduction

1.1 Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l. (the applicant) have submitted an application for a Development Consent Order (DCO) for a Strategic Rail Freight Interchange (SRFI), referred to as Rail Central at land at Arm Farm, Milton Malsor in South Northamptonshire (the Rail Central site).

1.2 This Alternative Site Assessment (ASA) provides an assessment of alternative sites that have been considered in selecting the Rail Central site. This ASA establishes an area in which it is appropriate to search for an alternative site, sets out the search criteria to assess potential sites and assesses the suitability of alternative sites.

1.3 A SRFI is a large rail served distribution park linked into both the rail and strategic road systems, capable of accommodating the large warehouses necessary for the storage, processing and movement of goods for manufacturers, retailers and end consumers. The aim of a SRFI is to optimise the use of rail in the freight journey by maximising rail trunk haul and minimising some elements of the secondary distribution journey by road, through co-location of other distribution and freight activities and by adopting locations close to centres of demand. Thus, a SRFI has specific locational requirements.

1.4 It is not, however, the purpose of this ASA to seek to justify the detailed suitability of the proposed development in its own right. The suitability of the proposed site from a planning and environmental perspective is assessed in detail within the Planning Statement (Document 7.1), Environmental Statement (ES) (Document 6.1) and Design and Access Statement (DAS) (Document 7.2).

1.5 In addition, further information on the design evolution and alternative iterations of the proposed development is provided in the DAS. There is no formally prescribed process or methodology for undertaking an ASA, and the process should be adapted to the characteristics of different projects. The method used in this assessment reflects the national planning policy requirements set out in the following section and the specific operational and locational needs of a SRFI.

Purpose of the Assessment

1.6 This Chapter sets out the process undertaken by the Applicant in considering potential alternatives for the proposed development. The EIA Regulations[1] require the ES to outline the main alternatives studied by the applicant and to give an indication of the main reasons for the applicant's choice, taking into account the environmental effects. Although the project benefits from a scoping opinion issued under the 2011 Regulations, notice has been formally served on the Planning Inspectorate (PINS) to confirm that the Rail Central Development Consent application will follow the 2017 Regulations.

[1] The Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 as amended by the Infrastructure Planning (Environmental Impact Assessment) (Amendment) Regulations 2012 and the Consequential Amendments Regulations 2012

1.7 The approach required by the 2017 Regulations[2] differs slightly from the 2011 Regulations, in that it asks for a description of the reasonable alternatives studied by the applicant, which are relevant to the proposed development and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment. An assessment of reasonable alternatives is provided within Chapter 3 of the Environmental Statement.

1.8 The policy requirements to consider alternatives as confirmed within the National Policy Statement for National Networks (December 2014) (NN NPS)[3] do not apply to the Proposed Development. Furthermore, the Proposed Development site is not located within an area of flood risk nor is it located within a National Park, the Broads or an Area of Outstanding Natural Beauty.

Background and General Approach

1.9 The assessment of alternatives has been undertaken in two main phases. These stages link directly to the consultation process undertaken for the proposed Application.

1.10 For the Phase 1 consultation, an Assessment of Alternatives was included in the first phase Preliminary Environmental Information Report (PEIR). The methodology adopted was simple and focussed on considering sites that local interest groups, stakeholders and the public had suggested could be possible alternatives.

1.11 It also included sites that had been shortlisted in the assessment undertaken for Daventry International Rail Freight Terminal III (DIRFT), as these are potential rail freight sites already identified within relatively close proximity to the Rail Central proposal.

1.12 A more thorough ASA was prepared as part of the Phase 2 consultation. This assessment was undertaken to supplement that earlier Phase 1 exercise. It adopted a more rigorous but consistent approach, using a defined methodology.

1.13 The Phase 2 ASA was based on a GIS mapping exercise, including mapping proximity to road and rail infrastructure and constraints mapping. Potential sites were identified and scored against a common matrix.

1.14 This final ASA submitted in support of the DCO application is consistent with the Phase 2 ASA. Albeit, the various alternative sites have been reviewed again, and updates to the document have been made where new information is available.

[2] The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017
[3] NN NPS Paragraphs 4.26 and 4.27

2. Need

2.1 The starting point for an assessment of alternatives is to understand the need that the proposed development is seeking to meet. This helps to frame the extent of the exercise, in terms of both geography and the opportunities available to satisfy that need.

2.2 The NN NPS sets the context for consideration of need in this case. It notes that need for SRFI's is driven by a combination of[4]:

- The changing needs of the logistics industry
- Rail freight growth
- Environmental factors, primarily reducing carbon emissions and removing freight from the UK's roads
- Economic benefits, including job growth

2.3 The Government's vision is to achieve a low carbon sustainable transport system that is an engine for economic growth that is safer and improves quality of life in our communities. The transfer of freight from road to rail has an important part to play in a low carbon economy and therefore helping to address climate change[5].

2.4 In order to achieve the transfer of freight from road to rail, a network of SRFIs is needed across the regions[6]. The alternative options to address the drivers of need set out in the NN NPS at Table 4 are considered to be neither viable nor desirable[7]. There is considered to be a compelling need for an expanded network of SRFIs[8].

2.5 Whilst it is recognised that capacity for SRFIs needs to be provided at a wide range of locations to provide flexibility to match the changing demands of the market,[9] it is also recognised that given the locational requirements of SRFIs the number of locations suitable will be limited, which restricts the scope to identify viable alternative sites[10].

2.6 The NN NPS recognises that SRFIs need to be located alongside major rail routes, close to major trunk roads and close to the urban areas that consume the goods being moved[11].

2.7 It is clear that National Policy establishes the need for a network of SRFI's across the Country in locations which have access to road and rail infrastructure and the markets they are intended to serve. This means that different regional geographies need to be served and there is no policy based restriction on the number of SRFIs required.

[4] NN NPS See paragraphs 2.47 to 2.52
[5] NN NPS Paragraph 2.5
[6] NN NPS Paragraph 2.54
[7] NN NPS Paragraph 2.55
[8] NN NPS Paragraph 2.56
[9] NN NPS Paragraph 2.58
[10] NN NPS Paragraph 2.56
[11] NN NPS Paragraph 2.45 and 2.54

2.8 The need context set out above provides important context for any consideration of alternative sites as clearly the delivery of a single SRFI will not meet the objectives of government policy (as set out in the NN NPS) or meet existing and emerging demand. It follows therefore that the NN NPS does not require applicants to demonstrate that their sites are the best of the available alternatives. Provided that other sites are capable of meeting the requirements of the NN NPS, this report does not seek to "discount" or "reject" such alternatives.

2.9 The key issue for this, or any SRFI site which is subject to an application, is whether the Proposed Development complies with the NN NPS.

3. Options Appraisal

3.1 The NN NPS requires all projects to be subject to an options appraisal[12], but makes clear that it is not necessary for the examining authority to reconsider this process, as opposed to satisfying them that this assessment has been undertaken. Footnote 61 of the NN NPS acknowledges that investment decisions on SRFIs will be made in the context of a commercial framework. This SRFI project is privately funded and is not subject to any funding bid or process that requires a formal Options Appraisal Report to be prepared as part of the business case to secure public funding.

3.2 Notwithstanding this, the DCO application comprises two Nationally Significant Infrastructure Projects (NSIPs); one of which relates to a major highway scheme (J15A of the M1). In addition, associated development also contains a large number of other highway works. The two respective NSIPs are fully integrated and each will not proceed without the other. In essence, the highway proposals at J15A of the M1 are a NSIP simply as a consequence of exceeding the thresholds in the Planning Act 2008 (PA2008). As such, the Proposed Development is assessed as one single project. However, in practice the Transport Assessment and the analysis of impacts on highways in the ES, both submitted in support of the Rail Central DCO, provide a significant amount of information to assess adverse impacts and have been prepared in accordance with WebTAG guidance[13] in any event.

3.3 The NN NPS notes that the appraisal should consider viable modal alternatives.

3.4 A number of potential options have been considered to meet the need for a network of SRFI's. These are:

(a) The no development scenario;

(b) Focussing on road only distribution schemes;

(c) Relying on existing SRFIs

(d) Relying on more, smaller rail freight interchanges (RFI)

(e) Alternative sites as considered in the remainder of this assessment, and;

(f) Alternative forms of development on this site.

3.5 These are considered further below.

(a) The no development scenario

3.6 This is not an option. The NN NPS confirms that the overriding government objective is to shift freight from road to rail to help reduce transport's carbon emissions and provide economic benefits[14]. The NN NPS establishes there is a compelling need for an

[12] NN NPS Paragraph 4.27
[13] The WebTAG documents consist of a collection of advice and guidance on modelling and appraisal of transport projects
[14] NN NPS Paragraph 2.40

expanded network of SRFIs throughout the country and that "SRFI capacity needs to be provided at a wide range of locations, to provide the flexibility needed to match the changing demands of the market." A no development scenario would also not meet the identified need for a network of SRFIs across the UK, and would leave freight movements on the strategic road network, with the associated greater level of emissions and cost of delays caused by congestion.

3.7 In terms of Rail Central, this option would not result in any environmental change and would leave the Rail Central site in productive agricultural use. However, it would have major opportunity costs in the form of unrealised economic and job growth opportunities.

(b) Focussing on road only distribution schemes

3.8 This option has similar disadvantages to the no development scenario. The economic benefits of growth in the logistics industry would be secured, but this would be in a manner which is, relatively speaking, less environmentally acceptable. The NN NPS recognises[15] that even with significant road infrastructure investment, forecast freight levels would lead to increasing congestion at ports and on the road network, and lead to increased transport related carbon emissions. It recognises that a modal shift to rail needs to be encouraged and that this will require investment in the rail network and having suitable freight terminals to serve the growing need.

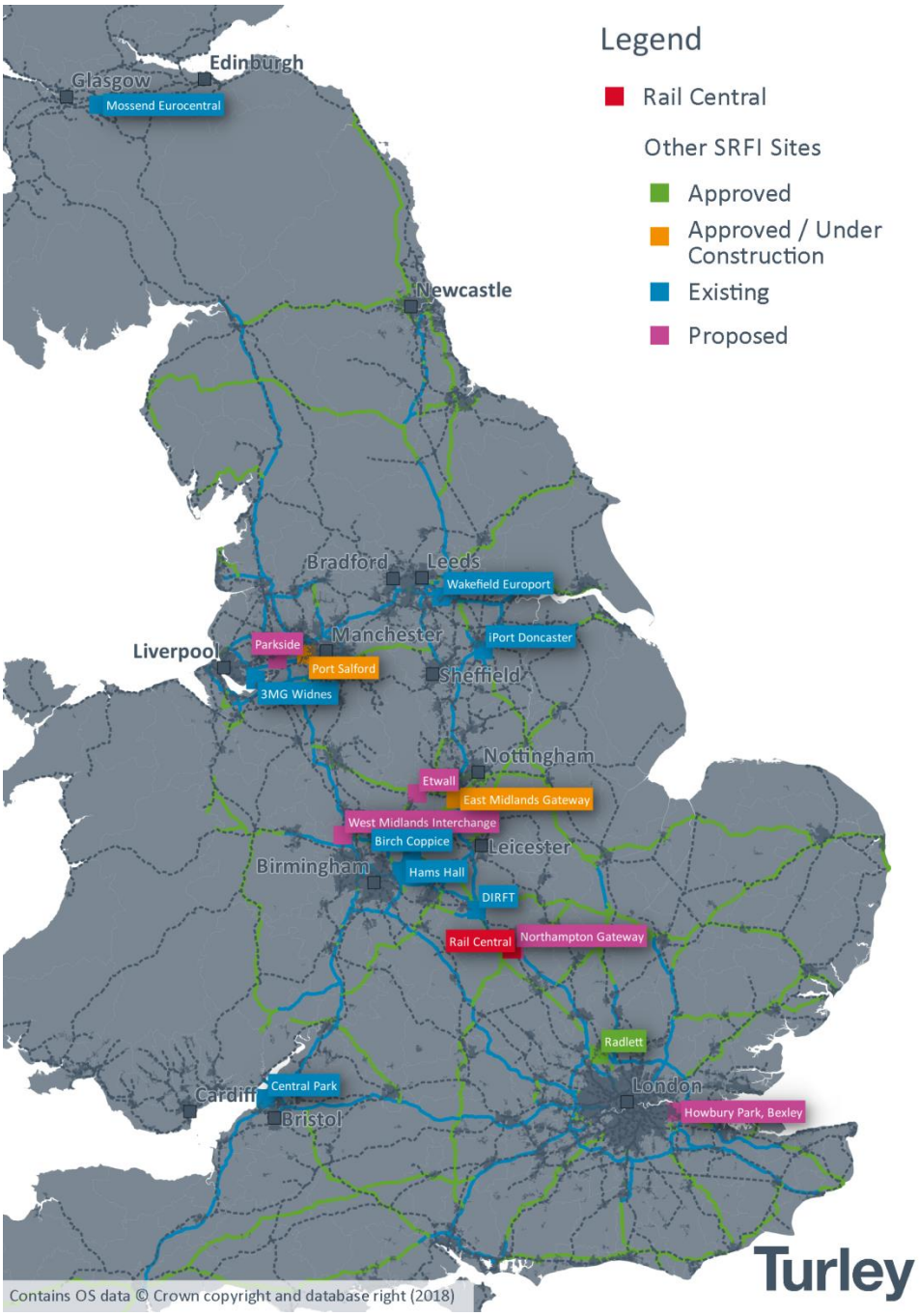
3.9 This option is not considered to be an acceptable option as it would not meet policy objectives and would result in a less environmentally acceptable alternative being adopted.

(c) Relying on existing SRFIs

3.10 The NN NPS recognises that while small parts of the country are served by existing SRFIs, relying on the existing network of RFI to manage demand is neither a viable nor desirable option, concluding: "perpetuating the status quo…is simply not a viable option"[16]. Road congestion would increase, ports would have increasing difficulties moving goods inland causing congestion and both costs and delays for shippers. This would constrain economic growth, investment and job creation.

[15] NN NPS Table 4: Options to address need, paragraph 2.55
[16] NN NPS Table 4: Options to address need, paragraph 2.55

Figure 3.1: Proposed and Operational SRFI Sites



3.11 This option is not considered to be an acceptable option as it would not meet policy objectives, would have significant economic opportunity costs and would result in a less environmentally acceptable alternative being adopted.

Relying on more, smaller rail freight interchanges

3.12 Whist this would achieve a modal shift to rail, smaller Rail Freight Interchanges (RFIs) would not have the capacity or efficiency to deal with forecast levels of freight growth. The NN NPS recognises that smaller RFIs have a place in the network of RFIs, but that

they cannot provide the scale, efficiencies and the related business facilities and linkages offered by SRFIs[17].

3.13 In order for the rail network to operate efficiently, larger SRFIs are required in addition to smaller RFIs or single rail served warehouses. Each of these has a role to play in removing traffic from the road network and can deliver economic opportunities and environmental benefits compared to a road only solution. However, to be efficient, these types of rail freight facilities must operate together and the SRFIs have a key role to play in bulk handling of goods and clearing port capacity.

3.14 This option is a partial solution but would still have economic dis benefits in terms of port congestion and effects on costs to shippers. This option is not considered to be acceptable as it only deals with part of the reason for the policy requirement for a network of rail freight facilities, and therefore does not meet the policy need in full.

Alternative sites

3.15 Within the identified assessment area, there are a small number of alternative sites for a SRFI which are considered later in this report. The methodology adopted shows that Rail Central is amongst the best locations in the East and West Midlands for a SRFI.

3.16 However, there is an identified need to secure a modal shift to rail and there is a need for more SRFIs and other rail served developments to be delivered in order to achieve a network of rail freight infrastructure. This has potential to encourage greater use of rail for distribution activity across the UK, through greater accessibility to rail freight services and markets.

3.17 There is no limit to the number of rail freight sites that can be given development consent in policy terms and it is expected that the delivery of new SRFI and the identification of suitable sites is to be led by the market. In market terms, operator requirements are the key driver, against a wider market where the vast majority of the current warehousing stock has no prospect of rail access. A greater availability of space and improved connectivity between rail infrastructure and its markets will serve to encourage operators to make more use of these facilities, with the commensurate environmental benefits compared to a road only option. Indeed, at a national level, newer SRFI facilities are emerging to fill identified gaps in the national network and clusters are beginning to form. Examples of SRFI emerging to deliver a network of sites include:

- iPort Doncaster, serving the east of Yorkshire and Humberside, with Wakefield Europort serving the west of the region;
- Port Salford, serving the Greater Manchester conurbation of the North West, between Widnes 3MG serving the Liverpool conurbation to the west and Wakefield Europort to the east;
- East Midlands Gateway (EMG) to serve the area north of DIRFT and south of iPort/Wakefield Europort;

[17] Table 4: Options to address need, paragraph 2.55 of the NN NPS

- Mossend International Railfreight Park strengthening existing provision with a mirror image development to Mossend Eurocentral immediately opposite;
- East Midlands Intermodal Park, serving the area between East Midlands Gateway, the North West, Yorkshire & Humberside;
- West Midlands Interchange, serving the Black Country, mid-Wales and the rest of the area between the Midlands and North West;
- Radlett and Howbury Park, serving London and the South East; and
- Rail Central and/or Northampton Gateway serving the area south of DIRFT and Northamptonshire.

3.18 The emergence of clustering reflects the experience of continental Europe, the scale of demand for SRFI in specific locations and major markets reflecting the success of the concept, as confirmed below:

(i) Hams Hall SRFI and Birch Coppice SRFI – less than 10km apart collaborating on rail services (some Felixstowe trains to and from Birch Coppice use the facilities at Hams Hall to change direction. Hams Hall is in turn less than 11km from the established Lawley Street Rail Freight Interchange (RFI) in the centre of Birmingham;

(ii) East Midlands Gateway SRFI and East Midlands Distribution Centre RFI – less than 3km apart;

(iii) Wakefield Europort SRFI and Leeds Stourton RFI – less than 3km apart;

(iv) 3MG Widnes SRFI and Garston RFI – less than 9km apart;

(v) Port Salford SRFI and Trafford Park RFI – less than 6km apart;

(vi) iPort Doncaster SRFI and Doncaster Railport RFI – less than 3km apart; and

(vii) DIRFT I, II and III (within which 4 separate RFI facilities effectively compete for business), to be supported by an emerging cluster of Rail Central and/or Northampton Gateway

3.19 The success of these co-located SRFIs is not accidental; it is a direct response to meeting demand and growth in rail freight accessibility in the markets they intend to serve. It also echoes the pattern of road-served distribution parks which also exist in clusters around major highway intersections (e.g. motorway junctions).

3.20 This is largely being achieved by new occupiers and businesses within those markets utilising rail freight (which is fully consistent with the policy objectives of the NN NPS) rather than diverting rail freight traffic from elsewhere. Indeed, it would be impractical, and against the grain of the NN NPS, for customers to rely upon remote facilities elsewhere to meet its own freight requirements.

Alternative forms of development

3.21 There are other potential development scenarios for the Rail Central site. These include:

- A rail freight terminal of lesser extent;
- A non- rail connected / served logistics development; and
- Residential or other non-employment related development.

3.22 The non-rail related development options have not been pursued, primarily because they will not meet the established need for a network of SRFIs across the UK. Whilst there is strong residential demand, this need is addressed elsewhere through local policies and a release of the Rail Central site for residential development would not maximise the functional and locational benefits of this site.

3.23 In the case of a reduced scale of development on this site, this option would not maximise the opportunity from creating such a development. Furthermore, the position of the railway infrastructure relative to the strategic highway access means that creating a smaller development should naturally occur around the rail infrastructure. This would create the need to provide significant new access infrastructure without providing the development associated with that infrastructure which would provide its funding. This option therefore represents an opportunity cost and creates a potential project viability issue.

3.24 Consideration has also been given to alternative layouts of the selected form of development. These were considered as part of the iterative process of site design and environmental assessment and are included in the Design and Access Statement. These early iterations of the masterplan are not presented in detail in this report as they add little to the consideration of options and represent the fine detail of the evolution of the current scheme[18].

3.25 However, there are key factors which have guided the general form of the development. These fixed parameters are:

- The locations at which rail connections can be achieved, both on the main line and the Northampton Loop Line (NLL);
- The location at which access to the strategic road network can be achieved, on the A43; and
- The need to cross Northampton Road.

3.26 These elements of the development are fixed and are all essential elements of the proposed scheme. These dictate the general extent of the development as well as factors such as the location of the intermodal and express freight facilities and the positioning of the directly rail connected units to the eastern side of the site. The difficulties of securing a rail link to the western side of the site, past the old

[18] Site masterplan options can be viewed in the Design and Access Statement

Northampton Road also dictates the positon of the rail served units to the western side of the site. These parameters have therefore heavily influenced the general form and nature of the proposed development and each of the alternatives has had to work within these limits.

Options appraisal conclusion

3.27 This options appraisal has considered high level alternatives to pursuing the type of development proposed in the application. Many of these options are discounted in the NN NPS as they will not contribute towards meeting the policy need for a network of SRFIs.

3.28 The reasoning that sits behind discounting those options that there are fundamental and strategic difficulties with not seeking to meet the need for a network of SRFIs as established in the NN NPS. These are essentially environmental and economic costs, which suggest that significantly enhanced rail freight provision in the UK is the best solution to ensuring continued economic prosperity and reducing the environmental burden of society's current need to move bulk freight to the UK and around the UK.

3.29 The Rail Central site is considered to be an excellent opportunity to provide a high quality, 'next generation' rail freight development that will contribute to the UK's ultimate aim of securing a network of rail freight infrastructure. In this context, and as explained within the Rail Operations Report (Document 7.5) submitted in support of this DCO application, its potential has been recognised by Network Rail which maintains a programme (in parallel with developments such as HS2) which focuses on seeking to respond to forecast growth in passenger and freight traffic through capacity enhancement.

3.30 Network Rail forecasts reflect the assumed delivery of new SRFI in Northampton. Rail Central is included in the quantum of floorspace and sites on which the aggregate forecast is based[19]. It is these forecasts which underpin the NN NPS which states that these forecasts should be accepted for planning purposes[20]. As the NN NPS explains[21], SRFI capacity is needed at a wide range of locations to match the changing demands of business. If this is not achieved, the NN NPS forecasts will not be met and wider government policy objectives on the economy, mobility and sustainability will be hindered.

[19] Page 15, Network Rail Freight Market Study, October 2013
[20] NN NPS Paragraph 2.49
[21] NN NPS Paragraph 2.58

4. Methodology

Assessment Area

4.1 The national policy solution to successfully deliver the transfer of freight from road onto rail is the creation of a network of SRFIs which can provide distribution floorspace within the same site as a RFI. A SRFI requires (by legislation[22]) an intermodal terminal (capable of handling at least four trains per day); it must also include warehouses to which goods can be delivered from the railway network either directly or by means of another form of transport. Indeed this is considered necessary to attract customers and to generate returns sufficient to justify the rail infrastructure investment costs. SRFIs must also be of significant scale (at least 60 ha in size). The SRFI concept therefore combines an interchange and warehousing activities on the same site. SRFIs should not be seen simply as locations for freight to access the railway but also sites for the accommodation of businesses capable now or in the future of supporting their commercial activities by rail[23].

4.2 The rail terminal facilities at a SRFI are used by the occupiers of the on-site warehousing at the SRFI and by companies located off-site in the surrounding catchment area of the SRFI. On-site occupiers of existing SRFI development floorspace have traditionally been in the form of National and Regional Distribution Centres (NDCs and RDCs) which, by their scale and nature, receive, store and distribute freight in the greatest volume and over longer distances thereby making rail use more competitive.

4.3 In addition to any rail connection, demand for NDCs and RDCs is strongly governed by certain locational requirements. In particular, for NDCs especially, the attractiveness of an area relative to another area is governed by the following intrinsic characteristics:

- A location in the UK which provides access to major population centres in all parts of the UK within a reasonable drive time. Drive time connections are crucial to the logistics industry as road is the predominant mode for moving freight and because of statutory limits on a driver's working (driving) hours
- A location convenient and central to the major container ports, key manufacturers and other suppliers of goods
- A location with convenient access to the country's two most significant motorways – the M1 and M6 - and trunk roads which provide supporting connections to the UK's main urban centres
- A location which provides a good supply of appropriately skilled labour as NDCs and other large warehouses offer significant employment opportunities

4.4 These inherent characteristics are displayed in the Midlands where the demand for large scale logistics remains strongest at locations with good access to the strategic motorway network where occupiers can serve a large proportion of the UK population,

[22] Section 26, Planning Act 2008

[23] NN NPS paragraph 4.88

as well as major ports and the Channel Tunnel, within appropriate drive times and with a ready supply of labour.

4.5 Therefore, in order to be successful in attracting occupiers and rail freight services, the location of SRFI will need to meet these key location considerations. In reality, therefore, most major NDC and RDCs are concentrated in the Midlands, therefore a concentration of SRFI developments in the region can be expected. The Midlands is also at the heart of the UK rail freight network.

4.6 It is therefore considered appropriate for any assessment area, considering sites for SRFI in the Midlands, to cover both the West and East Midlands for the purposes of a robust assessment.

4.7 As noted above, SRFIs provide rail access not only for on-site occupiers but also for other companies located offsite in the hinterland on non-rail-served sites. For SRFI, operational evidence indicates that in the case of the latter, the size of the road-based hinterland for traffic arriving or departing from the SRFI by rail is primarily within a 15km radius of the SRFI, although it can extend beyond this to a secondary catchment area potentially up to 50km. However it is the locational requirements of on-site warehousing to serve as NDCs or RDCs (along with a suitable connection on the Strategic Road Network (SRN)) which is a principal consideration in the location for a SRFI.

4.8 Therefore any assessment of alternative locations should be considered against where the demand for NDC's and RDC's is the highest, reflective of the locational characteristics that attract these type of occupiers. The Market Assessment Report submitted in support of the Rail Central DCO application demonstrates that the demand for large scale logistics is strongest in the Midlands and given the economics of rail freight and dynamics of the logistics market, SRFI's will inevitably need to be concentrated, albeit not exclusively, in the centre of the UK where locations have the greatest access to UK markets and where a large number of NDC and major RDC's are located and will continue to be located. Therefore the assessment area for alternative sites of the East and West Midlands is considered to be an appropriate one.

4.9 The catchment area for the assessment is shown on Plan 1 at Appendix 1

Approach

4.10 This assessment has adopted a methodology based on the locational criteria for SRFIs which are described in the NN NPS[24]. The locational criteria described include the following key factors:

- Proximity to major urban centres and supply chain routes;
- Good road access;
- Adequate links to the rail network;
- Loading gauge of W8 or more;

[24] NN NPS Paragraphs 4.84 to 4.89

- Capability to accommodate longer trains of 775 metres in length in one manoeuvre to and from the main line without intermediate splitting or shunting;

- Avoiding environmentally sensitive areas, defined as being residential areas or National Parks, the Broads and AONBs, taking into account the possibility of mitigation;

- Other environmental considerations such as flooding and agricultural land; and

- Availability of a workforce.

4.11 The methodology is based on a defined area of search, availability of key infrastructure and mapping constraints. Ultimately, the methodology follows a map based constraints "sieving" exercise over the East and West Midlands, which is the core of logistics activity in the UK and a strong central location where the majority of the UK can be served within the driver working limits set by the Working Time Directive.

4.12 The exercise focusses on many of the key constraints confirmed in the NN NPS and reiterated above, including proximity to motorway junctions, rail gauge, train length and environmental and key policy constraints. The "sieving" identifies any areas of land that are considered to be environmentally sensitive. These areas were subsequently removed from the process and hence the scoring mechanism used (see below) does not focus on the environmental constraints and instead focusses on the constraints of proximity to sensitive uses and the potential to mitigate adverse effects.

4.13 Once areas of search based on these criteria were identified, further elements of suitability were introduced and the sites compared for appropriateness as a SRFI.

4.14 This methodology is considered to be an appropriate means of standardising the approach to site assessment, and to ensure that a consistent outcome for each site is achieved. However, as it is a tool designed to standardise, it naturally has limitations in its ability to be used for fine grained comparison. For this reason the assessment is also supplemented by a qualitative review once a shortlist of sites has been selected.

4.15 The approach to each stage of the process is outlined below.

Stage 1: Sieving

4.16 Having defined a suitable assessment area, the "sieving" exercise was undertaken.

4.17 This sieving exercise focussed on a GIS based approach to mapping key infrastructure and environmental constraints. The following factors were mapped using data from data.gov, Historic England, Natural England, Environment Agency and GIS software:

(i) 5km distance from Motorway Junctions[25].

This ensures that the sites selected for review accord with the NN NPS criteria of having good road access and being capable of accessing the supply chain routes

[25] Defined as being motorway standard through DfT Circular 02/2013

and major urban areas which are likely to be the ultimate destination of many of the goods handled by the development. The 5km threshold has also been used in previous alternative site assessments undertaken for previous/existing SRFI proposals including Howbury, Radlett, DIRFT and West Midlands Interchange.

It is not considered appropriate to consider the potential to create new motorway junctions, owing to both the cost associated with such an intervention rendering SRFI projects unviable. There is also significant delivery times associated with new motorway junctions and, unless a motorway junction is expressly identified in Local Plans to facilitate strategic growth or is programmed by Highways England, the Department for Transport (DfT) has a presumption against the construction of new junctions[26]. No new motorway junctions are currently proposed in the search area.

(ii) 5km distance from railway lines.

This ensures that the sites selected can accord with the NN NPS criteria for having adequate access to the rail network. While a 5km threshold has been adopted, it is acknowledged that that this is a conservative approach as it is likely that identified sites towards the fringe of this range are unlikely to pose realistic and viable alternatives for the market to exploit. The 5km threshold has also been used in previous alternative site assessments undertaken for previous/existing SRFI proposals including Howbury, Radlett, DIRFT and West Midlands Interchange.

(iii) Rail Gauge of W8 and above[27] and contiguous track able to accommodate a 775m train.

This ensures that the sites selected can accord with the NN NPS criteria for having a suitable loading gauge and the ability to accommodate longer trains.

(iv) Environmental designations based on www.magic.gov.uk datasets.

This ensures that the sites selected can accord with the NN NPS criteria for avoiding environmentally sensitive areas.

4.18 These datasets were used to identify locations where there is a combination of good access to the strategic road and rail networks, with no or limited environmental constraints. This included the removal of nationally designated areas (i.e. Areas of Outstanding Natural Beauty and European Sites). This stage also included a review of existing Green Belt boundaries. It is recognised that the national need for development weighs in favour of NSIPs, even if this would result in the loss of existing designations, including Green Belt land. However, in bringing forward development on the Green Belt, the NN NPS[28] is clear that the Secretary of State would have to be convinced and promoters would need to demonstrate very special circumstances to justify planning consent for inappropriate development in the Green Belt. The NN NPS[29] also confirms that the Secretary of State will attach substantial weight to the harm to the Green Belt,

[26] See DfT Circular 02/2013
[27] Based on manual logging of the routes using Network Rail information
[28] NN NPS Paragraph 5.172
[29] NN NPS Paragraph 5.178

when considering any application for such development. Furthermore, it is recognised that there are alternative sites that would not require the loss of Green Belt land. Therefore, land identified as being within the Green Belt was sieved out in the early stages, identified as being more sensitive, in policy terms, to non-Green Belt designated land.

4.19 The outputs were used to further reduce the area of search. The next stage was to review the more detailed mapping to determine site boundaries which had the potential to offer train access with limited effects based on the physical infrastructure in the area, including roads, housing and other sensitive uses, canals, etc. This exercise was based on the professional judgement of the Applicants' team.

4.20 Once the sites had been identified, topographical data, flooding data, agricultural land classification and environmental constraints data was used to inform the site specific assessment.

4.21 Following this, workforce availability data, in the form of jobseeker's allowance (JSA) applicants and economically inactive people looking for a job[30], was obtained for the local authority area in which the site sits, and the immediately adjoining local authority areas. These were added to the qualitative discussion of the site scoring as a measure of whether labour availability would be likely to be a constraint to achieving a successful SRFI.

Stage 2: Site Assessment

4.22 Sites identified through the sieving process were combined with the sites identified in the initial alternatives assessment in April 2016. These sites were then subject to a qualitative analysis, focussing on the following factors:

- Proximity to a motorway junction;
- Access to rail network;
- Vehicle access routes;
- Site size;
- Site shape;
- Topography[31]; and
- Proximity to and potential effects on residential or other sensitive land uses.

[30] Both taken from ONS data (Appendix 9)

[31] Site size, shape and topography were included because in addition to the factors set out in the NN NPS they are practical issues which affect service; whether a site can accommodate a SRFI, which has a defined minimum size in the Planning Act; whether a critical mass of development can be achieved which is both viable and likely to generate the economic benefits of clustering similar uses together around a common rail facility; whether the site can accommodate large floorplate buildings which for both practical and institutional investment purposes need to be large, rectangular and have large yard areas; and finally topography is important as a level access needs to be achieved for the rail connection.

4.23 For each identified site, local plan and land use designations were identified and each was scored using a scale of -2 to +2. This scale was considered appropriate given the level of information available relating to potential sites and the specific NN NPS and NSIP thresholds which influence individual banding. Addressing the sites with a more finely grained scale would have required additional assumptions to be made, bringing in potential inaccuracies in grading and ranking. The scale utilised therefore allows for an accurate assessment, without ensuring the need to make unfounded assumptions. The utilised scale is presented at Table 4.1 below:

Table 4.1: Scoring Scale

Score	Performance
2	Very High
1	High
0	Neutral
-1	Low
-2	Very low

4.24 The scoring criteria for each of the factors noted above is set out in Table 4.2 below:

Table 4.2: Scoring Matrix

Score	Performance	Proximity to Motorway Junction	Access to Rail	Vehicle Access Routes	Site Size	Site Shape	Topography	Sensitive User Residential Amenity[32]
2	Very High	Up to 1km from junction	Access to more than one W10 gauge route section	Access to motorway all on A Class Road, no need to pass through residential areas	200Ha+ [33]	Large regular blocks of land capable of accommodating multiple large floorplate buildings. Long straight areas adjacent to rail line to allow multi-modal access	Largely flat site with little or no earth working required to achieve level rail access for intermodal facility	No sensitive properties nearby
1	High	1-2 km from junction	Access to W10 gauge route section	Access to motorway largely on A Class Road, but some using lower class roads	100-199Ha [34]	Fairly regular site, with long straight areas adjacent to rail line	Largely flat site with ability to achieve level rail access for intermodal facility with limited earth working	Physical development distant from sensitive properties, with potential for visual and noise screening

[32] Sensitive users have been defined as housing, care homes, hospitals, residential institutions. Sensitive areas were screened out by the sieving methodology.
[33] Meeting NSIP threshold and broadly comparable to successful SRFI DCO applications, e.g. DIRFT III and EMG
[34] Meeting minimum NSIP threshold, but with limited numbers of units and smaller than recent successful SRFI DCO applications, e.g. DIRFT III and EMG

Score	Performance	Proximity to Motorway Junction	Access to Rail	Vehicle Access Routes	Site Size	Site Shape	Topography	Sensitive User Residential Amenity[32]
0	Neutral	2-3 km from junction	Access to W8/9 route section, but close to W10 with no bridge structures between site and W10 route	Access to motorway mostly on lower class roads	60-99 Ha[35]	Fairly regular site ability to secure suitable rail access to provide intermodal facility	Sloping or hilly site but retains ability to achieve suitable rail access subject to moderate/ large scale earth works	Physical development close to sensitive properties but adequate opportunities to screen for significant noise and visual effects
-1	Low	3-4 km from junction	Access to W8/9 route section, with distant access to W10 gauge with no bridge structures between site and W10 gauge route	Access to motorway mostly on lower class roads, including the need to pass through residential areas	40-59 Ha[36]	Irregular site with ability to accommodate intermodal facility	Sloping or hilly site with levels difference between site and rail infrastructure that requires major earth works to achieve rail access	Physical development close to sensitive properties and limited opportunities to screen for significant noise and visual effects
-2[37]	Very low	4-5 km from junction	Access to W8/9 gauge route,	Access to motorway	Under 40 Ha[38]	Irregular site with no ability	Sloping or hilly site, with major	Physical development close

[35] Meeting minimum NSIP threshold, but with limited numbers of units and significantly smaller than recent successful SRFI DCO applications, e.g. DIRFT III and EMG.
[36] Not an NSIP, but meeting minimum size criteria set out in Strategic Rail Authority RFI Policy document (March 2004)
[37] Any sites that are identified as scoring Very Low in the matrix have been sieved out of the process and are not considered any further as they are subject to an absolute constraint that would curtail their operation as a SRFI

Score	Performance	Proximity to Motorway Junction	Access to Rail	Vehicle Access Routes	Site Size	Site Shape	Topography	Sensitive User Residential Amenity[32]
			with bridge structures between site and W10 gauge route	mostly on lower class roads, including the need to pass through significant residential areas, or more than one community		to accommodate multimodal access	levels difference between site and rail infrastructure that will not allow suitable rail access to be achieved	to sensitive properties with no opportunities to screen for significant noise and visual effects

[38] Not an NSIP, only capable of accommodating 1 large unit

4.25 The rankings used in the scoring matrix have been devised as follows:

- Proximity to a motorway junction
  - The distances selected are banded to reflect the desirability of logistics operators to be very close to motorway junctions. Most modern logistics developments aim to be almost directly on junctions. Further distance adds costs in mileage and emissions. The distance bandings are designed to reflect this general principle.
- Access to Rail
  - This is designed to directly reflect the requirement in the NN NPS to have access to W8 or greater rail infrastructure. However, W10 is the ideal gauge as this gives the best flexibility to accommodate all container sizes with no obstacles. This scoring includes provision for exceptional sites, like Rail Central, where access to more than one W10 line is available. It also provides for different scenarios where lower grade access is available with differing levels of ease of access to the W10 network, including obstacles such as bridges which may impede container size and / or ability to upgrade the line in the future. The "sieving" exercise has allowed the longlist sites to be limited to only those sites which can accommodate full length trains.
- Vehicle access routes
  - The scoring used allows for a subjective assessment of the route taking into account factors such as the class of the road and whether the best access route would need to pass through a more sensitive community. This approach takes into account the NN NPS requirement to demonstrate good road access.
- Site size
  - The site size criteria are based on whether the site could accommodate a NSIP scale SRFI project or would only be suitable for a smaller RFI. The scoring favours larger scale sites, which are equivalent to recent SRFI NSIP projects, as this scale of development is being actively pursued by commercial developers and thus demonstrates viability. This scale of development also offers the best opportunity to maximise the economic benefits and economies of scale of the development, compared to the associated costs of creating new rail connections and providing the necessary infrastructure to deliver a SRFI. The scoring reflects the lesser efficiencies and economic contribution of smaller NSIP SRFI projects and favours larger scale strategic options as these would be the sites that would offer a reasonable alternative to the application site.
- Site shape

- The scoring reflects the physical nature of large scale rail freight development, including the need to be able to accommodate multiple large scale rectangular buildings and with the availability of straight sections of railway suitable to accommodate an intermodal area.

- Topography

  - The scoring reflects the nature of the site and the effect of topography on the ability of the site to achieve a rail connection. The scoring favours those sites which are relatively flat and have flat areas adjacent to the railway. Sites which have topographical constraints which inhibit their ability to achieve a rail connection attract the lowest scores.

- Proximity to and potential effects on residential or other sensitive users

  - The effects on residential amenity and other sensitive users have been considered on the basis of general proximity and the potential for the development to introduce screening against the effects of a large scale SRFI development.

4.26 Each of the identified sites was scored using the performance matrix. Each identified site was scored against each of the criteria and a total score calculated.

4.27 At this stage, analysis of available workforce was included in the qualitative section. This data was included as an indication of whether there is likely to be a shortage of labour that such a SRFI would not be able to be supported by local labour. This was measured on a relative basis. Using the site area, the amount of development that could be supported on the site was calculated and then the number of employees that this would generate was calculated. This requirement was compared to the number of economically active people looking for work. If the number of employees generated by the development would exceed the available labour force, this was highlighted as being an additional issue to be taken into account alongside the scoring.

4.28 It is recognised that this local available workforce calculation has limitations. The labour need for a SRFI site will grow over the lifecycle of the development, and the total workforce provision will not be required immediately from the outset of the development. Furthermore, it is likely that the jobs available may be accommodated outside of the established catchment area. Notwithstanding its limitations, the assessment still offers a measured means of differentiating between the sites.

4.29 The available local workforce was calculated using the following formula:

- 40% of site area in Hectares (representing a 40% development density, common in large scale logistics schemes), multiplied by 10,000 (to convert to sqm), divided by 95[39]; or

- 0.4 x Ha x 10,000 / 95 = job generation; or

[39] Lower end of employment densities typically seen at distribution centres, which range from 70 – 95sqm per employee in the Homes and Communities Agency Employment Density Guide, 3rd edition November 2015

- Specific information/data has been used if available (e.g. for the proposed Northampton Gateway SRFI).

4.30 This method provides an estimate of job generation which allows comparison to the local labour pool.

4.31 Following this, further qualitative analysis was used to check rankings using professional judgement. The purpose of this was to ensure that the scorings had produced a reasonable reflection of whether the scheme was suitable for use as a SRFI. Any adjustments made to the overall ranking of the site as a result of this stage is clearly differentiated in the analysis section which provides a finer grained consideration of specific sites.

Stage 3: Assessment of previously short listed sites

4.32 This stage involved a review of the initial alternatives assessment work undertaken and scoring the sites identified as having rail access potential. This was undertaken to ensure that every site considered by the Applicant has been scored against a consistent framework.

4.33 Sites which have no direct rail connection have been discounted and are not analysed further. However, sites which are capable of gaining rail access have been scored.

Stage 4: Assessment of Rail Central

4.34 This stage scored Rail Central against the common scoring matrix, to allow comparative analysis to sites considered in Stage 3.

Stage 5: Comparative Assessment

4.35 Once each site had been allocated a total score, the site scores were tabulated and ranked.

4.36 All the sites were then considered qualitatively to address any limitations inherent in the scoring approach, alongside the Rail Central site. A professional judgement was made on the performance of each site and an overall comparative assessment made with the Rail Central site against the site selection criteria.

Overview and Conclusions

4.37 This methodology was devised to locate potential SRFI sites in the East and West Midlands, which is the target market for the proposed development and the focus of logistics activity in the UK. The methodology also allowed for the inclusion of sites which were suggested by local residents.

4.38 The methodology sieves out sites which do not meet key access requirements. It also sieves out sites which have high level environmental constraints, in the form of national and regional designations.

4.39 The sites were identified with the objective of finding larger scale SRFI sites. Each stretch of suitable rail infrastructure was considered and the best sites identified.

4.40 These were assessed against common scoring criteria seeking to achieve objective and impartial rankings. These were subject to a further stage of pure qualitative analysis in order to “sense check” the results and ensure strong sites were not being unfairly disadvantaged by the methodology.

4.41 The sites were then ranked and comparatively assessed.

5. Stage 1: Sieving Results

5.1 Stage 1 was primarily GIS based, with the mapped outputs provided at Appendices 1 to 8.

5.2 Plan 1 (Appendix 1) shows the catchment area for this preliminary assessment, comprising the East and West Midlands Regions.

5.3 Given the importance of motorway access to all modern logistic operations, Plan 2 (Appendix 2) shows the location of motorway junctions within these Regions and maps a 5km area of search around these.

5.4 Plan 3 (Appendix 3) overlays railway lines within this area of search. This has a limited effect on the area of search. However, rail freight uses need a loading gauge of at least W8 to function. Ideally, they will have access to W10 or W12 standard railways. These higher rail gauges offer better clearances and faster routes so that a variety of wagons can be utilised.

5.5 Plan 4 (Appendix 4) limits the area of search to those areas with stretches of W8 railway or above. This further reduces the area of search.

5.6 Plan 5 (Appendix 5) overlays key environmental designations taken from published government datasets[40] on the area of search. As this data is very detailed, Plan 5 is also shown across 6 sub-plans, Plans 5a to 5f.

5.7 Plan 6 (Appendix 6) shows the area of search further reduced by excluding the land constrained by environmental designations. It is also important to note that an ability to accommodate full length trains is also a key feature of a SRFI. A full length train is 775m long and SRFI should be capable, where possible, of handling 775m trains with on-site infrastructure configured accordingly. Plan 6 therefore highlights sections of rail track which are 775m long (including contiguous sections) which are both within the area of search and outside the environmental constraints. Sections of railway which are not long enough to handle a full length train have been excluded as sub optimal.

5.8 Plan 6 has then been split into 6 sub-plans, Plans 6a to 6f (Appendix 7), which show in more detail topographical constraints[41] and Flood Zones. Similarly, Plans 7-1 to 7-25 (Appendix 8) detail the agricultural land classification for each alternative site. In respect of agricultural land classifications, information has been derived from Natural England resources and therefore only provides a broad interpretation of the classification. More detailed analysis specific to the site may indicate variations in this classification.

5.9 All of these plans have been used to identify sites for assessment as described in Section 2.

[40] A full list of designations is provided at Appendix 5
[41] Using LIDAR data from the Environment Agency dataset, where this is available

5.10 A series of site plans has then been produced which show each of the selected sites in their local context with all relevant constraints shown.

5.11 For each site, a commentary of the existing environmental designations or land-use allocation (if appropriate) is set out along with any identified planning permission and/or consent that have been identified.

6. Stage 2: Site Assessment

Sites identified through Stage 1 Sieving

Figure 6.1: Site 1: Wadborough Park Farm, near Stoulton, Worcestershire

6.2 This site is located approximately 6km to the south east of Worcester. It is 258Ha and has the following constraints noted in the sieving analysis:

- Cooksholme Meadows SSSI located adjacent to the north west boundary; and
- The majority of the central area of the site is identified as Grade 2 agricultural land, whilst some areas in the north are Grade 3.

6.3 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	0	Access from B4084 to J7 of M5 is approximately 2.5km
Access to Rail	0	W8 rail gauge rail route
Vehicle access routes	-1	Most suitable access route from B4084 north west to J7 of M5. Route passes through 2 small Hamlets on Whittington Road.

Factor	Score	Notes
Site size	2	258Ha
Site shape	2	Large site of a regular shape
Topography	2	The site is flat by the rail line and slopes only around 10m across the width of the site. Capable of accommodating rail with little earth moving required.
Proximity to and potential effects on residential or other sensitive land uses	0	Site close to Littleworth (300m), Stoulton (200m) and Hawbridge (280m), but opportunities exist to provide visual and noise screening.
Total	**5**	

6.4 In terms of labour force availability, the site is 258Ha, applying the formula at paragraph 4.29, the site could generate in the region of 10,863 jobs. There are currently 22,900 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.5 In relation to local policy designations and planning status, the site has a number of Green Infrastructure policies, which seek to protect and enhance the landscape. A mineral safeguarding designation also covers much of the central area of the site. It is anticipated that these designations would not unduly restrict the development of a SRFI on the site. Furthermore, there are no relevant extant or current planning applications on the site.

6.6 This site scores well on size, shape and topography. However, it suffers from access to a lower gauge rail line, access via a “B” road and the need to drive past two small hamlets close to the motorway junction.

Figure 6.2: Site 2: Dairy House Farm, Grendon, near Tamworth

6.7 This site is located some 8km to the south east of Tamworth. It is 153Ha and has the following constraints noted in the sieving analysis:

- Small block of ancient woodland within the site boundary;
- The entirety of the site is categorised as being Grade 3 agricultural land;
- Area of Flood Zone 2 at northern edge of site, partly adjacent to rail sidings; and
- Scheduled Ancient Monument (Merevale Abbey) and Registered Park & Garden (Merevale Hall).

6.8 In addition there are two listed locks / basins on the canal which forms the northern boundary of the site, and a listed bridge which runs over the canal.

6.9 The scoring matrix has been utilised to produce the following results for this site:

Factor	Score	Notes
Proximity to a motorway junction	-2	4.8km to J10 of M42 from a potential grade separated access point on dual carriageway section of A5. 4km to second potential access point on Spon Lane (NE of site) which reduces the number of residential properties passed.

Factor	Score	Notes
Access to Rail	1	The site is bisected by the 4-track W10 gauge West Coast Main Line (WCML) route section, likely to require grade-separation of main line connections to avoid the need for flat crossings of up to 3 main line tracks by freight trains to/from the site.
Vehicle access routes	1	A5 access point all on A roads, but passes a number of residential properties. These are already likely to be heavily influenced by traffic effects on A5. Alternative route via Spon Lane involves B road access, but reduces the number of properties passed.
Site size	1	153Ha
Site shape	2	Regular shape with potential for long railway sidings and larger footprint buildings.
Topography	1	Relatively flat site, gradients cross rail line, but likely to be capable of being levelled.
Proximity to and potential effects on residential or other sensitive land uses	-1	Southern and western boundaries partially formed by residential properties. Immediately adjacent to Grendon. Potential for mitigation to be included but this is likely to be extensive to be effective and would significantly reduce development area.
Total	**3**	

6.10 In terms of labour force availability, the site is 153Ha, applying the formula at paragraph 4.29, the site could generate in the region of 6,442 jobs. There are currently 61,900 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.11 In relation to local policy designations and planning status, a small area within the centre of the site is designated as an Ancient Woodland. This could potentially curtail the developable area of the site. However, there are no policies that would entirely restrict the future development of the site. No relevant extant planning permissions or current planning applications have been identified.

6.12 This site scores well for its shape, but poorly for highways access and proximity and likely effects on residential properties. The 4-track nature of the WCML at this point

(from west to east being northbound Slow Line, bi-directional Fast Line, bi-directional Fast Line, southbound Slow Line) would make at-grade access to the main line difficult to achieve (a similar arrangement at the proposed Radlett SRFI requires full grade-separation).

Figure 6.3: Site 3: Land adjacent to Birch Coppice, near Tamworth

6.13 This site is located some 5km to the south east of Tamworth. It is located adjacent to the existing Birch Coppice RFI. It is 165Ha and has the following constraints noted in the sieving analysis:

- Blocks of ancient woodland to the south and south west;
- The site is predominantly categorised as being Grade 3 agricultural land, aside from a small area within the north east of the site which is Grade 4 agricultural land; and
- Kettlebrook Local Nature Reserve to the north east.

6.14 In addition there are 4 listed buildings in Freasley, around Freasley Hall, and a further listed building at Hall End Farm, which adjoin the site.

6.15 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	2	Access could be taken off a new junction on the A5 within around 500m of J10 of

Factor	Score	Notes
		M42. Alternatively, it may be feasible to make use of the existing Birch Coppice Business Park junction, just less than 1km from J10.
Access to Rail	1	The site is adjacent to a W10 gauge route. As noted below, topographical constraints limit the accessibility of the site to most of the available length of rail line.
Vehicle access routes	2	The site is adjacent to the A5, very close to the M42 with no need to pass through local communities.
Site size	1	165Ha
Site shape	-1	The site is irregular in shape owing to the location of the settlement of Freasley in respect of the site. Based on this, the available length of rail frontage, as well as the size of the site, it would appear difficult to accommodate a significant number of larger floorplate buildings as well as an intermodal facility.
Topography	1	The site is relatively flat at its southern end and it may be possible to achieve rail access at this point. However, the eastern boundary is dominated by the spoil mound, and so would need a very significant tip relocation exercise to gain access to rail at this point. This is unlikely to be economic, so reliance would need to be made on the southern area to gain access to the rail line.
Proximity to and potential effects on residential or other sensitive land uses	-1	The site is immediately adjacent to the settlement of Freasley. With extensive screening, it may be possible to reduce the impacts of development on the settlement, although this would significantly reduce the available development area of the site, which is already not an ideal shape for this type of use.
Total	**5**	

6.16 In terms of labour force availability, the site is 165Ha, applying the formula at paragraph 4.29, the site could generate in the region of 6,947 jobs. There are currently

61,900 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.17 In relation to local policy designations and planning status, the eastern and brownfield element of the site is designated as an 'Existing Industrial Estate' in the North Warwickshire Core Strategy. The area of land directly to the south east of Junction 10 of the M42 (northern area of the identified site) benefits from an extant outline planning permission, which consents the development of land within Use Class B1(c) (light industry), Use Class B2 (general industry), and Use Class B8 (storage and distribution) and demolition and removal of existing structures (North Warwickshire ref. PAP/2014/0648). Following the granting of this planning permission at appeal, a series of subsequent applications have been submitted to discharge conditions and seek approval for reserved matters.

6.18 This area of land within the north of the identified site is therefore considered to be committed. However, the uses permitted are consistent with the development of a SRFI, albeit this area of the site does not have direct access to the existing railway. To facilitate the development of a SRFI on this site, it would also require the southern and central elements to also be built out.

6.19 This site benefits from excellent road access and good rail access. However, it suffers due to the shape of the site and its proximity to a residential settlement, the necessary configuration of the site would be sub-optimal for a SRFI and would not offer the same advantages as other potential sites compared in this assessment.

Figure 6.4: Site 4: Land between Hinckley and Nuneaton

6.20 This site is located some 2km to the east of Nuneaton and 3km south west of Hinckley. It is 345Ha and has the following constraints noted in the sieving analysis:

- Areas of Flood Zones 2 and 3 along Sketchley Brook, Harrow Brook and River Anker; and
- The site is predominantly categorised as Grade 3 agricultural land, with an area in the west of the site categorised as being Grade 2. Of the Grade 3 land, some of the northern area is sub-categorised with small areas being Grade 3a.

6.21 In addition, it is in the Rugby Green Belt and thus will plays an important role in separating the two settlements.

6.22 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-1	Access could be taken off the existing A5 / A47 / B4666 roundabout. This junction is 3.9km from J1 of M69.
Access to Rail	1	The site has a long straight stretch of W10 gauge route within the site.
Vehicle access routes	2	The site could take direct access off the A5, without the need to pass through communities. It would pass adjacent to properties on the southern side of Hinckley, although are already likely to be highly influenced by traffic on the A5.
Site size	2	345Ha
Site shape	2	The site is regular with good opportunities to accommodate large floor plate buildings.
Topography	1	The site is relatively flat with gradients crossing the railway line. Suitable access should be achievable with limited earthworks.
Proximity to and potential effects on residential or other sensitive land uses	0	The site is located directly to the east of Nuneaton and to the south of Hinckley. As a result, the site has a number of residential properties along its north western and western boundaries; although given the size of the site it should be feasible to provide a good level of mitigation for noise and visual effects.
Total	**7**	

6.23 In terms of labour force availability, the site is 345Ha, applying the formula at paragraph 4.29, the site could generate in the region of 14,526 jobs. There are currently 35,200 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.24 In relation to local policy designations and planning status, positioned across two local authority areas, the majority of the site is designated as Green Belt whilst a central area is regarded as at high risk of flooding. The site therefore has some policy and fluvial constraints. No relevant extant planning permissions or current planning applications have been identified on the site.

6.25 This site has good vehicle access options and is of a suitable scale and shape to accommodate a SRFI. However, it is quite distant from the Motorway and would need considerable mitigation to ensure there were no effects on residential amenity.

6.26 In addition to the scoring undertaken in accordance with the set methodology, the site is in the Green Belt, which is a major policy constraint which must also be weighted in the balance of considering this site. As the site plays a significant role in maintaining the separation between Nuneaton and Hinckley, it is likely to be an important area of Green Belt which should not be lost unless there are no other alternatives available.

Figure 6.5: Site 5: Land at Burbage Common, Hinckley

6.27 This site is located some 3km to the north east of Hinckley. It is 222Ha and has the following constraints noted in the sieving analysis:

- Adjacent to Burbage Wood and Aston Firs SSSI to the south;
- Adjacent to Burbage Common and Woods Local Nature Reserve to the south;
- The entirety of the site is categorised as being Grade 3 agricultural land; and
- Area of Flood Zone 2 at the northern end of the site.

6.28 In addition, there are several listed buildings to the north of the site.

6.29 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	2 *(see note)*	The site is immediately adjacent to J2 of the M69. However, the best access route which doesn't involve a longer trip through either the urban area of Hinckley (c 10k) or Stoney Stanton (c 5km) would necessitate travel past two permanent residential caravan sites on Smithy Lane. This would involve a major upgrade at the B4469 junction. This location is very close to the Motorway roundabout and the area is highly constrained by woodland and residential caravan sites. Alternative access routes (c.5-10km to access J2) could be achieved at the north of the site although this area is similarly constrained by motorway embankments and a number of residential and commercial properties.
Access to Rail	1	Access to W10 gauge route. Part of the main line frontage is blocked by Burbage Common Road which bisects the site. Adequate length can be accessed at the northern side of the site.
Vehicle access routes	2	Vehicle access routes to the site are outlined above. Information presented to PINS indicates the provision of a direct access onto the M69 junction.
Site size	2	222Ha
Site shape	2	The site is regularly shaped. There will be a need to cross Burbage Common Road, although it should still be possible to accommodate large floorplate buildings.

Factor	Score	Notes
Topography	2	The site is relatively flat and gently sloping by the rail line. Suitable access should be achievable with little earth working.
Proximity to and potential effects on residential or other sensitive land uses	0	There are a number of properties at the northern end of Burbage Common Road, that form the northern boundary of the site, as well as permanent residential caravans and lodges at the southern end. Both would be directly affected by any potential access solution with little scope for appropriate mitigation.
Total	**11**	

6.30 In terms of labour force availability, the site is 222Ha, applying the formula at paragraph 4.29, the site could generate in the region of 9,347 jobs. There are currently 38,100 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.31 This site scores well on scale, topography, proximity to motorway (see below) and rail access.

6.32 Whilst this site is adjacent to a motorway junction, no immediate access is currently available onto it and any SRFI proposals would need to undertake a major upgrade either at the northern or southern ends of the site.

6.33 In relation to local policy designations and planning status, no relevant extant planning permissions or current planning applications have been identified. However the intention to submit a DCO application for a SRFI has been registered with PINS by DB Symmetry (Hinckley) Limited. At the time of writing, the independent project website[42] confirms that informal consultation will take place during summer 2018. Furthermore, the website confirms that statutory consultation will subsequently follow this in winter 2018. On the dedicated PINS National Infrastructure Planning website for the proposed development at Hinckley it is timetabled that the DCO application will be submitted to PINS in Q2 of 2019.

6.34 Information presented on the PINS website states that the proposals are to include railway sidings and a freight transfer area alongside the two-track railway between Hinckley and Leicester and a dedicated road access directly from junction 2 of the M69 motorway comprising the addition of a northbound off-slip and a southbound on-slip to this junction, which currently caters only for motorway traffic heading to and from the north.

[42] http://www.hinckleynrfi.co.uk/

6.35 Assuming the proposed vehicular access arrangements from the M69 are achievable and viable, the site scores well in the assessment.

Figure 6.6: Site 6: Land at Potters Marston

6.36 This site is located some 6km to the north east of Hinckley. It is 114Ha and is partially occupied by a Calor installation. It has the following constraints noted in the sieving analysis:

- Flood Zone 2 and 3 running in a corridor across the northern part of the site; and
- The entirety of the site is categorised as being Grade 3 agricultural land.

6.37 In addition there are a number of listed buildings in Potters Marston to the east.

6.38 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	The site is some 4.8km from J2 of the M69 motorway.
Access to Rail	1	There is a long stretch of W10 gauge route running along the southern boundary of the site.
Vehicle access routes	-2	Vehicle access to get to J2 would mean a circuitous route through Stoney Stanton passing a large number of residential

Factor	Score	Notes
		properties before eventually accessing the B4669.
Site size	1	114 Ha
Site shape	1	The site is triangular but should be able to achieve an intermodal facility and some larger floorplate buildings.
Topography	2	The site is relatively flat with flat land adjacent to the railway.
Proximity to and potential effects on residential or other sensitive land uses	0	The nearest properties are c.140m to the south of the site. Albeit the sensitive receptors are separated from the site by the existing railway line. There are reasonable prospects of implementing suitable mitigation against noise and visual effects.
Total	**1**	

6.39 In terms of labour force availability, the site is 114Ha, applying the formula at paragraph 4.29, the site could generate in the region of 4,800 jobs. There are currently 38,100 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.40 In relation to local policy designations and planning status, the site is designated as being in the countryside and is located within a Hazard Consultation Zone for Gas and the Calor Site. No relevant extant planning permissions or current planning applications have been identified.

6.41 This site has good access to rail and a relatively flat topography. However, road access is limited and there is potential for road access to cause significant amenity harm with limited opportunities to mitigate.

Figure 6.7: Site 7: Land between Ladbroke and Bishops Itchington

6.42 This site is located some 9.5km to the south east of Royal Leamington Spa. It is 391Ha and has the following constraints noted in the sieving analysis:

- Area of ancient woodland in the centre of the site; and
- The site is predominantly categorised as being Grade 3 agricultural land, aside from a small area within the north west of the site, which is confirmed as being Grade 4.

6.43 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	This site is approximately 3.8km from J12 of the M40. However, that is a straight line distance. The most direct route is via Hambridge Road, a single lane country road that passes under a railway bridge with a height restriction of 13ft 3inches. That route is approximately 5.2km. An alternative route exists via Deppers Bridge, and south through Bishops Itchington. This route is 7.1km and involves the use of the B4451 and some single track country lane.

Factor	Score	Notes
Access to Rail	1	The site has access to a long stretch of W10 gauge route.
Vehicle access routes	-2	As noted above, site access by vehicle is by B roads and lower, passing through two residential communities
Site size	2	391 Ha
Site shape	2	The site is large and broadly rectangular with the ability to accommodate multiple large floorplate buildings and long flat areas adjacent to the railway line.
Topography	1	The site is generally flat, although Weddington Hill is located within the central area. However, this is unlikely to affect the ability to get suitable rail access.
Proximity to and potential effects on residential or other sensitive land uses	0	The nearest properties are in the settlement of Ladbroke, c.120m to the west of the site boundary. Furthermore, the settlement of Bishop's Itchington is located c.450m to the west. Given the size of the site, it should be possible to mitigate significant amenity effects. The site access routes would however create concerns regarding impacts on amenity with little opportunity to mitigate traffic effects.
Total	**2**	

6.44 In terms of labour force availability, the site is 391Ha, applying the formula at paragraph 4.29, the site could generate in the region of 16,463 jobs. There are currently 22,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.45 In relation to local policy designations and planning status, the site has no specific designations, however the settlement of Ladbroke, which is located directly adjacent to the north east is designated as a conservation area. Through high quality design, it is envisaged that the conservation area of Ladbroke will not be impacted by the proposals. No extant planning permissions or current planning applications are present on the site.

6.46 This site scores well on scale, shape and topography. However, there are major issues with site access and proximity to the motorway network.

Figure 6.8: Site 8: Land between Knightcote and Fenny Compton

6.47 This site is located some 14km to the north west of Banbury. It is 276Ha and has the following constraints noted in the sieving analysis:

- Area of Flood Zone 2 and 3 on the northern boundary; and
- The site is predominantly categorised as being Grade 3 agricultural land, aside from a small area in the north of the site, which is Grade 4.

6.48 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-1	The nearest motorway junction is J12 of the M40, which is 3.7km away using Knightcote Bottoms (a single lane country road) for the majority of the distance and the B4451.
Access to Rail	1	The site has access to a straight section of W10 gauge route.
Vehicle access routes	0 *(See note below)*	The access route is via a single track country lane for around 3km that does not pass any houses.
Site size	2	276 Ha

Factor	Score	Notes
Site shape	2	The site is roughly triangular, but is large enough to accommodate multiple large floor plate buildings and has straight lines adjacent to the railway.
Topography	2	The site is flat and has level ground adjacent to the railway line.
Proximity to and potential effects on residential or other sensitive land uses	0	The site is c.130m from the settlement of Knightcote. However, the site is large enough to accommodate suitable mitigation to ensure there are no significant effects on amenity. Development of a major warehousing and logistics site in close proximity to a major ammunition storage facility could raise mutually exclusive safety and security constraints.
Total	**6**	

6.49 In terms of labour force availability, the site is 276Ha, applying the formula at paragraph 4.29, the site could generate in the region of 11,621 jobs. There are currently 22,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.50 Whilst this site has been scored 0 (against the vehicle access route factor) as it accords with this definition in the scoring matrix, it is notable that a 3km access on a single lane country road is clearly not adequate for the main entrance route to a SRFI. To adequately serve a SRFI, significant improvement works would be required to this route.

6.51 There are also the potential security implications of the nearby ammunition storage facility. In relation to local policy designations and planning status, the site has no specific designations. There are no extant planning permissions or current planning applications on the site.

6.52 This site scores well on topography, scale, shape and rail but its performance in practical terms will be significantly limited by site access considerations.

Figure 6.9: Site 9: Kilsby North

6.53 This site is located some 5km to the south east of Rugby. It was also identified in the DIRFT III Alternative Site Assessment as site 6 Kilsby North. It is approximately 238 Ha.

6.54 The site is predominantly categorised as being Grade 3 agricultural land, except for two small areas within the north of the site, which are confirmed as being Grade 4 and urban land.

6.55 The DIRFT assessment concluded that the southern area of the site would have limited capacity for new trains as freight trains would need to use the WCML Fast Lines which carry faster moving trains and would be less suitable for standard freight trains, other than at night. It was discounted at short list stage from the DIRFT Assessment[43].

6.56 The northern section was considered to be capable of accommodating a limited form of rail freight development and was considered further in the assessment. It was however, concluded that the shape of the site created limitations on rail layout which would affect path availability for other passenger and freight trains, and left little site capacity to accommodate warehousing as well as an intermodal facility.

6.57 The scoring matrix has been utilised to produce the following results for this site

[43] This would be the case for slower-moving freight trains (i.e. 75mph intermodal and 60mph conventional wagon services. Rail Central includes specific facilities to accommodate faster express freight trains (100-110 mph) which are more compatible with services on the WCML Fast Lines.

Factor	Score	Notes
Proximity to a motorway junction	0	The site is approximately 2.2km to J18 of M1. Access would be via the A5 and A428.
Access to Rail	2	The site has access to two separate W10 gauge routes.
Vehicle access routes	2	Access is all via A roads, with no need to pass through residential areas.
Site size	2 *(see note).*	The site is 238 Ha, although as noted in the DIRFT III assessment, the site is bisected by the WCML which creates two smaller areas of land.
Site shape	1	The site is regular in shape with straight edges adjacent to the rail lines.
Topography	2	The site is relatively flat with the ability to achieve level access for rail access.
Proximity to and potential effects on residential or other sensitive land uses	0	The southern area of the site would adjoin houses on the northern boundary of Kilsby; whist the northern boundary is adjacent to residential properties in the settlement of Hillmorton. However, due to the extent of the site and the narrow areas by which the site adjoins the settlements, it would be possible to screen the sensitive receptors from significant visual and noise effects.
Total	**9**	

6.58 In terms of labour force availability, the site is 238Ha, applying the formula at paragraph 4.29, the site could generate in the region of 10,021 jobs. There are currently 22,800 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.59 In relation to local policy designations and planning status, the site and immediate surrounding area are not subject to any specific designations.

6.60 No relevant extant planning permissions or current planning applications have been identified. However, the Council refused an application for 99 dwellings on the southern area of the identified site in November 2015 (Daventry District Council ref. DA/2015/0830). The application was refused for being outside the settlement boundary, consisting of unsustainable development, design grounds and for its impact to surrounding landscape and heritage assets.

6.61 This site has scored well, particularly in relation to rail and road access, scale and topography. However, it is noted that the more detailed assessment carried out in the DIRFT III assessment discounted both areas of this site due to technical rail issues related to the type of trains associated with DIRFT. This finding will be considered further in the comparative assessment.

Figure 6.10: Site 10: Part of Rugby Radio Station West

6.62 This site is located some 3.5km to the east of Rugby. It is 226Ha and has the following constraints noted in the sieving analysis:

- Areas of Flood Zone 2 and 3 to the north eastern boundary; and
- The site is predominantly categorised as being Grade 4 agricultural land, except for areas within the east of the site confirmed as being Grade 3a and 3b and a small area in the south confirmed as being Grade 3.

6.63 This site was also one of the alternatives considered in the DIRFT III Assessment, as Site 1 Rugby Radio Station (West). That study found that due to separation between the site and the NLL, with the A428 in between, a rail connection could be achieved by extending the rail line serving DIRFT II.

6.64 The DIRFT III assessment notes that the site is allocated as an urban extension, and that a planning application had been submitted for 6,200 homes and other uses. That assessment found that the site was a SRFI opportunity when considered against its assessment criteria, but that it was unlikely to be available for a SRFI. The DIRFT III assessment also noted a concern that proposing a SRFI here could prejudice the

delivery of a strategically important development for Rugby. The site was discounted from further consideration.

6.65 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	1	The site is 1.8 km to J18 of the M1 via the A5, and 1.9km via the A428.
Access to Rail	1	The site does not have direct access to the mainline, but access could be achieved through extending the existing DIRFT II rail line to the north.
Vehicle access routes	2	Access to the motorway is all via A roads, with no residential communities affected.
Site size	2	The site is 226 ha.
Site shape	2	The site is regularly shaped. There is no current rail access, but this could be achieved whilst still allowing space for multiple large floorplate buildings.
Topography	2	The site is relatively flat and appropriately graded access can be created to any new rail infrastructure.
Proximity to and potential effects on residential or other sensitive land uses	0	A detached residential property is positioned on the south western boundary of the site. The settlement of Hillmorton is c.150m to the south west of the site boundary. However, given the size of the site, it is considered that sufficient mitigation can be implemented.
Total	**10**	

6.66 In terms of labour force availability, the site is 226Ha, applying the formula at paragraph 4.29, the site could generate in the region of 9,516 jobs. There are currently 35,200 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.67 In relation to local policy designations and planning status, the site and immediate surrounding area are not subject to any specific designations.

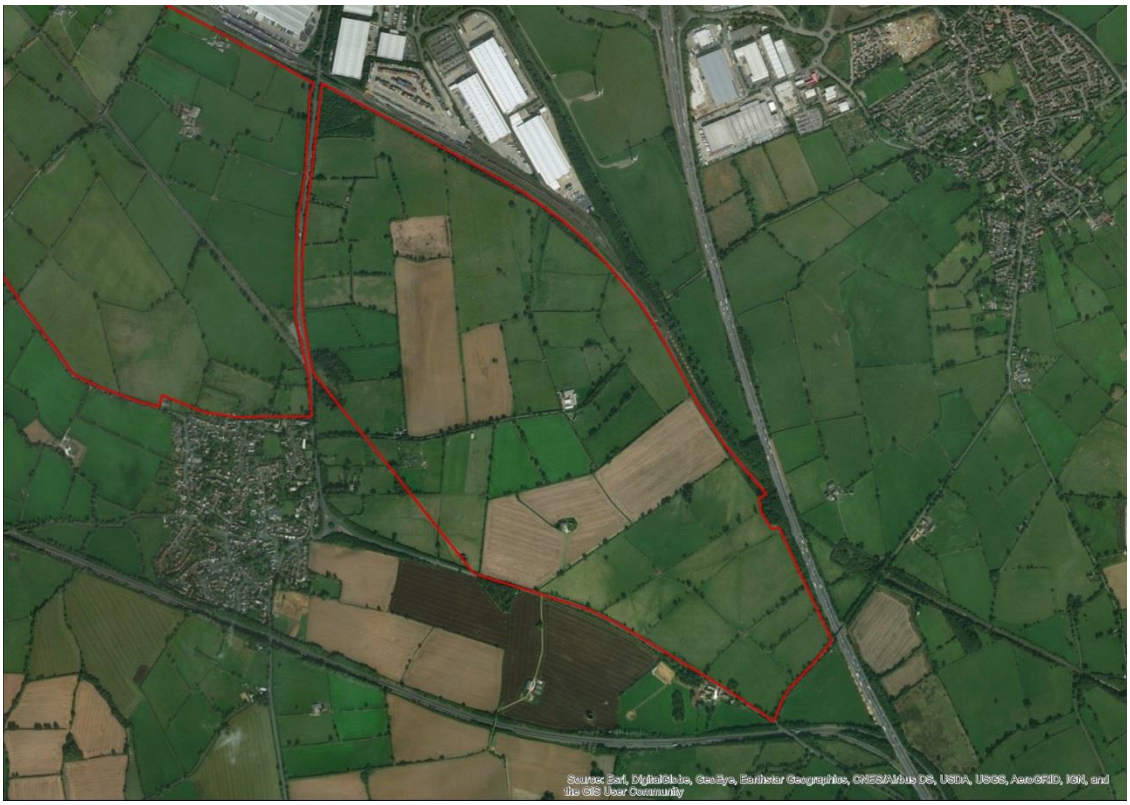
6.68 However, the site was allocated in the Local Plan as a urban extension and outline development was granted in May 2014 (Rugby Borough Council ref. R11/0699) (limited to 3 years for the submission of the first reserved matters) for the development of Use

Classes A1, A2, A3-A5, C1, C3, D1, D2 and B1, B2 and B8 (up to 106,000sqm). A Section 73 application to amend the previous permission was approved in June 2017 (LPA ref. R17/0022).

6.69 A series of subsequent reserved matters and discharge of conditions have been submitted. Some of these have been approved and a number are awaiting determination. Some works to the south of the site have also commenced.

6.70 This site scores well on a number of indicators. However, it is recognised that this site is to perform strategically important roles in the local area and is not available for development as a RFI.

Figure 6.11: Site 11: Kilsby East



6.71 This site is located some 6km to the south east of Rugby. It is 215Ha. The entirety of the site is categorised as being Grade 3 agricultural land.

6.72 This site was considered in the DIRFT III assessment, as Site 5 Kilsby East. This site was discounted as it was not capable of accommodating 750m rail sidings as much of the rail line is in a cutting, and the site slopes steeply up from the rail line to the south west.

6.73 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	0	The site is 2.3km from J18 of the M1

Factor	Score	Notes
Access to Rail	1	The site has access to a W10 gauge route (WCML slow lines), although achieving suitable access was considered not to be feasible in the DIRFT III assessment. Access to the WCML fast lines would not be possible as the route is in tunnel on this section of network.
Vehicle access routes	2	Access could be taken via the A5 directly to J18 with no need to pass through residential properties.
Site size	2	215Ha
Site shape	2	The site is a regular shape with relatively straight boundaries to the rail line.
Topography	-2	The rail sidings are in cutting for much of the boundary of the site and the site slopes up by around 40m to the south west.
Proximity to and potential effects on residential or other sensitive land uses	0	The site is c.270m from the eastern boundary of Kilsby, furthermore, a small cluster of residential properties are located directly to the south of the site, albeit they are separated from the site by the A5. Despite this, given the scale of the site, there are opportunities to provide appropriate screening to limit significant noise and visual effects.
Total	**5**	

6.74 In terms of labour force availability, the site is 215Ha, applying the formula at paragraph 4.24, the site could generate in the region of 9,053 jobs. There are currently 22,800 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.75 In relation to local policy designations and planning status, the site and immediate surrounding area are not subject to any specific designations. There are no extant planning permissions or current planning applications on the site.

6.76 This site scores well on road access but very poorly on topography, which means that it is not feasible to achieve a suitable rail access to this site.

Figure 6.12: Site 12: Land North of Long Buckby Wharfe

6.77 This site is located some 5km to the north east of Daventry. It is 114Ha and has the following constraints noted in the sieving analysis:

- Areas of Flood Zone 2 and 3 running along stream corridors across the north of the site and diagonally across the south western corner; and
- The site is predominantly Grade 3 agricultural land, albeit some areas centrally are sub-categorised as being Grade 3a and 3b. Furthermore, very small areas within the north and south of the site are categorised as being Grade 2.

6.78 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	As J17 of the M1 does not allow access, the nearest junction is J18, some 8km away. Access would be via the A5.
Access to Rail	1	The site has access to a W10 gauge route but only the fast lines which would restrict rai freight traffic to express freight and limited overnight intermodal and conventional wagon services.
Vehicle access routes	1	The A5 passes the eastern side of Kilsby, adjacent to residential properties, although these are already likely to be

Factor	Score	Notes
		affected by the road traffic.
Site size	1	114Ha
Site shape	0	The site is long and thin which will limit its ability to provide suitable rail sidings as well as large distribution buildings.
Topography	0	The site slopes up to 30m, peaking in the central area. Whilst there is potential to re-grade this, it may be difficult given the limited width of the site and the need to retain level rail access along one boundary.
Proximity to and potential effects on residential or other sensitive land uses	0	The site adjoins residential properties to its southern boundary, with many being separated by the Canal. There are however opportunities for screening along this boundary.
Total	**1**	

6.79 In terms of labour force availability, the site is 114Ha, applying the formula at paragraph 4.29, the site could generate in the region of 4,800 jobs. There are currently 22,800 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.80 In relation to local policy designations and planning status, the site and immediate surrounding area are not subject to any specific designations. There are no extant planning permissions or current planning applications on the site.

6.81 This site scores moderately on most of the measures, although access to the motorway network is via a convoluted and distant route as the nearest junction does not allow direct access. Rail accessibility is also severely restricted.

Figure 6.13: Site 13: Land to the North West of Long Buckby

6.82 This site is located to the north east of Long Buckby, some 8km to the north east of Daventry. It is 360Ha and has the following constraints noted in the sieving analysis:

- Areas of Zone 2 and 3 flood risk along the eastern boundary; and
- The site is predominantly Grade 3 agricultural land; however a small area within the south is categorised as being Grade 2.

6.83 In addition, there are a number of Listed Buildings on Long Buckby and Watford, and there is a Scheduled Ancient Monument (Watford Park C18 Garden) to the west of Watford. A single Grade 2 listed building sits adjacent to the southern boundary at Murcott.

6.84 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	The nearest motorway is J18 of the M1. Access would need to be taken through the settlement of Watford on the B5385 and then north via the A5, past Kilsby to J18 (9.8km). Alternatively, access could be taken through West Haddon to reach the A428, via Crick (6.3km).
Access to Rail	1	The site has access to a relatively straight

Factor	Score	Notes
		section of W10 gauge route.
Vehicle access routes	-1	The vehicle access route options would both involve travelling through residential communities to access an A class road.
Site size	2	360Ha
Site shape	2	The site is relatively regular and is large enough to accommodate multiple large floorplate buildings.
Topography	0	The site slopes some 40m in height, although given the size of the site, it should be possible to regrade the land to accommodate development and a suitable rail access.
Proximity to and potential effects on residential or other sensitive land uses	0	The southern boundary of the site is directly adjacent to the settlement of Long Buckby. Furthermore, the northern boundary of the site borders the settlement of West Haddon. However, given the great extent of the site, it is anticipated that significant mitigation measures could be implemented.
Total	**2**	

6.85 In terms of labour force availability, the site is 360Ha, applying the formula at paragraph 4.24, the site could generate in the region of 15,158 jobs. There are currently 22,800 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.86 In relation to local policy designations and planning status, there are no planning designations on the site. No relevant extant planning permissions or current planning applications have been identified on the site.

6.87 This site scores well on size, shape and rail access. However, its distance from the motorway and need to pass through residential areas to get to A class roads is a major limitation.

Figure 6.14: Site 14: Land to the West of Bugbrooke and South of Nether Heyford

6.88 This site is located some 9km to the south west of Northampton. It is 133Ha and has no constraints noted in the sieving analysis. There is a listed canal bridge close to the northern boundary, and there are a number of listed buildings nearby in Nether Heyford.

6.89 A large area within the centre of the site is categorised as being Grade 2 agricultural land, whilst all remaining land is Grade 3.

6.90 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-1	Nearest motorway is J16 of M1 (3.7km) although gaining access to this junction would necessitate travelling through the settlement of Nether Heyford and using residential streets.
Access to Rail	1	The site has access to a W10 gauge route section, but only the Fast Lines, which would restrict rail freight traffic to express freight services and limited overnight intermodal and conventional wagon services.
Vehicle access routes	-1	The nearest motorway junction would

Factor	Score	Notes
		necessitate travel through the centre of Nether Heyford with only a short stretch at the northern end of the route being on an A class road.
Site size	1	133 Ha
Site shape	2	The site is a regular shape with potential to accommodate multiple large buildings and suitable rail infrastructure.
Topography	0	The site slopes some 40m down to the rail line. However, it should be feasible to secure relatively level rail access with suitable earth working.
Proximity to and potential effects on residential or other sensitive land uses	1	The nearest sensitive receptor is a number of residential properties to the north west of the site, which are c.100m away. Furthermore, the settlement of Upper Stowe is located c.500m to the west of the site. It is however understood that some mitigation measures could be implemented on the site to lessen the impacts. Due to lack of proximity to the motorway, vehicular access to the M1 is only possible with movement through the centre of Nether Heyford.
Total	**3**	

6.91 In terms of labour force availability, the site is 133Ha, applying the formula at paragraph 4.29, the site could generate in the region of 5,600 jobs. There are currently 33,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.92 In relation to local policy designations and planning status, the site is designated as being in a Special Landscape Area. This has the potential to restrict the development of the site for a SRFI. However, given the overarching need for SRFIs, it is considered that this Special Landscape Area designation could be overcome to ensure that the development of a SRFI would not be restricted. No relevant extant planning permissions or current planning applications have been identified.

6.93 This site scores well on shape and rail access, although rail freight access into the WCML Fast Lines would be limited to express freight services and some overnight intermodal and conventional wagon services. It also has major limitations in terms of the routes available to secure access to the motorway and the likely effects on residential amenity of doing so.

Figure 6.15: Site 15: Land South of Bugbrooke

6.94 This site is located some 8km to the south west of Northampton. It is 278Ha and has the following constraints noted in the sieving analysis:

- Areas of Flood Zone 2 and 3 to the western boundary; and
- The entirety of the site is categorised as being Grade 3 agricultural land.

6.95 In addition, Lower Downs farm house, at the north eastern corner of the site is Grade II listed, and there is a listed canal bridge to the north east of the site. Further clusters of listed buildings exist in nearby Bugbrooke, Gayton and Pattishall.

6.96 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	The nearest motorway junction is J16 M1 (3km), although J15a M1 (3.75km) is also close. Securing access to J16 would mean travelling through both Bugbrooke and Nether Heyford (6km). Access to J15a would be less disruptive but would still involve travelling through Rothersthorpe and residential areas of Hunsbury Meadows (south west Northampton) and is a 7.4km route.

Factor	Score	Notes
Access to Rail	1	The site has access to a W10 gauge route section, but only the Fast Lines, which would restrict rail freight traffic to express freight services and limited overnight intermodal and conventional wagon services.
Vehicle access routes	-2	Vehicle access routes to the motorway involve several km of route which is not on A class roads, and all options involve passing through multiple residential communities.
Site size	2	278Ha
Site shape	1	The site is a regular shape and is capable of accommodating multiple large buildings.
Topography	-1	The site has several hilly peaks with gradient changes of up to 50m. Two of these peaks are close to the railway line.
Proximity to and potential effects on residential or other sensitive land uses	1	The nearest sensitive receptors are residential properties located in the settlement of Pattishall, c.270m to the south west. Due to the distance of the site from the motorway, vehicle access routes will pass through multiple residential communities.
Total	**0**	

6.97 In terms of labour force availability, the site is 278Ha, applying the formula at paragraph 4.29, the site could generate in the region of 11,705 jobs. There are currently 33,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.98 In relation to local policy designations and planning status, the very northern tip of the site is designated as a Special Landscape Area, whilst this designation is also located parallel, but not adjoining the sites western boundary. A well designed scheme should be able to mitigate against impacting upon this designation. No relevant extant planning permissions or current planning applications have been identified on the site.

6.99 This site scores well on size and rail access, but has topographical limitations which would require major remodelling. Rail freight access into the WCML Fast Lines would be limited to express freight services and some overnight intermodal and conventional wagon services. Access options are both distant from the motorway and would be likely to have major residential amenity effects.

Figure 6.16: Site 16: Northampton Gateway

6.100 This site is currently being promoted as a SRFI and is located directly to the east of Rail Central. A DCO application was submitted in May 2018. This was subsequently accepted by PINS for examination in June 2018. The site is located some 5km to the south of Northampton. The site is 220ha (varying site areas are referenced within the DCO submission) in area and has the following constraints noted in the sieving analysis:

- Roade Cutting SSSI affected by the southern part of the development;
- The entirety of the site is categorised as being Grade 3 agricultural land. A small area within the west of the site is sub-categorised as being Grade 3a and 3b; and
- Adjacent to Courteenhall Registered Park and Garden.

6.101 In addition, there are a number of listed buildings at Collingtree, Roade, and within Courteenhall Gardens, including Courteenhall House.

6.102 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	2	The site adjoins J15 of M1.
Access to Rail	1	The site has access to a W10 gauge route along a straight boundary.

Factor	Score	Notes
Vehicle access routes	2	Access can be secured easily to the M1.
Site size	2	216Ha
Site shape	2	The site is a regular shape with an ability to accommodate multiple large scale buildings.
Topography	2	The site is generally flat.
Proximity to and potential effects on residential or other sensitive land uses	0	The nearest sensitive receptors are residential properties within the settlement of Collingtree, which are c.100m to the north east, albeit they are separated from the site by the M1 motorway. Further sensitive receptors are located at Lodge Farm, which is c.100m to the west of the site. It is anticipated that suitable screening opportunities are available to protect the amenities of these receptors.
Total	**11**	

6.103 In terms of labour force availability, the site is 216Ha, applying the formula at paragraph 4.29, the site could generate in the region of 9,094 jobs[44]. There are currently 33,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.104 In relation to local policy designations and planning status, the northern area of the site is designated as an Important Local Gap, which seeks to prevent the coalescence of settlements. Land directly adjacent to the eastern boundary of the site is designated as a Historic Park and Garden.

6.105 However, the site is currently being promoted for use as a SRFI, with a DCO application that has been accepted by PINS for examination.

6.106 This site scores well against the majority of the criteria as it has excellent motorway access and access to a rail line. It is large and relatively flat and has the ability to accommodate multiple large floorplate buildings. This site is also being promoted as a SRFI site.

[44] Phase 2 consultation information for Northampton Gateway assumes that the development will generate 7,544 FTE jobs

Figure 6.17: Site 17: Land North of Penkridge

6.107 This site is located some 6km to the south of Stafford. It is 328Ha and has the following constraints noted in the sieving analysis:

- Area of Flood Zone 2 and 3 in the northern area of the site; and
- The site is predominantly categorised as being Grade 3 agricultural land, albeit a small area in the north is Grade 2.

6.108 In addition, there are a number of listed buildings in Penkridge to the south and Dunston to the north.

6.109 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	2	The neatest motorway is J13 of the M6, which is around 1km to the north.
Access to Rail	1	The site has a straight section of W10 gauge route running through its centre.
Vehicle access routes	-1	Motorway access from the eastern part of the site could be gained via a new junction on the A449, although there are a number of residential properties which would be passed at Dunston. These properties are already likely to be

Factor	Score	Notes
		affected by traffic on the A449 which limits the effects. However, in order to access the western part of the site, it would be necessary to either bridge the railway line, which may limit the ability to provide suitable intermodal facilities, or to travel north through Dunston (School Lane) or south, via the northern part of Penkridge (Levedale Road). Both routes pass residential properties. The northern route through Dunston also passes by a school, and the southern route adds considerable distance to the motorway junction (c. 4km).
Site size	2	328Ha
Site shape	2	The site is large and regularly shaped. It is capable of accommodating multiple large buildings.
Topography	2	The site is generally flat.
Proximity to and potential effects on residential or other sensitive land uses	0	The southern boundary of the site is immediately adjacent to residential properties at the northern edge of Penkridge. However, it is anticipated that suitable measures to mitigate against the impacts of the development can be implemented.
Total	**8**	

6.110 In terms of labour force availability, the site is 328Ha, applying the formula at paragraph 4.29, the site could generate in the region of 13,811 jobs. There are currently 59,500 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.111 In relation to local policy designations and planning status, the site is located within Open Countryside. There are no relevant extant planning permissions or current planning applications on the site.

6.112 This site scores well on a number of criteria, although is ultimately limited by proximity to residential uses, including on the main route to the motorway.

Figure 6.18: Site 18: Land to the South of Stafford

6.113 This site is located some 3km to the south of Stafford. It is 282Ha and has the following constraints noted in the sieving analysis:

- Corridor of Flood Zone 2 and 3 in the eastern area of the site; and
- The site is predominantly categorised as being Grade 3 agricultural land. However, a small area within the centre and east of the site is identified as being Grade 2 agricultural land.

6.114 In addition, there are several listed buildings at Dunston to the east.

6.115 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	1	The nearest motorway is J13 of the M6. Access can be achieved through Dunston which is a 1.1km route.
Access to Rail	1	The site has a straight length of W10 gauge route on its boundary.
Vehicle access routes	-1	Vehicle access to the motorway could be achieved through Dunston, using School Lane, which is a narrow country road that passes through a small Hamlet and houses in Dunston before reaching the

Factor	Score	Notes
		A449. An alternative route is via Ash Flats Lane and Chain Lane, which runs to the north through a residential area, before reaching the A449 to the north of the motorway junction (2.4km).
Site size	2	282 ha
Site shape	2	The site is relatively regular in shape with an ability to accommodate multiple large floorplate buildings.
Topography	0	The site is relatively flat although there is a corridor of lower land that follows the route of a brook and which is subject to flooding. The brook runs parallel to the rail infrastructure and may need to be diverted and re-levelled to facilitate the development of a SRFI.
Proximity to and potential effects on residential or other sensitive land uses	0	The north western boundary of the site is boarded by residential properties at the settlement of Coppenhall. Furthermore, a number of residential properties located to the south of Stafford are c. 520m from the site boundary. Dependent upon chosen access routes, other sensitive receptors in the settlements of Dunston and Stafford may also be affected.
Total	**5**	

6.116 In terms of labour force availability, the site is 282Ha, applying the formula at paragraph 4.29, the site could generate in the region of 11,873 jobs. There are currently 59,500 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.117 In relation to local policy designations and planning status, the site is located within open countryside. There are no relevant extant planning permissions or current planning applications on the site.

6.118 This site scores well on size and shape, but has access difficulties, despite being close to a motorway junction.

Figure 6.19: Site 19: Land South of Great Bridgeford

6.119 This site is located some 4km to the north west of Stafford. It is 100Ha and has no constraints noted in the sieving analysis. There is a listed bridge in Great Bridgeford, on the route from this site to Motorway.

6.120 With regards to agricultural land classification, the site consists of a mixture of Grades 2 and 3 with a small area of Grade 4 in the north of the site.

6.121 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	0	The nearest motorway is J14 of the M6, which is 2.7km away, via Great Bridgeford, using the A5013
Access to Rail	1	The site is bounded by the 4-track W10 gauge WCML route section. At-grade access could be achieved into the Slow Lines nearest the site, but direct access to the Fast Lines would be likely to require grade-separation.
Vehicle access routes	-1	Access to the motorway would need to be taken from Newport Road (B5405) to access the A5013 running from Great Bridgeford to the Motorway junction.

Factor	Score	Notes
		Newport Road has residential properties along the length that would be used by vehicles accessing the site.
Site size	0	100 Ha
Site shape	0	The site is relatively regular in shape and should be able to accommodate a rail connection.
Topography	0	The site slopes down to the railway line, but it should be feasible to secure an access with appropriate earth moving,
Proximity to and potential effects on residential or other sensitive land uses	0	A number of residential properties are located adjacent to the northern boundary of the site, in the settlement of Great Bridgeford. However, it is anticipated that through mitigation, the impact of the development can be lessened. Gaining access to the M6 motorway from the site would however require traffic to navigate through Great Bridgeford, potentially causing an impact to the existing settlement.
Total	**0**	

6.122 In terms of labour force availability, the site is 100Ha, applying the formula at paragraph 4.29, the site could generate in the region of 4,211 jobs. There are currently 50,700 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.123 In relation to local policy designations and planning status, there are no designations on the site. There are no relevant extant planning permissions or current planning applications of relevance.

6.124 This site scores well on rail access, but the 4-track nature of the WCML at this point (from west to east being northbound Slow Line, southbound Slow Line, northbound Fast Line, southbound Fast Line) would make at-grade access to the Fast Lines difficult to achieve. The site also suffers from road access issues and proximity to a number of houses that would be affected by the development.

Figure 6.20: Site 20: Land at Baldwin's Gate

6.125 This site is located some 8.5km to the south west of Stoke on Trent. It is 65Ha and has no constraints noted in the sieving analysis. The entirety of the site is categorised as being Grade 3 agricultural land.

6.126 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	The nearest motorway junction is J15 of the M6 (4.5km). However, the road distance is around 11km using the A51 to the south and west, before heading north to the junction. This involves passing a number of isolated residential properties. A shorter route (8.5km) exists, travelling via properties at Hill Chorlton, to access the A53 through Baldwin's Gate and then the A5182 east to the motorway.
Access to Rail	1	The site is bounded by the 4-track W10 gauge WCML route section. At-grade access could be achieved into the Slow Lines nearest the site, but direct access to the Fast Lines would be likely to require grade-separation.

Factor	Score	Notes
Vehicle access routes	1	The vehicle access routes are described above. Both routes are distant from the motorway and involve passing numerous isolated dwellings, or travelling through a residential community. However, the longer route can be mostly achieved using A class roads.
Site size	0	The site is 65Ha.
Site shape	0	The site a fairly regular and may be able to accommodate rail access.
Topography	0	The site slopes down to the railway line. It may be possible to achieve a rail access as well as suitable buildings.
Proximity to and potential effects on residential or other sensitive land uses	0	The nearest sensitive receptors are residential properties directly adjacent to the south eastern boundary of the site. There may however be opportunities to mitigate the main impacts of the development from these properties.
Total	**0**	

6.127 In terms of labour force availability, the site is 65Ha, applying the formula at paragraph 4.29, the site could generate in the region of 2,737 jobs. There are currently 38,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

6.128 In relation to local policy designations and planning status, the site is designated as an area of Landscape Restoration and Enhancement. Whilst the forest adjacent to the north of the site is designated as a Natural Asset. With considerate design and suitable mitigation, it is understood that these designations could be overcome. However, this may limit the scale of the development. There are no relevant extant planning permissions or current planning applications on the site.

6.129 This site primarily suffers from very poor highways access, although its scale is also a limitation in the context of securing a SRFI. The 4-track nature of the WCML at this point (from west to east being northbound Slow Line, southbound Slow Line, northbound Fast Line, southbound Fast Line) would make at-grade access to the Fast Lines difficult to achieve.

Figure 6.21: Site 21: Covidien, Staveley

6.130 This site is located some 6km to the north east of Chesterfield. It is 200Ha and has the following constraints noted in the sieving analysis:

- Areas of Flood Zone 2 and 3 running along the River Rother corridor; and
- The site is predominantly categorised as being urban land, with a small area of Grade 3 agricultural land in the north of the site.

6.131 This site has a history of various heavy industrial uses, including foundries, chemical works, coal mining and landfill. The land is allocated for part housing and part commercial (50Ha), with the commercial focussed around the Works Lane / Hall Road area.

6.132 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	The nearest motorway junction is J29a of the M1. A new link road has been completed by the developers of Markham Vale on part of the route, which is 4.8km.
Access to Rail	1	The site has access to a W10 gauge route.

Factor	Score	Notes
Vehicle access routes	2	Access to J29a would be taken from the A6192 to J29a. The route does run past some residential properties, but it is in cutting and well screened from the houses.
Site size	2	The site is 200Ha. The site's allocation in the Core Strategy would suggest 50Ha of employment land is available, although it has been assumed that a wider area can be used for the purposes of scoring.
Site shape	1	The site is fairly regular with a relatively straight section of rail access.
Topography	0	The site is fairly flat, although there are some mounds adjacent to Barrow Hill (north of the railway line) which may need regrading. The River Rother corridor may need to be diverted and regraded to allow suitable building floorplates to be achieved.
Proximity to and potential effects on residential or other sensitive land uses	0	The northern boundary of the site is close to properties in Barrow Hill (c 100m), whilst the southern boundaries border the existing settlements of Hollingwood and Staveley. However, it is anticipated that there are opportunities to screen the sensitive receptors from any development.
Total	**4**	

6.133 In terms of labour force availability, the site is 200Ha, applying the formula at paragraph 4.29, the site could generate in the region of 8,421 jobs. There are currently 8,700 people looking for work in the surrounding local authority areas, the labour force requirement for the development can therefore only just be met in the local area. Labour availability could therefore possibly be a constraint to delivering a SRFI in this location.

6.134 In relation to local policy designations and planning status, The site has numerous designations that comprise the following:

- Staveley Regeneration Route;
- Staveley & Rother Valley Corridor Area Action Plan;
- Existing Business and Industrial Development;

- Tree Woodland Planting;
- Sports Pitches; and
- Open Countryside.

6.135 The site is allocated via the adopted Chesterfield Core Strategy (PS5) to be redeveloped for a sustainable community to deliver 2,000 homes and 50ha of employment uses. At the time of writing, the Council website confirms that an Area Action Plan (AAP) is currently in the process of being finalised and submitted to Secretary of State for examination.

6.136 There are no extant planning permissions considered relevant on the site. Notwithstanding this, a screening and subsequently a scoping opinion has been issued by the Council in respect of redeveloping the western area of the site for mixed use development. Furthermore an outline planning application for this development was submitted in September 2017 (Chesterfield Borough Council ref. CHE/17/00644/OUT). However, the application is still awaiting determination. Should development come forward in this regard, it would restrict the development and operation of the site as a SRFI.

6.137 This site performs well on access, size and shape, although it is distant from the main motorway junction. Alternative development proposals are being progressed.

Overview of Sites identified during Sieving

6.138 The following table summarises the sites identified through the sieving exercise and their associated scores, the highest scoring of these sites are considered alongside the Rail Central site (refer to Section 9):

Site Number	Site Name	Site Score
1	Wadborough Park Farm, near Stoulton, Worcestershire	5
2	Dairy House Farm, Grendon, near Tamworth	3
3	Land adjacent to Birch Coppice, near Tamworth	5
4	Land between Hinckley and Nuneaton	7
5	Land at Burbage Common, Hinckley	11
6	Land at Potters Marston	1
7	Land between Ladbroke and Bishops Itchington	2
8	Land between Knightcote and Fenny Compton	6
9	Kilsby North	9
10	Part of Rugby Radio Station West	10
11	Kilsby East	5
12	Land North of Long Buckby Wharfe	1

Site Number	Site Name	Site Score
13	Land to the North East of Long Buckby	2
14	Land to the West of Bugbrooke and South of Nether Heyford	3
15	Land South of Bugbrooke	0
16	Northampton Gateway	11
17	Land North of Penkridge	8
18	Land to the South of Stafford	5
19	Land South of Great Bridgeford	0
20	Land at Baldwin's Gate	0
21	Covidien, Staveley	4

6.139 There are four sites which stand out alongside Rail Central as scoring particularly well. These are:

- Site 5 – Land at Burbage Common, Hinckley – an emerging SRFI proposal;
- Site 9 - Kilsby North: Considered and discounted as part of the DIRFT III alternatives assessment (but considered further in the comparative assessment at Section 9 of this document);
- Site 10 - Rugby Radio Station West: Considered and discounted as it is unavailable due to other committed development; and
- Site 15 - Northampton Gateway: A current SRFI proposal.

6.140 With the exception of Site 10, these sites (Sites 5,9 and 15) are considered further in the comparative assessment at Section 9 of this report.

7. Stage 3: Sites identified by Local Representation and Other Studies

7.1 This section of the report considers those sites which were reviewed in the early alternatives assessment. It discounts those sites without rail access, but scores the remaining sites utilising the same methodology applied to the wider search area.

7.2 The following sites were identified by people living locally, who suggested that they should be considered as alternatives. The sites are listed below, alongside a note of whether they are considered further in this analysis and if not, the reason for discounting them at this stage:

- Northampton Highgate: See Site 15 Northampton Gateway;
- Pineham Extension: Discounted due to lack of rail connection potential;
- Land to the South of J15a, M1: Discounted due to lack of rail connection potential;
- Land to the East of J15a, South of M1: Discounted due to lack of rail connection potential;
- Land to the East of J15a, North of M1 (Milton Ham Business Park): Discounted due to lack of rail connection potential;
- Land to the East of NLL, North of M1 (Northampton South SUE): Considered further in the below section;
- Midway Park, J16 M1: Discounted due to lack of rail connection potential;
- Midway Park, Phases 2 & 3, J16, M1: Discounted due to lack of rail connection potential; and
- DIRFT III, J18, M1: Existing SRFI Consent, not considered further.

7.3 The following sites were considered as they were identified as possible rail freight sites in the DIRFT III Alternatives Assessment:

- Eurohub, Corby;
- Etwall Common (East Midlands Intermodal Park);
- East Midlands Distribution Centre, Castle Donington – rail terminal currently being activated but discounted as too small to qualify as a SRFI; and
- East Midlands Gateway – discounted as it forms part of committed DCO development as a SRFI.

7.4 In addition to these sites, a further RFI has been promoted at Four Ashes. This NSIP project is referred to as West Midlands Interchange and the DCO application has now been submitted to PINS. The site was sieved out of this assessment as set out in Section 6, because it is within the Green Belt. However, as the Four Ashes site is being promoted and has potential to contribute to the network of SRFI's required by national policy, that site is included for assessment in this section of the report.

7.5 The remainder of this section of the report considers these sites against the common scoring framework.

Table 7.1: Site 22: Land to the East of Northampton Loop, North of M1 (Northampton South SUE)

7.6 This site is located to the immediate south of Northampton. It is 97Ha and has the following constraints noted in the sieving analysis:

- Areas of Flood Zone 2 and 3 running along the northern boundary; and
- The entirety of the site is categorised as being Grade 3 agricultural land, with sub-categories of Grade 3a and 3b confirmed centrally.

7.7 There are also a number of listed buildings in the nearby settlement of Collingtree.

7.8 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	0	The site is adjacent to the M1 and very close to J15. However, there is no direct highways access with the shortest route being around 2.5km via Collingtree Park and down the A45.
Access to Rail	1	The site has access to a W10 gauge route. However there is a lack of frontage onto the main line and this would require rail sidings to be laid perpendicular to the main line. This would operationally less efficient than those laid parallel to the main line with access at each end.
Vehicle access routes	-1	Site access would need to be taken via Windingbrook Lane, Rowntree Road, Wooldale Road and the A45. This passes by houses in Collingtree Park.
Site size	1	102 Ha
Site shape	1	The site is regularly shaped and could accommodate larger floorplate buildings.
Topography	1	The site is relatively flat.
Proximity to and potential effects on residential or other sensitive land uses	0	Numerous sensitive receptors are located within the surrounding area of the site. Specifically, these include residential properties in the settlements of Collingtree, and the Collingtree Park and Merefield all of which bound the site to the north and east. It is however anticipated that mitigation measures could be implemented to reduce the impacts of developing the site.
Total	**3**	

7.9 In terms of labour force availability, the site is 102Ha, applying the formula at paragraph 4.29, the site could generate in the region of 4,295 jobs. There are currently 14,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

7.10 In relation to local policy designations and planning status, The site has numerous designations that comprise the following:

- Greenspace;

- Nature Conservation Value;
- Locally Important Landscape Area;
- Proposed Residential Area; and
- River Nene and Grand Union Canal Policy.

7.11 The site was the subject a planning application (Northampton Borough Council ref. N/2013/1035) and subsequent appeal (PINS ref. APP/V2825/W/15/3028151), which resulted in the approval of a scheme for 1,000 homes in August 2016. The first reserved matters application was considered at Committee on 15 February 2018 and subsequently approved on 7 March 2018 (Northampton Borough Council ref. N/2017/1566). Furthermore, applications to discharge conditions have also been submitted. Notwithstanding this, at the time of writing, it is not evident that construction of the development has not commenced.

7.12 This site performs reasonably well on access to rail, size and shape, although it is relatively distant from the main motorway junction no roads that are shared with residential uses.

7.13 Achieving rail access would also be difficult from both directions of travel on the main line, as the site has a limited rail frontage of 700m. To accommodate full length trains would require a triangular junction with the main line linked to sidings lain perpendicular to the main line rather than parallel; a less efficient arrangement than the “passing loop” sidings laid parallel to the main line as can be achieved at Rail Central.

7.14 This site is also not considered to be available given the recent planning permission received for a large housing scheme.

Figure 7.1: Site 23: Eurohub, Corby

7.15 This site is located to the immediate south east of Corby. It is 106Ha and has no constraints noted in the sieving analysis. The entirety of the site is categorised as being non-agricultural land.

7.16 This site would function as an extension to the existing Eurohub development in Corby. The site was assessed in the DIRFT III alternative site assessment.

7.17 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	The nearest motorways are the M1 / M6 junction, some 40km away to the west. The A1 is some 25km to the east.
Access to Rail	-2	The site is not currently rail served, although has potential access to a W7 gauge rail line if the rail infrastructure is extended to the site.
Vehicle access routes	2	Vehicle access routes to the strategic highways network are long, but nearly all on A class roads (A43 and A14 to M1; and A43 to the A1). There is no need to pass through residential areas.
Site size	1	106Ha

Factor	Score	Notes
Site shape	1	The site is a regular shape and has potential to accommodate a rail link.
Topography	1	The site is relatively flat.
Proximity to and potential effects on residential or other sensitive land uses	0	The closest sensitive receptor is a Holiday Inn located c.80m to the north east of the site. Furthermore, a number of residential properties are located c.120m to the south of the site at Little Stanion. The properties at Little Stanion are already extensively screened due to existing woodland to the south of the site, whilst screening to benefit the Holiday Inn is considered possible.
Total	**1**	

7.18 In terms of labour force availability, the site is 106Ha, applying the formula at paragraph 4.29, the site could generate in the region of 4,463 jobs. There are currently 11,000 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

7.19 Outline planning permission was granted in December 2013 (limited to five years to commence development) for the development of Use Classes B1/B2 and B8 (Corby borough Council ref. 12/002589/OUT). An application to vary this permission was submitted in August 2017 and was subsequently approved on 13 February 2018 (Corby Borough Council ref. 17/00388/RVC). Following the grant of the revised planning permission, a series of applications seeking reserved matters and to discharge conditions have been submitted.

7.20 This site performs well on access, size and shape, although its distance from the main motorway junction is a major limiting factor.

7.21 This extension site is not directly rail served. The site has planning permission for a rail connected development and it is understood that the site owners do not intend to implement the rail connection due to cost concerns. The developer which controls the site, Prologis, is not marketing the site as a rail served scheme. It is considered that the rail connection is unlikely to be included in any future development of this site.

Figure 7.2: Site 24: Etwall Common (East Midlands Intermodal Park)

7.22 This site is located some 9km to the south west of Derby. It is 268Ha and it has no constraints noted in the sieving analysis. The entirety of the site is categorised as being Grade 3 agricultural land.

7.23 The site has been promoted as a SRFI opportunity and it was subject to public consultation in 2014. To date no DCO application has been submitted. Furthermore, the PINS website for the scheme confirms that the applicant has not yet set a timetable for the project.

7.24 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	-2	The site is 19km from J24a of the M1
Access to Rail	1	The adjacent main line is cleared for W10 gauge to the southeast where it joins the existing W10 gauge Birmingham - Derby line. The site has W7 gauge access northwest from the site to Crewe.
Vehicle access routes	2	The motorway can be accessed by the A50 with no need to pass through residential communities
Site size	2	268 Ha

Factor	Score	Notes
Site shape	2	The site is regularly shaped with straight boundaries adjacent to the railway line
Topography	2	The site is relatively flat.
Proximity to and potential effects on residential or other sensitive land uses	0	The closest sensitive receptors are a cluster of residential properties located c.100m to the south east of the site. Furthermore, there are a number of residential properties located along the western boundary of the site. It is however considered possible that the development could be screened from these receptors.
Total	**7**	

7.25 In terms of labour force availability, the site is 268Ha, applying the formula at paragraph 4.29, the site could generate in the region of 11,284 jobs. There are currently 26,700 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

7.26 In relation to local policy designations and planning status, the site has no designations. Furthermore, no relevant extant planning permissions or current planning applications have been identified.

7.27 This site performs well on access, size and shape, although its distance from the main motorway junction is a limiting factor.

7.28 A smaller adjacent site at Etwall Common (93,000sqm) was noted in the DIRFT assessment. The DIRFT assessment notes that there would be a resulting focus on regional rail need, with the site serving urban areas primarily to the north.

7.29 The DIRFT assessment was undertaken in 2012. Since then, this site has been notified as a NSIP project and the site promoter, Goodman, has completed informal consultation on a proposed intermodal facility which could provide up to 6 million sqft of floorspace. This is comparable to the scale of the Rail Central proposals.

7.30 The project was subject to informal consultation with a timeline for commencing formal consultation in May 2014, with submission of the application in spring 2015. The development was subject to a screening request and opinion in summer 2014 and it is understood that work was continuing on development of a DCO application, with formal consultation expected in 2016/17 and submission in early 2017[45]. No formal consultation has subsequently progressed.

7.31 The proposals would address a more northerly area and market, centred on an area of existing manufacturing (Toyota, JCB, Nestle, Rolls Royce, Bombardier).

[45] See http://www.emipark.co.uk/public-consultation/

Figure 7.3: Site 25: West Midlands Interchange

7.32 As explained above, this site is being promoted as a SRFI by Four Ashes Ltd. This NSIP project is referred to as West Midlands Interchange and a DCO application was submitted to PINS on 3 August 2018. This was subsequently accepted for examination by PINS on 24 August 2018.

7.33 The site was sieved out of the assessment as set out in Section 6 because it is within the Green Belt, which is considered to be a constraint to delivering a SRFI. Notwithstanding this, as the site is being actively promoted and has the potential to contribute to the network of SRFI's required by national policy, the site is assessed below.

7.34 The site is located approximately 10km north of Wolverhampton and immediately west of Junction 12 of the M6 in South Staffordshire.

7.35 The site comprises approximately 297Ha of land and other than its location within Green Belt; the site has no landscape or ecological designations of a national, regional or local importance. The site is categorised as being entirely Grade 3 agricultural land, with some sub-categorised Grade 3a and 3b land within the west of the site.

7.36 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	2	The site is adjacent to J12 of the M6, the current proposals for the development seek to utilise this existing junction

Factor	Score	Notes
		arrangement.
Access to Rail	1	The W10-gauge twin-track WCML bisects the site.
Vehicle access routes	2	With limited amendments to the existing highway network, vehicles can access the site via J12 of the M6 and the A5. This route does not require vehicles to navigate through residential areas.
Site size	2	297 Ha
Site shape	2	The site is large and relatively regular in shape.
Topography	0	The site is largely level and will require only minimal site works to be suitable for development. However, the railway line is positioned below the level of the site. Ground works will need to take place to ensure a level rail access can be achieved.
Proximity to and potential effects on residential or other sensitive land uses	0	The closest sensitive receptors to the site are residential properties located directly to the north of the site. However, due to the scale of the site, it is envisaged that suitable mitigation measures can be implemented to protect the amenity of the sensitive receptors.
Total	**9**	

7.37 In terms of labour force availability, the site is 297Ha, applying the formula at paragraph 4.29, the site could generate in the region of 12,505 jobs. There are currently 33,400 people looking for work in the surrounding local authority areas and on this basis we conclude that labour availability is not likely to be a constraint to delivering a SRFI in this location.

7.38 In relation to local policy designations and planning status, the South Staffordshire Local Plan (1996) Proposals Map confirms that the site for the most part is designated as being within the Green Belt, whilst the existing built area is designated as Employment Use, with a further area designated as an Employment Proposal. Furthermore, the site also carries the designation of Landscape Improvement Area.

7.39 The Green Belt and Employment Site designations have been carried forward to the Site Allocations Document, which PINS have confirmed is sound and was adopted at the Council committee meeting on 11 September 2018. There are no extant permissions of relevance on the site, however it is currently being promoted as a SRFI and a DCO application has been accepted for examination by PINS.

7.40 Much of the site is designated as being within the Green Belt, which would typically be restrictive to this form of development. However, through the submission of the DCO application, very special circumstances are identified for the proposals. A neutral rating has therefore been awarded in this factor.

7.41 This site performs well on access, size and shape, the only noticeable limitation being the level change between the rail access and the site. However, it is understood that through the course of the development, this issue can be overcome.

7.42 The site was subject to Stage 2 consultation between Wednesday 5 July and Wednesday 30 August 2017 with a further focussed consultation (Stage 2a) being undertake between December 2017 and January 2018. Should a DCO be secured on the site, it will add to the regional supply of rail served space and the choice available for rail connected space to meet market demand arising from the northern extent of the West Midlands and Staffordshire.

Overview

7.43 The following table summarises the sites identified through the sieving exercise and their associated scores:

Site Number	Site Name	Score
22	Land to the East of Northampton Loop, North of M1 (Northampton South SUE)	3
23	Eurohub, Corby	1
24	Etwall Common (East Midlands Intermodal Park)	7
25	West Midlands Interchange	9

7.44 West Midlands Interchange stands out as scoring well and is currently progressing through the DCO process. It therefore needs to be considered further in the comparative assessment.

7.45 In addition, as Etwall Common is currently being promoted as a SRFI by a reputable logistics developer, despite scoring slightly lower than the other top performing sites, this site has also been considered further in the comparative assessment (Section 9).

8. Stage 4: Rail Central

8.1 In order to compare the potential alternative sites against the proposed Rail Central site on a like for like basis, Rail Central has been scored below.

Figure 8.1: Rail Central

8.2 This site is located approximately 6km to the south of Northampton. It is 294Ha and has the following constraints noted in the sieving analysis:

- Areas of Flood Zone 2 and 3 running along the Milton Malsor beck corridor.
- Roade Cutting SSSI at the southern end of the site

8.3 In addition, there is a listed railway bridge to the south of the site, a number of listed buildings in Milton Malsor and a flight of Grade II listed locks on the Northampton Arm of the Grand Union Canal.

8.4 The scoring matrix has been utilised to produce the following results for this site

Factor	Score	Notes
Proximity to a motorway junction	1	The site is within 2km J15a of the M1.
Access to Rail	2	The site has access to two W10 gauge route sections, the Fast Lines via

		Weedon and the Slow Lines via Northampton.
Vehicle access routes	2	Site access will be taken directly off the A43 with no need to travel through either the settlements of Milton Malsor or Blisworth.
Site size	2	294Ha.
Site shape	2	The site has large regular areas capable of accommodating multiple large floorplate buildings, with long straight sections of site adjacent to rail infrastructure.
Topography	2	The site is largely flat with little earth working required to achieve level rail access.
Proximity to and potential effects on residential or other sensitive land uses	0	The site is close to residential properties along Northampton Road. However, the parameters plan, master plan and assessment work in the ES show that there is adequate provision to ensure potential effects can be mitigated.
Total	**11**	

8.5 In relation to local policy designations and planning status, for the most part, the site does not have any designations within the South Northamptonshire Local Plan (1988-2006). Notwithstanding this, a small area of the site located directly adjacent to the east of the NLL is designated as being within an Important Local Gap. On the basis of the current proposals, it is not considered that the scheme will conflict with this designation. The site does not have any extant planning permissions of relevance. However, as is the purpose of this DCO application, the site is being promoted as a SRFI.

8.6 This site performs well on access, size, shape, and rail connectivity. The key issues are a slightly longer distance from the main motorway junction compared to other sites and its close proximity to a small number of residential properties, albeit mitigation can be provided to reduce the likely impact on the properties. The site will also have direct access onto the A43, providing good access to junction 15a of the M1 motorway.

9. Stage 5: Comparative Assessment

9.1 The preceding sections of this report have identified the following sites as being notable high scores for further consideration.

Table 9.1: Site Summary

Site Number	Site Name	Site Score
-	Rail Central	11
16	Northampton Gateway	11
5	Land at Burbage Common	11
9	Kilsby North	9
25	West Midlands Interchange	9
24	Etwall Common (East Midlands Intermodal Park)	7

9.2 This section of the report considers those sites in more detail and compares them to Rail Central.

Etwall Common (EMIP)

9.3 This site is located close to Derby alongside the A50 and A50/A38 junction. It is close to a number of employers in the region including JCB, Nestle and Toyota. The site scores moderately well on the standard matrix, and has potential to operate as a rail freight terminal.

Site Capacity

9.4 The site is approximately 255 ha and is a sufficient size for a SRFI. There is currently a waste water treatment facility on site, a composting facility, an existing flood attenuation pond, three residences and overhead electricity lines (x2) supported by steel lattice pylons across the north of the site which would need to be relocated for development to proceed. A number of residential properties adjoin the site boundary. Parts of the site have been subject to previous gravel extraction which has been filled in through licensed waste tipping. In the past the majority of the land has been used for intensive sewage sludge recycling and as such is unsuitable for growing crops direct for human consumption. As a consequence the land is used to grow crops for biofuels or animal feed uses only. As such, while the site is of sufficient size, there are on-site constraints that are likely to add significantly to the cost of bringing this site forward.

9.5 This site was not considered in the DIRFT assessment as the latter focussed on a much smaller adjacent site (93,000sqm). The DIRFT assessment notes that there would be a resulting focus on regional rail need, with the site serving urban areas primarily to the north.

9.6 The DIRFT assessment was undertaken in 2012. Since then, this site has been notified as a NSIP project and the site promoter, Goodman has begun informal consultation on

a proposed intermodal facility which could provide up to 6m sqft of floorspace. This is more comparable to the scale of the DIRFT and Rail Central proposals.

9.7 Various site layout options – which showed how the proposed warehousing could be arranged and effectively served by rail access as well as ensuring residential amenity, were the subject of non-statutory consultation between May and July 2014.

Topography

9.8 The site generally slopes from around 62m above ordnance datum (AOD) in the north eastern corner to around 50m AOD in the south west corner. Along the southern boundary on Carriers Road, the land rises up to form a ridge line that obscures views further into the site when viewed from the road. The A38/A50 junction and the associated earthworks also provide some screening of views into the site.

9.9 Topographical variations across the site are unlikely to impact on site capacity.

Rail Infrastructure

9.10 The site is located adjacent to the Derby to Stoke line which broadly runs through the centre of the site. The various design options presented in 2014 suggest the proposed full length intermodal terminal will be located alongside the main line with alternate options for rail-linked warehouse units and a car loading terminal. The existing railway provides direct access to the Birmingham to Burton line at the Derby end which provides a route to locations in the north and also to the Midland Main Line at Sheet Stores Junction near Long Eaton. Network Rail has confirmed that the site is cleared to W10 gauge southeast to where it joins the existing W10 gauge Birmingham - Derby line. W7 gauge exists northwest of EMIP to Crewe.

Road Infrastructure

9.11 The site is bordered by the strategic road network to both the north and the east of the site (the A50 and A38). The site does not have any existing access to either of these roads and current masterplan options propose access via a new junction on the A50 and direct access onto the A38/A50 junction. The DIRFT site assessment (2012) also noted that the Highway Agency (now Highways England) had raised concerns about the safety implications of the potential access arrangements and the congestion levels that could result.

9.12 Existing public transport in the area is limited to longer distance services and express routes between settlements. Investment in new bus services would offer the potential to secure sustainable links to nearby settlements such as Burton and Derby.

Environmental

Landscape/Visual

9.13 The site does not contain or lie close to any statutory landscape areas such as National Parks or Registered Parks or Gardens. With the exception of existing development on site, the landscape is relatively flat and open predominately comprising large agricultural fields.

9.14 The visual impact arising from SRFI development is likely to be significant most obviously from the perspective of existing residential properties located around the

edges of the site and public footpaths that run to the site boundary. The edge of Etwall and Egginton – the nearest villages to the site approximately 0.5km and 0.7km away will have part direct and part filtered views of the development. Other villages further away are likely to be partially or fully obscured by intervening vegetation. Others receptors such as road users may experience an impact; however, this is something that would need to be confirmed as part of additional survey and site assessment work.

Heritage

9.15 There are no designated heritage assets on the site although there are numerous Conservation Areas which surround the site; three of which have direct views into the site. These include the Trent and Mersey Canal Conservation Area - an important ecological corridor and popular route for walkers, anglers and cyclists which presents views towards the site at various points along the canal; Repton Conservation Area, approximately 2.3km from the site which has views towards the site from the northern edge of the Conservation Area; and Newton Solney Conservation Area which lies approximately 2.6km from the site at its closest point and has some long views across the site. The only listed building which has any potential relationship with the site is Willington House Farmhouse (Grade II Listed) on Etwall Road.

9.16 The prevailing cultural heritage of the site and immediate surroundings does not indicate that the SRFI development would present any significant adverse local impacts. A geo-physical survey over part of the site found only limited evidence of archaeological assets to be preserved with modern activities likely to have removed any archaeological remains over slightly more than a third of the site.

Air Quality/Noise

9.17 The site is fairly well isolated with only those residential properties which border the site likely to be affected by the proposals. With the proposed site access being identified at the opposite end of the site from these properties, no significant air quality or noise impacts are likely to arise from the development. The site is not located within an Air Quality Management Area.

Biodiversity

9.18 The site consists primarily of large arable fields with associated hedgerows and narrow field margins with strands of semi-natural woodland and areas of grassland and tall ruderal vegetation. A number of ponds exist within and outside the site. Surveys undertaken in 2013 indicate great crested newts are not present on the site; however the scoping opinion for the SRFI proposals indicates that subsequent surveys have revealed the presence of a small population of two great crested newts to be present in two ponds in woodland located in the southern part of the site. Other surveys reveal that presence of bats, reptiles (grass snake, common lizard and slow worm), a wide assembly of winter birds (of no more than county level value) and common invertebrates. Redevelopment of the site for a SRFI is likely to give rise to some significant impacts that will need to be mitigated.

9.19 The nearest statutory designated site is Hilton Gravel Pitts SSSI approximately 1.4km to the north west which is designated for its range of breeding birds and overwintering

wildfowl. The designated site is not considered to provide significant constraints to development.

9.20 No detailed agricultural land classification surveys are publicly available but the scoping report indicates detailed surveys of similar land locally have identified Subgrade 3b (moderate).

Land Use Policy

9.21 The South Derbyshire Local Plan (Part 1) was adopted in June 2016 while the Local Plan (Part 2), covering non-strategic housing allocations and development management policies, was adopted in November 2017.

9.22 Local Plan Policy INF3 sets out the detailed criteria with which SRFI proposals are required to comply. The criteria references to rail access arrangements, vehicular access arrangements and a range of environmental issues.

Other

9.23 The site is located within Flood Zone 2.

Conclusions

9.24 The Etwall Common project was subject to informal consultation with a timeline for commencing formal consultation in May 2014, with submission of the application in Spring 2015. A request for a screening opinion was issued by the applicant in Summer 2014 and screening opinion was issued by PINS in September 2014.

9.25 The latest project update available on the PINS website for Etwall Common confirms that the applicant has not yet set a timetable for the project. However previous updates on the PINS website dated September 2016 confirmed that the developer was preparing a SOCC and intended to formally consult in late 2016 / early 2017. It noted that technical rail work (GRIP stages 1 and 2) were complete and the submission of the application was anticipated in the first quarter of 2017. No further update has been provided on the PINS website or the SRFI website. While this in itself is not problematic, it does suggest that the project remains in the initial phase of development, with the creation of SRFI facilities not likely to be delivered in the immediate future. Comparison with Rail Central suggests that it is at least eighteen months behind in programme terms.

9.26 In the alternatives assessment presented during the Stage 1 consultation process for Etwall Common, it was noted that this site would address more northerly markets than Rail Central, centred on an area of existing manufacturing (Toyota, JCB, Nestle, Rolls Royce, Bombardier). This is still considered to be the case, particularly in respect of Toyota whose factory is located immediately north of the site. The site also has limitations as it is further from the motorway network than Rail Central, despite there being good A Road access to the M1.

9.27 This site is considered to be a good SRFI site and it is being promoted by a reputable logistics developer. However, it is located significantly further north than Rail Central in the search area serving Derby and Nottingham to the north. Furthermore, given its distance from the strategic road network, and existing rail gauge issues, taken with the low score achieved on the scoring matrix in comparison to Rail Central, the site is not

particularly high performing for SRFI development. Notwithstanding this, should the site come forward as a SRFI, it could help to create a network of SRFI, expanding the current network further north towards Derby and Nottingham.

West Midlands Interchange

9.28 The West Midlands Interchange (WMI) site is approximately 10km to the north of Wolverhampton and immediately west of Junction 12 of the M6 in South Staffordshire.

9.29 A large proportion of the land is in agricultural use with other notable areas of mineral workings in the east and woodland (Calf Heath Wood) towards the centre of the site. Existing residential properties are located along Croft Lane and the A5 around the northern part and boundary of the site, with further farming and residential properties positioned around or close to the site boundaries.

9.30 The WMI site is currently characterised by a large area of sand and gravel mineral extraction within the east known as Calf Heath Quarry; a patchwork of agricultural fields with hedgerows and trees to the west and south of this and an area of mixed woodland known as Calf Heath Wood.

9.31 A DCO application for the development of a SRFI was submitted to PINS on 3 August 2018. This was subsequently accepted for examination by PINS on 24 August 2018. Through the DCO application, detailed information has been made available, which has permitted a more detailed review of the site.

Site Capacity

9.32 The site is approximately 297ha. The current masterplan includes a full-length rail terminal located directly adjacent to the WCML and sufficient space for up to 743,200sqm (GIA) of warehousing, as well as significant strategic landscaping and open space as confirmed in the information submitted in support of the DCO application.

Topography

9.33 The topography of the site is relatively level, with localised topographical features associated with the canal cutting, railway and quarry workings.

Rail Infrastructure/ Capacity

9.34 The site has over 2km of frontage onto a suitable main line (WCML branch via Penkridge, W10 gauge and electrified) and thus able to accommodate main line access from either direction of travel and on-site stabling/ handling sidings running parallel with the main line.

Road Infrastructure

9.35 The WMI site has direct connections to the strategic highway network via the A5, which provides onward connectivity to Junction 12 of the M6 as confirmed in the ES for the development. The main access to the WMI site for vehicular traffic would be via the A5 and would be provided between Junction 12 of the M6 and the Gailey Roundabout. The other principal means of access will be onto the A449 for vehicles travelling to the M54 and Wolverhampton. There would be a secondary access from the site to Vicarage Road which would give access to the southern element of the site, provide an access for local employees and act as an alternative route to the M6.

9.36 There is a considerable variance in levels between the site and the WCML. Providing adequate access from the rail line will therefore require significant levelling works to be undertaken.

Environmental

Landscape/ Visual

9.37 A large proportion of the land is under agricultural use with other notable areas of mineral workings in the east and woodland (Calf Heath Wood) towards the centre of the site. The existing Four Ashes Industrial Area lies outside the site to the south, contained between the railway and the canal. Existing residential properties are located along Croft Lane and the A5 around the northern part of the site, with a number of other farming and residential properties positioned around or close to the site boundaries.

9.38 The ES confirms that the character of the site is affected by a number of significant features including its current uses as predominantly arable farming, quarrying and Calf Heath Wood, as well as by the influence of features surrounding and crossing the site including the canal, railway, roads and dwellings, and the industrial area of Four Ashes.

9.39 The ES confirms that a number of significant adverse temporary effects have been identified on visual receptors during construction, notably Minor/Moderate to Major adverse effects on certain properties within view of the proposals, and Moderate to Major adverse effects on the canal towpath and Calf Heath reservoir. It is however anticipated that these effects will reduce during the completed development phase of the SRFI.

9.40 Furthermore, the ES confirms that the development will give rise to significant landscape effects (moderate to adverse) and result in significant visual impacts during construction and operation with effects reducing as new planting matures. The changing character of the site will have a significant effect on the existing openness of the Green Belt.

Cultural Heritage

9.41 The ES confirms that several historic features associated with the canal are located within or near the site. These comprise the canal itself, lock keeper's cottages including the Grade II Listed 18th century Round House located between two of the land parcels west of Gailey along the northern edge of the site. Adjacent to the Round House, Gailey Wharf is a Grade A locally listed building which includes a restored 18th century revolving crane. Furthermore, the Canal itself is within a Conservation Area that runs through the site.

9.42 The ES notes that the proposed SRFI will cause effects on the setting of the canal, however it is proposed to be mitigated through careful design of the landscaping so as to minimise the visual and setting impacts. Potential effects are identified relating to the demolition of the locally listed Heath Farm. These effects are seen to be minimised by Historic Building Recording prior to demolition. The ES confirms that no significant residual effects have been identified in relation to above ground cultural heritage.

Air Quality/ Noise

9.43 The ES confirms that the main source of existing air pollutants close to the site is road traffic in particular associated with the main road network to the north, east and west of the Site. This includes the A5, M6 and A449.

9.44 With regards to air quality, the ES confirms that negligible to slight residual effects have been identified for dust at construction stage and operational traffic on human receptors adjacent to the road network. In respect of noise, the ES confirms that noise from on-site operational activities is likely to give rise to moderate adverse effects at a number of receptors around the site.

Biodiversity

9.45 The ES confirms that there are no internationally or nationally designated sites for nature conservation located on or adjacent to the site. Without mitigation, there is the potential for development of the site to affect protected species. The ES confirms that surveys at the site have recorded the presence of several protected rare, declining or notable species including:

- Great crested newts and other amphibians;
- Birds, including breeding birds;
- Farmland birds and water birds;
- Invertebrates;
- Several species of bats; and
- Terrestrial mammals including badgers, hedgehogs and otters.

9.46 The ES confirms that there are significant residual effects in the operational phase, generally at the site or local scale (notably on farmland birds) or while habitats develop. This is balanced in part through the provision of significant new and enhanced habitat including the proposed community parks and offsite farmland bird mitigation land, to be maintained in the long term, which would provide benefits to a range of wildlife and which would be managed for the duration of the operational phase. The habitats created would address local and national biodiversity action plan targets.

9.47 Furthermore, it is noted within the ES that a number of veteran trees will be lost as a result of the proposed development.

Land Use Policy

9.48 The WMI site lies within Green Belt land and in accordance with the NN NPS[46] the Secretary of State would have to be convinced and promoters would need to demonstrate very special circumstances exist to justify planning consent for inappropriate development in the Green Belt. The NN NPS[47] also confirms that the Secretary of State will attach substantial weight to the harm to the Green Belt, when

[46] NN NPS Paragraph 5.172
[47] NN NPS Paragraph 5.178

considering any application for such development. Furthermore, the NN NPS[48] is clear that infrastructure projects may comprise inappropriate development which is, by definition, harmful to the Green Belt and for which there is a presumption against development, except in exceptional circumstances.

Other

9.49 According to the Environment Agency flood maps for planning, the WMI site is located within Flood Zone 1 and therefore has a 1 in 1,000 annual probability of tidal/ fluvial flooding. Notwithstanding this, Environment Agency data suggests that the site may be susceptible to surface water flooding.

Conclusions

9.50 On the scoring matrix, the site scored 9 points. Measuring 297Ha, the site is a considerable size and has minimal constraints that could restrict the future delivery of the site. Notwithstanding this, there is a significant level change between the WCML and the surrounding site area. Gaining suitable rail access will therefore require significant levelling works to be undertaken. From information submitted in support of the DCO application it is understood that this level change can be addressed.

9.51 The ES for the development discusses the various impacts that are a result of the proposals. These primarily include adverse impacts on heritage, ecology and nature, landscape and noise which the proposals have sought to mitigate and minimise where possible in accordance with the NN NPS.

9.52 The key differences in the scoring of the site against the Rail Central scheme are that WMI has closer access to the Motorway, whilst Rail Central has access to two W10 rail lines.

9.53 Having access to two W10 railway lines allows Rail Central to offer services to the emerging Express Freight market, which allows it to better utilise the faster moving WCML. This is a clear distinction between the two sites which suggests that Rail Central is more adaptable to anticipated future changes in the rail freight market.

9.54 Whilst access to the motorway is closer at the West Midlands Interchange scheme, this is only marginally better than the Rail Central scheme, where routes utilise A roads and do not pass through predominantly residential areas. Conversely, access to two W10 rail lines is considered to be a much greater advantage.

9.55 Furthermore, from a planning policy perspective, the WMI is located within the Green Belt. This sets a requirement on the DCO application to demonstrate very special circumstances for the release of land from the Green Belt. This factor further separates WMI and the Rail Central scheme, with Rail Central being preferable from a planning policy position.

9.56 Providing that the planning basis for providing a SRFI on land in the Green Belt can be adequately justified through the demonstrated of very special circumstances, WMI is a relatively high scoring site. WMI would seek to serve a more northern markets and and would expand the network of SRFIs between the North West and the Midlands.

[48] NN NPS Paragraph 1.78

Kilsby, North

9.57 This site is located approximately 5km to the south east of Rugby. It was also identified in the DIRFT III Alternative Site Assessment as Site 6 Kilsby North. The site area is approximately 238Ha.

9.58 The southern area of the site would have limited capacity for new trains as freight trains would need to use the WCML which is faster moving and less suitable for standard freight trains, other than at night. The northern section is considered to be capable of accommodating a limited form of rail freight development. However, the shape of the site creates limitations on rail layout which would affect path availability for other passenger and freight trains, and leaves little site capacity to accommodate warehousing as well as an intermodal facility. The details of the site are assessed below, although the DIRFT III Assessment discounted the site from its short list stage on the basis of the restricted nature of the site for rail access and its capacity for warehousing alongside an intermodal facility.

Site Capacity

9.59 The site is approximately 238Ha in area and is therefore sufficient to accommodate a SRFI. The site is primarily in agricultural use and is subdivided into a number of field parcels. Notwithstanding this, there are a number of small farm holdings and individual detached residential dwellings located within the site. The northern area of the site also includes Hamilton Wharf, which is a small marina, linking directly to the Oxford Canal.

9.60 Hillmorton, which is a residential suburb of Rugby, is located directly adjacent to the north west of the site. Furthermore, the settlement of Kilsby is located directly to the south of the site.

9.61 The site is not presently being promoted as a SRFI, on this basis, there is limited information regarding the possible capacity to deliver such a development. Notwithstanding this, considering the size of the site, this is not considered to be a constraint.

Topography

9.62 The site is considered to be relatively flat, higher ground is primarily located to the east of the site, which is approximately 124m AOD. From this location, the topography gently slopes downwards towards the north west, reaching approximately 102m AOD where the site intersects the Oxford Canal.

9.63 The general topography of the site is unlikely to impact upon the deliverability of a SRFI.

Rail Infrastructure/ Capacity

9.64 The WCML runs through and dissects the site; from the south east to the north west of the site. The WCML Northampton Loop forms the northern boundary of the site. The DIRFT Assessment confirmed that a new access point onto the WCML Northampton Loop line would be required, whilst the use of the existing DIRFT I crossing would also be required.

9.65 As a result and again as confirmed by the DIRFT Assessment, this would create a requirement to accommodate the rail infrastructure (including the necessary 775m siding) within the narrow triangle of land between the WCML and NLL. The limited size of this triangle (approx. 67ha) would make accommodating both 750m sidings and a terminal facility very difficult to achieve. Even shorter starter sidings (i.e. less than 750m) would be very difficult to accommodate.

9.66 Additionally, due to the variances in height between the site and the WCML, significant earth works would be required to ensure adequate rail access could be achieved.

9.67 On this basis, although the site is within close proximity to rail infrastructure, it would be difficult to achieve the necessary standards required to support a SRFI development.

Road Infrastructure

9.68 All routes bounding the site are single carriageways. Access to the M1 is currently along the A428, which becomes a dual carriageway where it meets DIRFT I. However, to access this road from the eastern section of the site will require a bridge over the railway or upgrading works to the A5.

9.69 Access via the B4038 to the south of the site is not considered suitable, this would require major road improvement works within the settlement of Kilsby. Furthermore, it is likely that the use of this route would cause a major disturbance to the settlement.

9.70 Additional assessment work may determine that access to the site could be achievable, however it is likely to require significant upgrading works to the highway network.

Environmental

Landscape/ Visual

9.71 The site does not contain or lie in close proximity to any statutory landscape areas such as National Parks or Registered Parks or Gardens. With the exception of some existing development on the site and the dissecting railway line, the site is relatively flat and open predominantly comprising large agricultural fields. The development of a SRFI site would therefore significantly impact upon the existing landscape of the site.

9.72 The most obvious adverse impacts will be experienced by occupiers of existing residential dwellings situated adjacent to the site boundary. Furthermore, visual impacts will also be experienced from the many public footpaths, which are located within and adjacent to the site.

9.73 As a result of road and rail routes being in close proximity to the site, users of these routes will see the development as they pass by, and this will result in an adverse visual impact, albeit transient for those receptors.

9.74 Through the design of the scheme, it is envisaged that some of these impacts could be mitigated, however, it is considered inevitable that some landscape and visual impacts will remain.

Cultural Heritage

9.75 There are no designated heritage assets within the site, however the Oxford Canal within the north of the site is in a Conservation Area. Furthermore, there are a number of listed buildings that are in close proximity to the site boundary. These include the following:

- A large number of primarily Grade II listed buildings within the settlement of Kilsby;
- The Grade II listed Wharf Farmhouse located directly adjacent to the north west of the site; and
- The scheduled ancient monument of Watling Street Roman Road, situated to the east of the site.

9.76 Given the proximity of these heritage assets, it is probable that a SRFI development on this site will create some impact on setting. Notwithstanding this, it should be possible to implement some form of mitigation to reduce adverse impacts. From an initial appraisal it is not evident that heritage constraints would restrict the development of the site as a SRFI, however their proximity would need to be considered in designing an appropriate scheme.

Air Quality/ Noise

9.77 For the most part, the site is relatively detached from sensitive receptors. Notwithstanding this, residential properties that do lie in close proximity to the site would be likely to experience adverse air quality and noise impacts.

9.78 Again, as with heritage implications, it is envisaged that both of these matters could be mitigated through the careful design of a SRFI development on the site.

Biodiversity

9.79 The site consists of primarily large fields with associated hedgerows and narrow field margins, with strands of semi natural woodland. There are no statutory biodiversity or ecological designations on the site or within close proximity.

9.80 Although additional assessments would need to be undertaken to ascertain the biodiversity value of the site, this initial appraisal does not demonstrate that it will cause any major constraints to the delivery of a SRFI on the site.

Land Use Policy

9.81 A small portion of the northern element of the site is located within Rugby Borough Council and is therefore covered in the Rugby Core Strategy. It is part of a wider allocation for an Urban Expansion. Adjacent to the proposed Urban Expansion is another designation, indicating the presence of a Regionally Important Geological Site.

9.82 The remainder of the site is located within the area covered by the Daventry Local Plan and the West Northamptonshire Joint Core Strategy (pre submission version). The Daventry Local Plan indicates the presence of a footpath in the vicinity of the northern corner of the site, although the policy relating to this allocation has not been saved. There are no other site specific allocations in the Daventry Local Plan. The West

Northamptonshire Joint Core Strategy contains no policy allocations for this part of the site.

Other

9.83 No relevant extant planning permissions or current planning applications have been identified. However, the Council refused an application for 99 dwellings on the southern area of the identified site in November 2015 (Daventry District Council ref. DA/2015/0830). The application was refused for being outside the settlement boundary, consisting of unsustainable development, design grounds and for its impact to surrounding landscape and heritage assets. This indicates that in bringing forwards a SRFI on the site, the development would need to overcome a number of possible constraints.

9.84 The entirety of the site is located within Flood Zone 1 and therefore has a 1 in 1,000 annual probability of tidal/ fluvial flooding.

Conclusions

9.85 This site scored 9 points on the scoring Matrix. It is clearly a strong site which has the characteristics of a good potential rail freight site.

9.86 This site was considered in detail in the DIRFT III assessment. That assessment considered a larger site, the northern part of which is included in this assessment. The southern part of the site assessed by the DIRFT III team was discounted from the analysis.

9.87 The DIRFT III assessment considered that the northern section of the site was considered to be capable of accommodating a limited form of rail freight development. However, it concluded that the shape of the site created limitations on rail layout which would affect path availability for other passenger and freight trains, and left little site capacity to accommodate warehousing as well as an intermodal facility.

9.88 This site clearly has merit as a SRFI location. However, this site scores lower than Rail Central and has acknowledged technical difficulties in delivering a similar quantum of rail served floorspace. Based on the scoring matrix and the above analysis, Rail Central appears to perform more favourably; however Kilsby North still represents a site which could complement and expand the network of SRFIs.

Land at Burbage Common, Hinckley

9.89 Consisting of an area of approximately 222Ha, the site at Burbage Common is located to the west of the M69. The north and north western boundary is defined by the Leicester to Nuneaton railway line, which has the capacity for W10 gauge trains. The settlement of Hinckley is located approximately 3km to the west of the site.

9.90 Notification has recently been submitted to PINS by DB Symmetry (Hinckley) Limited confirming the intention to submit a DCO application for a SRFI on the site. The application website confirms that statutory consultations are planned for winter 2018. Furthermore, the PINS infrastructure website confirms that the DCO application will be submitted in Q2 of 2019. Information presented on the PINS website states that the proposals are to include railway sidings and a freight transfer area alongside the two-

track railway between Hinckley and Leicester and a dedicated road access directly from junction 2 of the M69 motorway comprising the addition of a northbound off-slip and a southbound on-slip to this junction, which currently caters only for motorway traffic heading to and from the north.

9.91 Assuming the proposed vehicular access arrangements from the M69 are achievable and viable, the site scores well in the assessment.

Site Capacity

9.92 The site is approximately 222Ha and is therefore of sufficient size to accommodate a SRFI. The site is predominantly in agricultural use and subdivided into a number of different field parcels. Notwithstanding this, there are a number of singular detached residential dwellings and small farm holdings on the site. A small area within the south of the site is also occupied by a permanent traveller site. Residential dwellings associated with the village of Elmesthorpe are located to the north east of the site boundary.

9.93 As the site is in the early stages of being promoted for a SRFI, there is limited information currently available regarding its possible layout. Notwithstanding this, based on the site area it is envisaged that a SRFI can be accommodated alongside necessary mitigation measures to lessen the impact of the proposals.

Topography

9.94 The site generally slopes from around 112m AOD in the southern corner, to around 90m in the north. The M68, which runs along the sites eastern boundary, fluctuates from being above and below the general height of the site. Again, the railway line running along the sites northern and north western boundary fluctuates from being above and below the general height of the site.

9.95 The general topography of the site is unlikely to impact upon the delivery of a SRFI in this location.

Rail Infrastructure/ Capacity

9.96 The W10 gauge Leicester to Nuneaton railway line runs adjacent to the north and north western boundary of the site.

9.97 There are areas within the site boundary where the topography of the railway line and site are broadly level. Direct accesses to the railway line from parts of the site are blocked due to the location of Burbage Common Road. Adequate access should however be achievable from the northern site area. It is therefore envisaged that with some earthworks, reception lines into the site could be created. Albeit, detailed design work would need to be undertaken to demonstrate that this is feasible.

Road Infrastructure

9.98 The eastern boundary of the site is defined by the M69 with access possible from junction 2, which is located directly adjacent to the south eastern corner of the site. No detailed analysis of this junction has been undertaken, however it is anticipated that significant improvements are proposed comprising the addition of a northbound off-slip and a southbound on-slip to this junction, which currently caters only for motorway traffic heading to and from the north.

9.99 If these proposals ultimately prove unviable, the site would therefore need to gain access to the B4669 in the first instance. This would then provide onward connection to the M69. In doing so, the B4669 would need considerable improvement works. Furthermore, achieving direct access to the B4669 from the site is constrained by proximity to two existing permanent residential caravan sites and dense areas of woodland habitat.

9.100 Alternative access routes (approximately 5-10km additional distance to access J2) could be achieved at the north of the site although this area is similarly constrained by motorway embankments and a number of residential and commercial properties.

9.101 On this basis, although the strategic road network is within close proximity to the site, access to it will likely require significant investment in road infrastructure to create a suitable access. Detailed feasibility, design and mitigation work will therefore need to be undertaken to establish the means of achieving access.

Environmental

Landscape/ Visual

9.102 The site does not contain or lie in close proximity to any statutory landscape areas such as National Parks or Registered Parks or Gardens. With the exception of existing development on the site, the landscape is relatively flat and open, predominantly comprising large agricultural fields.

9.103 The development of a SRFI would be likely to affect the existing landscape of the site, in comparison to the existing nature as predominantly land in agricultural use. However, the actual impacts of this would only be established following a detailed analysis of landscape and visual impact issues.

Cultural Heritage

- There are no designated heritage assets within the site, although the conservation area of Aston Flamville is located approximately 1km to the south of the site. Furthermore, there are a number of listed buildings which are in close proximity to the site boundary. These include:

- Three Grade II listed properties to the north of the site;

- A cluster of Grade II listed properties within Aston Flamville;

- A series of Grade II and II* listed properties within the settlement of Hinckley;

- A cluster of Grade II and II* listed properties within the settlement of Stoney Stanton; and

- A cluster of Grade II properties located within the settlement of Sapcote.

9.104 It is anticipated that given the scale of the proposed site many of the views from the historic designations can be mitigated. The full extent of any impacts would however only be established following a full assessment of development on the site.

Air Quality/ Noise

9.105 For the most part, the site is fairly well isolated with only residential properties that are in close proximity to the site likely to be affected by the proposals. With regards to properties to the north of the site, it is envisaged that measures can be undertaken to mitigate against air quality and noise impacts.

9.106 However, the permanent caravan sites to the south of the site are likely to experience some detrimental air quality and noise impacts. The extent of these impacts will only be established following a detailed assessment as part of the emerging scheme.

Biodiversity

9.107 The site consists primarily of large arable fields with associated hedgerows and narrow field margins with strands of semi-natural woodland. In addition, the site is in close proximity to the following statutory designations:

- Adjacent to Burbage Wood and Aston Firs SSSI to the south; and
- Adjacent to Burbage Common and Woods Local Nature Reserve to the south.

9.108 Due to the close proximity of these designations, the design of the SRFI scheme will need to be carefully considered. However, given the size of the site, it is envisaged that mitigation measures can be implemented in the south of the site to reduce the impact on these designations.

9.109 Detailed agricultural land assessments and ecological surveys will need to be undertaken alongside the promotion of the site as a SRFI.

Land Use Policy

9.110 The site in its entirety is designated as being located within the 'Countryside'. This designation generally restricts against widespread development. Albeit, this designation does not carry the same restrictive weight as a Green Belt designation.

9.111 No relevant extant planning permissions or current planning applications have been identified on the site that would restrict the future development of the site as a SRFI.

Other

9.112 A small area within the north of the site is located within Flood Zone 2; however it is not considered that this will detrimentally impact the delivery of the site as a SRFI. The remainder of the site is within Flood Zone 1 and therefore has a 1 in 1,000 annual probability of tidal/ fluvial flooding.

Conclusions

9.113 The site generally scores well on most measures within the scoring matrix. It is at the early stages of being promoted as a SRFI by a reputable logistics developer. It is within close proximity of the strategic highway network, with proposals to secure access on to the M69, and has access to a W10 rail line.

9.114 Land at Burbage Common achieves the same score in the matrix as Rail Central, which is a reflection of the site location in proximity to important transport infrastructure and the lack of environmental constraints identified on the site. Notwithstanding this, the

site is only at the early stages of being promoted for SRFI development. As such, limited information regarding the proposals has been available to fully assess the potential SRFI scheme at Burbage Common.

9.115 However, this analysis has highlighted a number of key issues that will need to be addressed through the detailed design of the scheme. These include the proximity to sensitive biodiversity designations, impact on the permanent caravan sites to the south and the ability to find a feasible access route to the site.

9.116 Notwithstanding this, although the site has been identified within this alternative site assessment exercise, it will a serve a different area of the region being almost 50km to the north west of Rail Central.

9.117 Although the site at Burbage Common may be a good SRFI site on its own merits, this can only be confirmed upon the review of more detailed information when it is available. For these reasons and similarly to the other sites considered as part of this assessment, Land at Burbage Common could function as a complementary SRFI to the wider SRFI network, including Rail Central.

Northampton Gateway

9.118 The site is located between the M1 motorway to the east (near J15a) and the WCML to the west, to the south east of the settlement of Milton Malsor. The site is being advanced through the DCO process as a SRFI proposal by the promotors and applicant for the proposals, Roxhill (Junction 15) Ltd. The proposals have been subject to a Stage 2 public consultation process which was held between 9 October until 24 November 2017. A further focused consultation was held between December 2017 and February 2018. Furthermore, a DCO application was submitted in May 2018. This was subsequently accepted by PINS for examination in June 2018. A pre-examination hearing has been arranged for 9th October 2018.

Site Capacity

9.119 The site comprises an area of approximately 219ha (main site). The most recent masterplan shows a scheme with 5m sqft[49] of logistics space and a single connection to the NLL. In comparison, Rail Central will provide 7.4m sqft of logistics space and has two direct connections and full inter-connectivity, to the NLL. The Northampton Gateway proposal also includes road infrastructure including a new bypass to the village of Roade, improvements to Junction 15 and 15A of the M1 motorway, the A45, and other highway improvements at junctions on the local highway network.

Topography

9.120 The site generally slopes from the west to east; at its peak along the western boundary, elevations are approximately 102m AOD, falling to its lowest elevation of approximately 80m AOD with the shallow valley associated with the Courteenhall Brook along the south eastern boundary which flows to the north east.

[49] Proposals include 1.6msqft of mezzanine

Rail Infrastructure

9.121 The western boundary of the site is defined by the WCML NLL (W10 gauge) running from London to Scotland serving the West Midlands, North Wales and the North West, providing the site with excellent rail connectivity. The SRFI proposals intend to capitalise on this proximity, with direct connection to the WCML Northampton Loop (W10 gage); providing a set of three 775m reception sidings; a 775m headshunt and run round loop to permit shunting moves around the site; a three track intermodal terminal (775m); rail connections to four warehouses; and a rapid rail freight terminal. There are connections to both the southbound and northbound lines in both directions enabling trains being able to enter and leave the site in both directions.

Road Infrastructure

9.122 The proposal also includes road infrastructure including a new bypass to the village of Roade, improvements to Junction 15 and 15A of the M1 motorway, the A45, and other highway improvements at junctions on the local highway network. The information submitted as part of the DCO application indicates that J15 is operating well over its design capacity and is a congestion 'hot-spot'. The SRFI proposes an upgrade to Junction 15, lane widening and new signals at J15A and new bypass for Roade. It is asserted that highway modelling demonstrates that this package of works would remove congestion on the highway network (particularly at M1 Junction 15 and 15A and at Roade). Existing traffic would reassign to principal road networks consisting of the A508 between the A5 and M1 Junction 15 and Junction 15A and thereby lead to a consequential reduction in traffic on many of the surrounding roads.

Environmental

Landscape /Visual Impact

9.123 There is no statutory landscape designations that cover any part of Northampton Gateway other than the Roade Bypass extending into the edge of a locally designated Special Landscape Area largely located to the south east of Roade.

9.124 The ES confirms that at a local level, the effects of the development will vary on different receptors at different stages of the development process. The proposals would represent a significant change to the existing landscape not only built development but also through the provision of bunding and green infrastructure. The ES concludes that at worse the Northampton Gateway scheme will result in moderate long-term residual landscape and visual effects.

Cultural Heritage

9.125 The ES identifies 51 listed buildings within 1km of the main site along with two buildings within the main site which are considered to be non-designated heritage assets. The ES also identifies a number of heritage assets surrounding the bypass corridor. There are also three Conservation Areas and a Registered Park and Garden located within 1km of the site.

9.126 The Heritage Chapter of the ES concludes that the proposal will result in no more than a minor impact on the identified listed buildings and asserts that many of the effects have been identified as negligible.

Air Quality/Noise

9.127 In terms of noise impacts the ES suggests that no significant adverse effects are anticipated from operational rail noise or vibration, or road traffic associated with the site or the proposed Roade bypass.

9.128 There are two Air Quality Management Areas (AQMA) close to the site and the primary focus of air quality monitoring is nitrogen dioxide (NO_2). NO_2 is closely associated with major roads with the closest AQMA being on the M1 adjacent to the site and extends along the stretch of motorway running north-west from Junction 15 and around Collingtree to the east of the M1. The other AQMA of relevance is on the A45 at Wooton to the north of Junction 15.

9.129 The ES indicates that the proposals will reduce HGV miles on the national network and therefore result in potential improvements at a number of AQMA's across the UK – mostly on the strategic network and key ports. Furthermore, the ES confirms that the proposed highway mitigation measures, such as the M1 J15 and J15A improvements and a Roade by-pass will result in reduced localised emissions, thereby having a positive effect on air quality in a number of locations and communities.

Biodiversity

9.130 The site is dominated by arable farmland and boundary hedgerows, with areas of grassland, scattered woodland blocks, mature trees and ponds. There are no statutory designated sites within or adjacent to the site but the Upper Nene Valley Gravel Pits Special Protection Area (SPA)/Ramsar site is located approximately 5km to the west of the site. The Roade Cutting Site of Special Scientific Interest (SSSI), which is geological (not ecological) interest, falls within the boundary of the bypass corridor. There are no non-statutory Local Wildlife Sites (LWSs) within the boundary of the site. There are a number of potential LWSs (pLWSs) within the boundary of the site including 236/Unnamed pLWS of Highgate Wood, Roade Cutting pLWS and Roade pLWS. Protected or notable species present include badgers, roosting and foraging bats, farmland and woodland birds, great crested newts (GCN), invertebrates, common lizard, grass snake and otter.

9.131 The DCO submission documents indicate that the significant habitat losses resulting from development will be off-set through the re-creation and favourable management of hedgerows, trees, grassland and wetland features. It is indicated that where appropriate, the most sensitive habitats (hedgerows and neutral grassland) will be retained by translocation into part of the site green infrastructure. This would be a significant undertaking and appears impractical over an extensive site area. Overall, the ES confirms that the proposed development provides an opportunity to establish new habitats for nature conservation and to deliver a net gain for biodiversity in the locality.

Land-Use Policy

9.132 The South Northamptonshire Local Plan Proposals Map designates the site as being an Area of Important Local Gap. Saved Policy EV8 of the South Northamptonshire Local Plan confirms that "in order to prevent the coalescence of settlements the Council will not permit development which would significantly intrude into (…) important local gaps as shown on the proposals map".

9.133 On this basis, development within this land use designation is generally considered to be incompatible. Notwithstanding this, in drafting the South Northamptonshire Local Plan Part 2 (pre-submission draft), the Council does not intend to carry forward the principles of Saved Policy EV8. Policy Site Development Principles 1 within the pre-submission draft of the Local Plan Part 2 does however set out a number of principles to limit the coalescence of settlements.

9.134 It is anticipated that the Northampton Gateway scheme will need to have regard to these policies during the examination of the DCO application.

Other

9.135 The socio-economic information provided through the DCO submission asserts that the SRFI development could support around 7,544 additional jobs once fully operational.

9.136 For the most part, the site is located within Flood Zone 1, however the assessment and site specific modelling provided submitted alongside the DCO application indicate that small areas of the site are at an increased risk and within Flood Zones 2 and 3 (medium and high risk). The areas identified as being at increased risk from surface water flooding are limited to low lying areas of the site and the immediate corridors of existing drainage ditches/watercourses. Mitigation is proposed comprising the creation of a Sustainable Urban Drainage System (SuDS) to reduce surface water runoff rates with surface runoff restricted to existing greenfield annual flow rate with attenuation volume provided across the site. Residential impacts are identified as negligible.

Conclusion

9.137 This site scores well on most measures in the scoring matrix. It is currently being promoted as a SRFI by a reputable logistics developer. It has good access to the motorway network and access to a W10 rail line.

9.138 Northampton Gateway achieves the same score in the scoring matrix as Rail Central which is a reflection of the strategic nature and strength of this area as a location for rail freight development. This also reflects one of the limitations of the adopted methodology, in that it does not allow a fine grained enough analysis of sites in comparable areas, or as in this case, adjacent to each other. This is why qualitative analysis is provided for in the methodology. However, the national policy aim is not to develop a limited number of SRFI sites; it is to create a network of SRFIs and to ensure the growth of rail freight capacity and the associated economic and environmental benefits of this sector.

9.139 In assessing the degree and scale of environmental impact, it is important to note that a like for like comparison is difficult as the Northampton Gateway ES does not set out a standardised methodology for the assessment of environmentally significant effects. Instead different approaches are adopted across the whole of the ES resulting in a series of separate technical assessments as opposed to an ES which should be a cohesive and integrated report on the outcome of the EIA process. Many of the methodologies adopted also do not appear to have been followed through in topic assessments. The inconsistency of assessment methodology applied potentially compromises the ES and the conclusions within it. Notwithstanding this, for the

following assessment, we have largely accepted the conclusions of the Northampton Gateway ES at face value unless otherwise stated.

9.140 In appraising both schemes, it is important to note that Rail Central is almost 30% larger in site size and also delivers significantly more commercial floorspace than Northampton Gateway. Despite this, an appraisal of both schemes reveals that both are comparable in respect of environmental impacts. The environmental impact assessment in respect of air quality, archaeology, ground conditions, lighting, human health and waste all conclude that significant effects would not arise from the proposals. Both schemes identify a residual benefit in terms drainage and reduced flood risk although the residual benefit is identified as being significant for Rail Central. Both schemes are anticipated to give rise to significant benefits in respect of socio-economics and both will positively encourage the movement of freight from road to rail resulting in significant beneficial effects on HGV miles on the highway network and CO_2 emissions.

9.141 There are some key specific impacts and/or differences within certain topic areas which are worth explaining. These are summarised below:

(a) Landscape and Visual

Both Rail Central and Northampton Gateway do not affect any designated landscapes.

Northampton Gateway is located in an area between the NLL and the M1 motorway defined as "Area of Important Local Gap" within the South Northamptonshire Local Plan Policy EV7. Rail Central maintains the "Area of Important Local Gap" through significant landscape mitigation around its development zones comprising of hedgerow planting, ecological mitigation, woodland block planting, farmland and footpath diversions.

Northampton Gateway is in a rural, and slightly more contained landscape than Rail Central, though the site is influenced by urbanising features including the NLL to the east and southeast and by the M1 to the north and east and Northampton beyond the M1.

Rail Central is larger and in a slightly more open rural landscape than Northampton Gateway, though the local landscape of Rail Central does have some urbanising influences including the Northampton/Towcester Road, JBJ Business Park, and the Milton Business Park, and transport routes with noticeable traffic movement and noise from the WCML to the south, the NLL to the east, and A43 to the West. The Rail Central site does benefit from some containment being in a slight bowl of land with a ridgeline and the embankments of the WCML to the south, rising land to the south east and east and the embankments of the NLL and Milton Malsor to the north, rising land and Gayton Road to the northeast and the A43 to the West.

In terms of impacts, both schemes will have significant effects on their respective sites and immediate surroundings during construction, at year 1 and year 15, but the respective effects are limited and localised. Both schemes will

have limited and localised effects to County Landscape Character Areas (The Tove Catchment, and Bugbrooke and Daventry) though neither scheme's assessment identifies significant effects to these LCA's during construction or operation.

The relative effects of each scheme on the local landscape and landscape character are similar in level and extent (limited and localised), and are comparable. However, it should be noted that the Roade Bypass element of Northampton Gateway will add to the landscape and visual effects of this scheme, extending the overall effects of the scheme over a wider area in the vicinity of Roade and Stoke Bruerne in the south. The Northampton Gateway ES Appendix 4.4 Landscape Effects Table, and Appendix 4.5 Visual Effects Table identifies that the Roade bypass scheme will give rise to significant landscape and visual effects during construction and operation to a number of sensitive receptors including the local landscape character, residential receptors and public rights of way, which are greater than the very limited and localised landscape and visual effects resulting from the proposed works to J15a and other minor highway works included as part of Rail Central.

Considering the landscape and visual context and considering the nature, size and scale of the Rail Central and Northampton Gateway SRFIs in their own right, the visual effects are limited and localised. Significant visual effects during the construction and operational phases are anticipated to be experienced by a relatively small number of receptors overall, the majority of which are in close proximity to each site or where views may be gained from limited elevated locations overlooking each respective site. A number of these affected receptors are in close proximity to one another including a number of Public Rights of Way on elevated land overlooking the sites to the south, and to the east of Blisworth, so the geographical extent of visual effects is limited and localised. From such locations, the proposed embedded and adaptive landscape and visual mitigation of screen bunding and planting will be effective in the medium to long term in softening and screening the lower level elements of Rail Central such as acoustic barriers and service yards.

Both schemes propose areas of earth bunding and planting for landscape and visual mitigation. Since the PEIR, Rail Central has sought to refine the Green Infrastructure, ecological and landscape & visual mitigation proposals and has increased the height and extent of earth bunding, and reduced the maximum height of buildings within Zone 3a, to reduce the visual effects of the site. Rail Central is proposing sensitively designed screen bunding with maximum 1:5 gradients to outer facing slopes which takes consideration of existing land form and contouring and avoids an overly engineered appearance. Whereas Northampton Gateway appears to rely on much steeper earth bunds with 1:3 gradients, which are more engineered in appearance and therefore appear incongruous with the existing topography of the site.

In addition, Rail Central has refined its substantial Green Infrastructure, ecological, and landscape & visual mitigation proposals to further respond to local landscape character through the introduction of more regular planting

blocks, particularly to the east of the site, as well as providing: internal estate roads which will have ecological corridors that seek to replicate field edge vegetation with a ditch line and banked hedgerow; retention of existing trees and field edge vegetation where possible; and the use of predominantly native and locally occurring species throughout the scheme. The proposed scheme of Green infrastructure, ecological, and landscape & visual mitigation will also contribute to the strategic biodiversity network habitat reservoirs through the creation of neutral grassland, woodland and calcareous grassland.

The Applicant for Rail Central is providing a fund available to certain residents affected by the Proposed Development, to enable the purchase and planting of trees, or management of existing hedgerows at affected properties. This fund will be secured through a section 106 obligation as part of the DCO application. If this fund is taken up, the introduction of this additional mitigation would have a significant benefit and would reduce adverse effects.

For Rail Central and Northampton Gateway, the introduction and the effectiveness of the proposed embedded mitigation together with and the adaptive mitigation measures, mean that relatively few significant residual visual effects remain in the long term and that the proposed developments can be integrated into the landscape in the medium to long term.

In summary Rail Central and Northampton Gateway give rise to a similar level and significance of landscape and visual effects during both the construction and operational phases and both seek to employ mitigation measures which mean that relatively few significant residual visual effects remain in the long term and that the proposed development can be integrated into the landscape in the medium to long term.

(b) Ecology and Green Infrastructure

The baseline ecological conditions are similar for both Rail Central and Northampton Gateway, as are the predicted impacts. Both schemes consider that their impacts can largely be mitigated, leaving only a few residual minor adverse impacts as well as offering beneficial impacts. The ecological impact assessment for Northampton Gateway indicates that the majority of impacts are not considered to be significant and that the majority of adverse effects will be off-set in the mid- to long-term by the creation and favourable management of ecological habitat. It acknowledges that the loss of arable fields will lead to the unavoidable displacement of some protected farmland birds (the Northampton Gateway site is used by Golden Plovers, whereas the Rail Central site is not). Both schemes will have potential to affect bats, with Northampton Gateway likely to have a greater effect on badgers and GCN, and the Rail Central scheme having a greater effect on barn owl roosts and mature/veteran trees.

Both schemes demonstrate a positive net gain in biodiversity, possible largely because of provision of new habitat that is more valuable than the intensively farmed agricultural land that will be lost. However, Rail Central has undertaken a specific Biodiversity Assessment using the Warwickshire, Coventry and Solihull Biodiversity calculator and following the methods set out in Defra's biodiversity

offsetting pilot which confirms Rail Central delivers a net gain in biodiversity. The GI provision for Rail Central is designed to enhance retained vegetation, and to buffer features that are important for ecology, including the Grand Union Canal to the south. The GI will be augmented by specific adaptive mitigation that requires collaboration with ecological consultants to specifically design the habitat identified in the Illustrative Landscape Plan, so that it complements and reflects the existing local habitats. In addition to the on-site GI provision, Rail Central proposes a dedicated 26ha area for ecology mitigation located at J15a. This is considered to be an advantage over the Northampton Gateway provision where the on-site GI frequently requires habitat to fulfil landscape/screening/productive agricultural roles in addition to biodiversity. While there is loss of veteran trees, it is considered therefore that Rail Central will deliver more green infrastructure and biodiversity gains than Northampton Gateway.

(c) Built Heritage

The Northampton Gateway ES confirms that within a 1km radius of the Main Site, there are 51 listed buildings, three Conservation Areas, and a Registered Park and Garden. The ES notes that the majority of these will not be affected by the development proposals due to a lack of any visual or functional association between them but no visuals or plans are provided to support this. The ES notes that Northampton Gateway will require the demolition of two non-designated barns on the Main Site.

The Northampton Gateway ES confirms that the development will result in no more than a minor impact on the identified listed buildings and conservation areas within proximity to the site. Furthermore, many of the effects have been identified as negligible. This appears to be on an assumption that the proposed bunding will reduce or mitigate the visual effect of the development. However, there is no assessment as to the impacts of the bunding itself which could be considered to affect the heritage assets by creating an incongruous and engineered feature within the landscape. Should this assessment to be included, significant effects on heritage assets may arise.

The ES for the Rail Central scheme assesses all heritage assets within a 2km radius of the site. It confirms that adverse effects will be caused on a limited number of heritage assets as a result of Rail Central. These principally relate to the Milton Malsor Conservation Area (as a result of the Main SRFI Site) together with the Grand Union Canal Conservation Area (as a result of the highway works). The ES for Rail Central concludes moderate adverse effects on 3 (out of 203 assessed) heritage assets which are considered to be affected by the scheme, together with lower/ less significant effects to a limited number of other heritage assets. With the exception of one, these effects are indirect. This takes into account the effect of the Rail Central bunding unlike the Northampton Gateway ES.

Both schemes affect heritage assets within their immediate vicinity but due to their differing locations, different assets would be affected. The Rail Central

scheme has been robustly assessed and is supported by plans and visuals which help illustrate the level of effects identified. However, the level of effect for Northampton Gateway is potentially understated due to the lack of supporting assessment, plans and visuals within the ES Chapter.

(d) Agriculture

Northampton Gateway would affect approximately 220ha. All of this would be lost except 24ha of land which would be retained as agricultural land. Of the agricultural land to be lost, 33ha (12%) is best and most versatile (BMV) land in Grades 2 and 3a, with the remainder classified as moderate quality Subgrade 3b. This loss is assessed as a moderate adverse effect. Rail Central would involve 298ha of agricultural land, of which 89ha (30%) is BMV land, which is also considered to result in a moderate adverse effect. The extent of agricultural loss for Rail Central is a result of its size compared to Northampton Gateway but in terms of environmental impact, both result in an impact which is considered significant in EIA terms.

(e) Transport

Based on information contained within the Northampton Gateway DCO submission, the site is forecast to result in a total of 1,044 two-way vehicle movements during the AM peak hour and 1,303 two-way vehicle movements during the PM peak hour.

In comparison, Rail Central is forecast to result in a total of 1,233 two-way vehicle movements during the AM peak hour and 1,566 two-way vehicle movements during the PM peak hour. Therefore, in general terms, it can be seen that Rail Central is likely to result in a higher trip generation than Northampton Gateway. This is due to the fact that Rail Central is a larger scheme than Northampton Gateway.

The proposed mitigation associated with Rail Central is appropriate to minimise the impact of the proposals. From the information submitted as part of the DCO application, the impact of Northampton Gateway on the local highway network is intended to be mitigated.

Both Rail Central and Northampton Gateway traffic analyses have been carried out based on study areas agreed as appropriate with Highways England and Northamptonshire County Council, with capacity assessments carried out to determine where highway improvements may be appropriate. The highway improvement strategy for Rail Central includes capacity improvements at eight locations on the strategic and principal road network (including major improvements at M1 J15A), along with two road safety improvements on the A43 and a proposed foot/cycleway along Northampton Road.

In comparison, Northampton Gateway's highway improvements include major improvements at M1 Junction 15 (including improvements along the A45 and A508 approaches) and a new bypass at Roade. There are also more minor works proposed at M1 J15A, two locations on Knock Lane and 3 locations on the A508,

along with a new foot/cycleway along the A508 and further financial contributions towards other junction improvements.

Overall, the highway improvements proposed as part of Rail Central are more significant than those proposed as part of Northampton Gateway. However, this reflects the larger scale of Rail Central, and as set out in their respective assessments, both schemes are forecast to result in a net benefit to the overall operation of the highway network.

9.142 Overall, despite Rail Central delivering significantly more floorspace, both SRFI schemes have environmental impacts of a similar scale, albeit with different types of effects at different receptors. In addition, both of the proposals seek to mitigate environmental impacts to ensure they are reduced to an acceptable level.

9.143 It is also relevant to consider both schemes in respect of the operational and technical aspects being proposed within each SRFI proposal.

9.144 The table below (Table 9.2) presents a number of key differences between Rail Central and Northampton Gateway. Rail Central offers significantly more commercial floorspace than Northampton Gateway, it is also anticipated to generate more jobs (over 8,000) and generates greater economic benefits. Rail Central also provides direct access to two W10 railway lines and full connectivity between them. This enhanced flexibility and resilience in its infrastructure puts Rail Central at a distinct advantage. The Rail Central Express Freight Interchange will allow direct and quick access as opposed to Northampton Gateway which requires more time due to the need to shunt freight within the site. This will make other operations within the Northampton Gateway scheme less efficient than Rail Central. Rail Central also provides a range of additional facilities which aid the attractiveness of the SRFI as well as providing positive consequences to the efficiency of the rail network.

Table 9.2: Rail Central and Northampton Gateway Operational Comparison

	Rail Central	Northampton Gateway
Rail Connections	Rail Central has 4 main line access points onto two separate branches of the WCML (Fast and Slow Lines).	2 main line access points onto one branch of the WCML (Slow Lines).
Rail Inter-Connectivity	Full electrified inter-connectivity provided between WCML Fast and Slow Lines, maximising direct routeing opportunities to and from site onto the main line. This also enables main line access to be maintained throughout when either the WCML Fast Line or Slow Line is closed for maintenance (up to 27 separate occurrences per annum).	No direct interconnectivity provided between WCML Fast and Slow lines, access to Fast lines available via at-grade crossings 4 miles to the south (Hanslope Junction) and 20 miles to the north (Hillmorton Junction) Northampton Gateway would lose main line access in the event of maintenance activity blocking access to both main line

		connections on the Slow Lines.
Intermodal Terminal	Prior to first occupation, sufficient infrastructure will be constructed to enable the intermodal terminal to serve at least four trains per day. The phased expansion of the intermodal terminal will then take place in accordance with meeting demand and rail freight traffic growth. This approach was successfully utilised at Hams Hall SRFI which delivered its intermodal terminal in phases with each phase added in response to demand and traffic growth. The development of iPort SRFI is also being delivered in phases.	Rail Terminal will be constructed prior to first occupation of any development.
Overall Commercial Floorspace	702,097 sqm (GEA)[50]	468,000 sqm (GIA) plus 155,000 sqm in the form of mezzanines
Trains per day and capacity for growth	First phase of rail operations with 4 trains per day in and out of site, growing commensurate with warehousing and interchange facilities. The GB Freight Model (used in NR Freight Market Study as endorsed by the NN NPS) indicates that 7.4m sqft of floorspace would generate the equivalent of 13 intermodal trains per day in and out of site.	Rail Operation Report suggests that 4 trains per day each way will be achieved growing to up to 16 trains per day as the critical mass of development grows. However, this may be overstated because on a like-for-like comparison, the GB Freight Model output suggests the equivalent level of rail freight traffic from 5m sqft of floorspace would be 9 trains per day in and out of the site.
Rail Connected Floorspace	Approximately 179,250 sqm (GEA) would be rail connected. The level of rail-connected warehousing at SRFIs varies considerably from no provision at Hams Hall SRFI, iPort Doncaster,	The illustrative masterplan confirms that Units 4 – 7 could be rail connected. This would equate to 303,143 sqm (GIA)

[50] In preparing the DCO application, the Applicant for the Rail Central site has taken the view that it is appropriate to use Gross External Area (GEA) as a parameter. The maximum area that could be achieved from the development is set out on the Parameters Plan. Northampton Gateway which has taken a different approach for their submission, using Gross Internal Area (GIA). This approach provides maximum flexibility with regards to building out the development as the requirements of each occupier will vary.

	East Midlands Gateway and Howbury Park; limited provision at Mossend, 3MG and BIRFT; and greater provision at DIRFT and Northampton Gateway. Providing a diversity of SRFI facilities in functional terms will help maximise choice to occupiers.	
Electrification	Electrification is proposed from the outset of the development in agreement with Network Rail.	Electrification is proposed from the outset of the development.
Express Freight Terminal	Rail Central has direct and dedicated electrified access on WCML (Fast Lines) for express freight trains, allowing trains to arrive and depart in either or both directions with no intermediate shunting. Internal electrified access to the WCML Slow Lines provides continuity of access when the Fast Lines are closed for maintenance. The express freight facility will be delivered in accordance with a programme agreed with Network Rail in order to minimise disruption to rail services. The DCO includes drafting requiring a commitment to including the express rail freight facility, in agreement with Network Rail (Network Rail).	Northampton Gateway requires intermediate shunting of all express freight trains between the main line and the terminal, significantly slowing the processing of trains through the terminal.
Sidings	Rail Central has 10 x 775m sidings available (6 accessible by cranes), plus additional sidings serving the rail-linked warehouse units, express freight terminal and train maintenance depot. Provision of 4 electrified reception sidings (2 on either side of the site plus the interconnecting trackwork) allow for electric trains and multiple units to use the site.	Northampton Gateway has 6 x 775m sidings (5 accessible by cranes assuming outer line is electrified), plus additional sidings serving the rail-linked warehouse units, express freight terminal and aggregates terminal. Reception sidings assumed to be electrified outside of the intermodal terminal, express freight terminal, warehousing and aggregates terminal.

	In terms of the number of sidings provided, Rail Central has taken the decision to forego floorspace for providing additional space for sidings, to maximise the operational flexibility available to operators, and to provide the capability for future growth as per the NN NPS.	
Other rail-related facilities	Operational Control Room. Rail Central proposes a Train Maintenance Depot allowing trains to be stabled, maintained and fuelled on site rather than at off-site locations. This reduces the need for trains to be moved off site, maximising the efficient use of available mainline capacity. Early engagement with NR identified opportunities to minimise movement of light engines and empty stock to and from remote depots elsewhere on the network, which would be a less efficient use of main line capacity. The Train Maintenance Depot provides a facility enabling train operators to undertake crew changes, servicing and repair of traction and rolling stock without having to leave the site or incur empty running to and from site. This enhances the centralised and integrated suite of rail-related facilities on site and helps make best use of capacity on and off the main line.	Operational Control Room.
Aggregate Rail-head	Not provided. In reviewing the various options for rail freight facilities and services on site, it was concluded that the additional HGV movements and associated dust /	Provided. The proposals for Northampton Gateway make explicit provision for an aggregates terminal within the intermodal terminal area.

	noise which would arise from handling aggregates traffic (up to 200 HGV trips per 2,000 tonne train), plus the pathing of heavier and slower Class 6 aggregate trains on and off the main line, would not be desirable.	
GRIP Feasibility	Network Rail has informed the design of the rail infrastructure and main line connections; the assessment has progressed to GRIP2 validating technical and operational feasibility of the main line connections.	No reference has been provided to any GRIP feasibility work having been undertaken with/by Network Rail.
Transport Access	Direct access onto the A43 (T) and providing connectivity to J15a of the M1. The A43(T) provides an alternative strategic route on the trunk network and connections to the M40 and to surrounding towns such as Towcester.	Direct access onto the A508, providing connectivity to J15 of the M1.
Sustainability	The current proposals for Rail Central exceed that offered by Northampton Gateway. Main commitments/ targets are: Committed to achieving a BREEAM Excellent rating New Buildings will target a 20% reduction in carbon dioxide emissions over Building Regulations Electric vehicle Charging infrastructure	Following completion of a BREEAM 2018 Design and Procurement Pre-Assessment, the scheme currently achieves a translatable BREEAM 'Very Good' rating. In respect of sustainability, very little in the way of deliverables are committed to. It is however noted that Solar PV systems could be incorporated within the development. This could include the provision of Battery Energy Storage System (BESS), which could provide an energy supply for electric vehicles to operate on the site. The buildings are aiming to deliver a 9% improvement over current Building Regulations.
Road to Rail	In the road-only comparator scenario, the annual distance travelled by HGV across the road network equates to 263,550,000 HGV.km. With the Rail Central SRFI fully operational, this reduces to	No reference to or assessment of GHG emissions in the assessment of likely significant effects associated with the construction or operational phases of the proposed development is carried out in the DCO submission.

	210,605,000 HGV.km per year, saving of circa 52.95 million HGV.km per year, and equivalent to a 20.1% reduction.	
Economic Benefits	Estimated 8,090 gross full time equivalent (FTE) jobs. This takes account of: The lower employment densities typically seen in rail-connected warehouses, due to the need to accommodate rail infrastructure; and The absence of detailed design and layout information at the current point in time, with internal arrangements dependent upon the operational requirements of the end user.	Estimated 7,400 FTE jobs accommodated through provision of 623,000sqm floorspace. This takes account of: The proposed mezzanine, albeit a lower employment density has been assumed for this space (155,000sqm).

9.145 The other difference between these two sites is their distance to the strategic highway network. Whilst Northampton Gateway is closer to J15 than Rail Central is to J15a, the differences in distance are very limited (J15 is located directly adjacent to the Northampton Gateway site and Rail Central is within 2km from Junction 15a) and in practical terms both sites have good connections to the strategic road network. Both routes are on higher class roads and will not involve passing through residential communities. However, Rail Central is positioned on the A43 (T) and benefits from significant highway resilience offering alternative access arrangements if necessary.

9.146 Bringing all the analysis together, Rail Central is larger than Northampton Gateway in commercial terms and has the ability to connect to the WCML, as well as the NLL. Along with additional facilities such as the Train Maintenance Deport, this presents additional market, operational and technical advantages over Northampton Gateway which makes Rail Central more resilient, flexible and more adaptable to the changing rail freight market. Therefore, it is concluded that the Rail Central site is the better performing SRFI site. However, it is recognised that Northampton Gateway is being formally pursued in addition to the Rail Central site. Both schemes could contribute towards creating a network of SRFIs and the clustering of such infrastructure in this particular location. This scenario has therefore been the subject of cumulative impact assessment in the ES.

10. Overview and Conclusions

10.1 The NN NPS is clear that the Government has concluded there is a compelling need for an expanded network of SRFIs and not having such a network is not an option. In that context, this assessment has applied several distinct stages of work to identify possible alternative SRFI sites across a broad search area. It has employed a sieve mapping technique using a GIS system over the East and West Midlands. This was used to identify sites with good rail access, close to motorway junctions and with very few environmental constraints.

10.2 The sites were then scored using a common scoring matrix, which was designed to identify the best performing potential rail freight sites. The scoring prioritised factors including proximity to motorways, access to high gauge rail lines, local access routes, site levels, shape, size and proximity to sensitive land uses.

10.3 Further sites not identified in the screening exercise but which have been suggested by local representation or short listed in other similar studies were included in the analysis and scored using the same matrix.

10.4 The scores achieved by each of the sites identified were then reviewed and the highest scoring sites selected for comparative analysis. This process was subjective and focussed around the topics identified as important in the scoring matrix. The comparative analysis not only assesses the locations in terms of SRFI operations and environmental impacts, but also concludes with an understanding of the possible role each site would perform in operating as a network of SRFI facilities as required by the NN NPS.

10.5 The assessment has demonstrated that, despite the large area of search, the development opportunities for SRFI proposals are limited. A total of 25 locations were identified as satisfying key SRFI characteristics as defined by the NN NPS. Of these, only five locations (20%) present realistic SRFI opportunities and were identified for further comparative analysis. Within this context, it is not surprising, therefore, that four of the five alternative sites assessed for further comparative analysis are the subject of on-going DCO applications for SRFI proposals and each has the potential to provide SRFI facilities.

10.6 Indeed, this in itself demonstrates the rigour of the assessment methodology and is a reflection of the East and West Midlands being a significant area of developer interest to deliver a network of SRFI to meet burgeoning demand. It is also reflective of the NN NPS which makes it clear that it is for the market to determine the viability of particular proposals. All shortlisted sites comprise greenfield and all would result in the loss of agricultural land with associated biodiversity effects. Comparison of environmental benefits is difficult due to the size and scale of SRFI development and the individual nature of each candidate site. Each give rise to environmental effects of similar scales, albeit with different effects across different disciplines and at different receptors. It is not the case that one site is clearly preferable to another, in terms of development effects. It is important to note that the delivery of a single additional SRFI will not meet the objectives of government policy nor does the NN NPS require applicants to

demonstrate that their sites are the best available alternatives. Indeed, where the NN NPS policy tests are met, it would be appropriate for all sites to come forward to fully respond to Government policy to assist in creating the network of SRFIs needed.

10.7 Overall, therefore, it is the conclusion of this assessment that there are very limited SRFI opportunities within the broad search area. Comparisons of environmental impacts are difficult, due to the contrasting scale of each site and the different impacts which arise as a result. None of the other sites, however, creates development opportunities with clear environmental, operational or market benefits equivalent to Rail Central.

10.8 Four of the five sites which present realistic development SRFI opportunities are the subject of developer interest and are being pursued through the DCO process. Three of these locations would serve different areas of the Midlands (and potentially beyond) and do not present realistic alternatives. They would, however, provide complementary facilities to Rail Central and expand the SRFI network as required by the NN NPS with the overriding objective of securing access to the rail network and fostering the transfer of freight from road to rail to support economic growth in an environmentally responsible manner.

10.9 The study concludes that there are two clear top performing sites – Rail Central and Northampton Gateway that would seek to serve broadly the same core catchment area. They score the same using the scoring matrix but there are differences in performance between these two sites which allow them to be distinguished.

10.10 Northampton Gateway has very good access to the strategic road network. However, whilst it is closer to the motorway than Rail Central, this in itself is not a major distinguishing factor between these two sites. Environmental impacts are comparable albeit each project results in different effects at different receptors. Rail Central does however, have the ability to directly connect to the WCML, as well as the NLL and this presents, along with its additional infrastructure, enhanced operational and technical advantages over Northampton Gateway which make it more resilient, flexible and more adaptable to the changing rail freight market.

10.11 On this basis, it is concluded that the Rail Central site is the better performing SRFI site. However, it is recognised that Northampton Gateway to be consented in addition to Rail Central. Northampton Gateway could also be complementary to Rail Central and, along with Rail Central, could contribute to the required network of SRFI's. This scenario with Northampton Gateway also being consented and delivered has therefore been the subject of cumulative impact assessment in the Rail Central ES.

Appendix 1: Plan 1 – Catchment Area

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Rail Central Site

Region

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 1 - Catchment Area

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

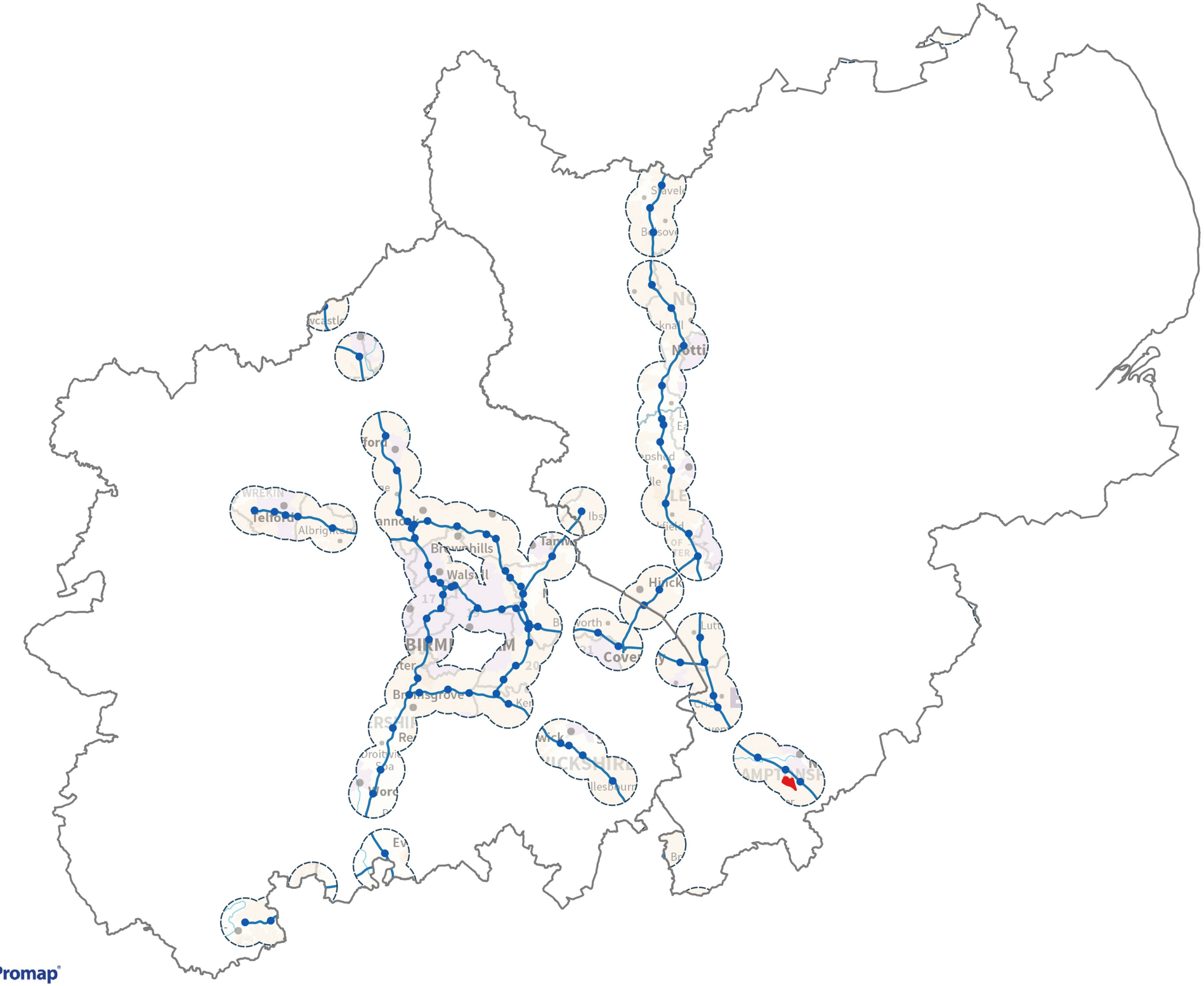
Drawing Number:
3002_101

Date:
22_11_2016

Revision:
1.2

Turley

Appendix 2: Plan 2 – Motorway Junction Buffer



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Rail Central Site

Region

Motorways (OS Open Data)

Junctions

5k Buffer from Motorway Junction

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 2 - Areas within 5km of a Motorway Junction

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_101

Date:
22_11_2016

Revision:
1.2

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Appendix 3: Plan 3 – Railways within Motorway Junctions

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Rail Central Site

Region

Railway

5k Buffer from Motorway Junction

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 3 Railway line overlay

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_102

Date:
22_11_2016

Revision:
1.2

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Appendix 4: Plan 4 – W8 Gauge Railways and Above

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Rail Central Site

Region

W8 / W10 / W12 Gauge

Area for Site Search

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 4 - W8 Gauge and above

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_104

Date:
22_11_2016

Revision:
1.3

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Appendix 5: Plan 5 – Key Environmental Designations

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- Rail Central Site
- Region
- Flood Zone 2
- Flood Zone 3
- Key Environmental Designations
- Search Area
- Rail Gauge W8 and above / Greater than 795m

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 5 - Key Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_105

Date:
22_11_2016

Revision:
1.2

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Appendix 6: Plan 6 – Excluding Environmental Designations

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Excluded Environmental Designations (White Areas)

Rail Central Site

Region

Search Area

Rail Gauge W8 and above / Greater than 795m

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 6 - Excluding Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_106

Date:
22_11_2016

Revision:
1.1

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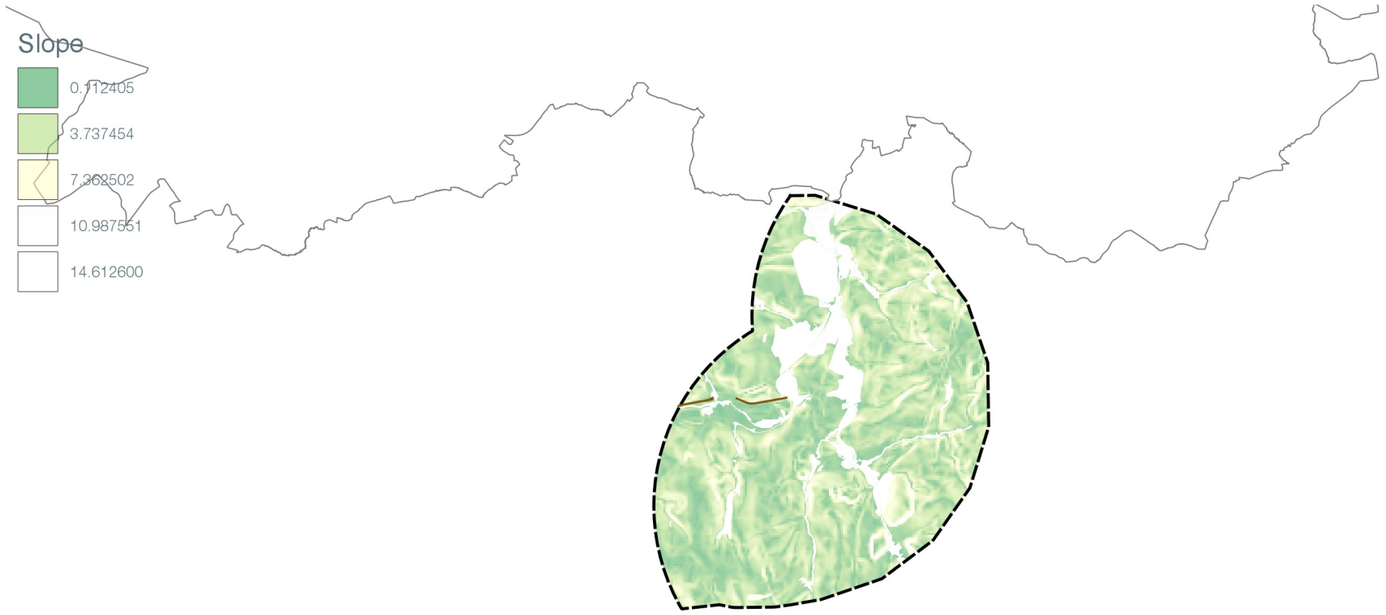
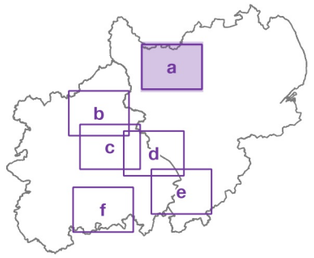
Appendix 7: Plans 6a – 6f – Excluding Environmental Designations





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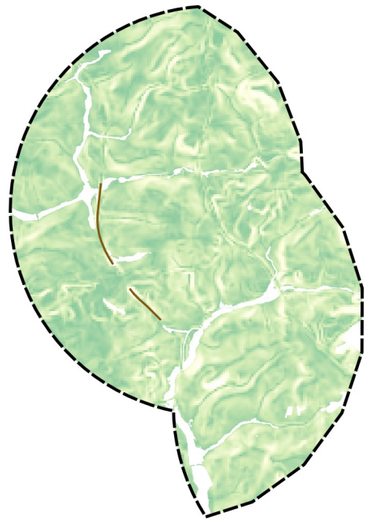
Excluded Environmental Designations (White Areas)

Search Area

Region

Rail Gauge W8 and above / Greater than 795m



Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 6a - Key Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_106

Date:
22_11_2016

Revision:
1.1

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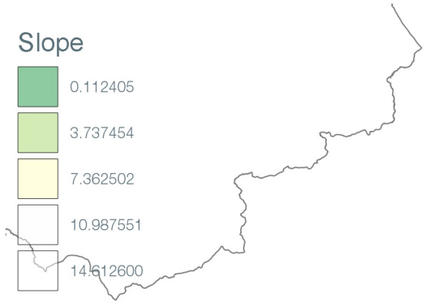
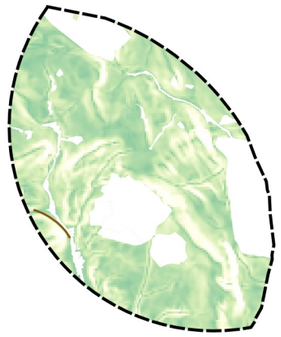
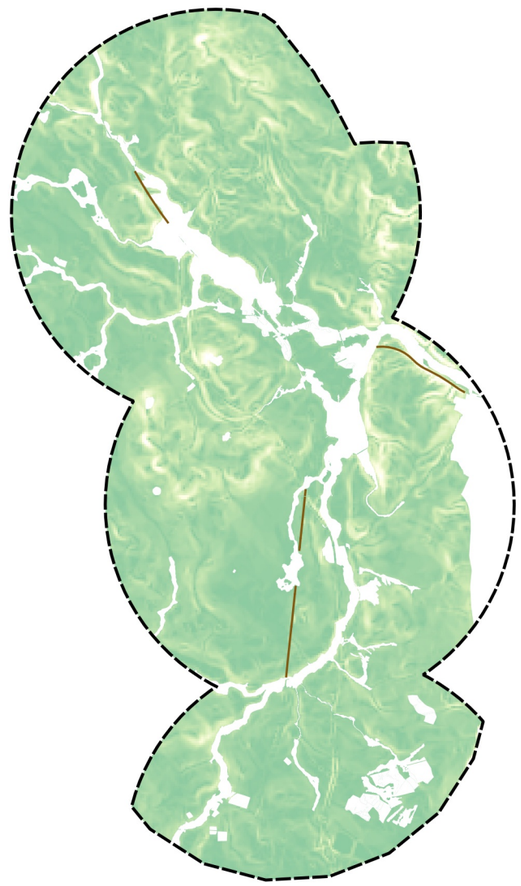
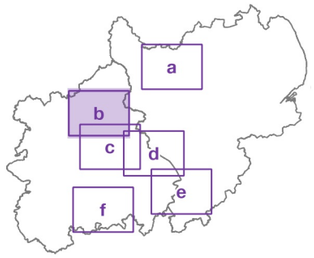
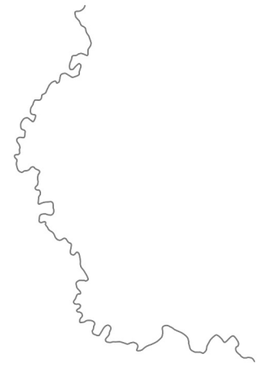
Turley











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Excluded Environmental Designations (White Areas)

Search Area

Region

Rail Gauge W8 and above / Greater than 795m

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 6b - Key Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_106

Date:
22_11_2016

Revision:
1.1

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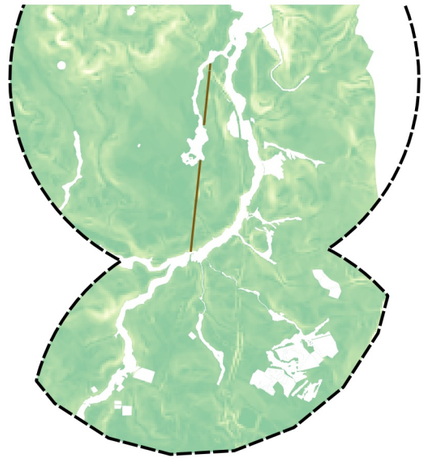
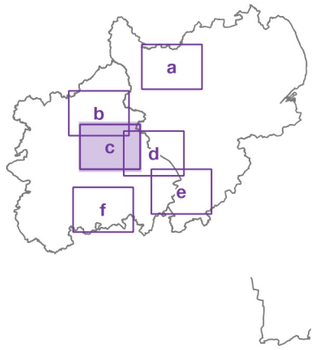
Slope

- 0.112405
- 3.737454
- 7.362502
- 10.987551
- 14.612600





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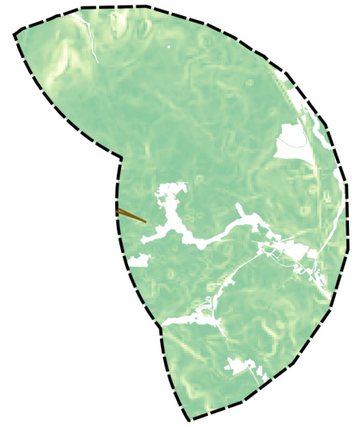
Excluded Environmental Designations (White Areas)

Search Area

Region

Rail Gauge W8 and above / Greater than 795m



Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 6c - Key Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_106

Date:
22_11_2016

Revision:
1.1

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Slope

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- 10.987551
- 14.612600

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Excluded Environmental Designations (White Areas)

Search Area

Region

Rail Gauge W8 and above / Greater than 795m

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 6d - Key Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_106

Date:
22_11_2016

Revision:
1.1

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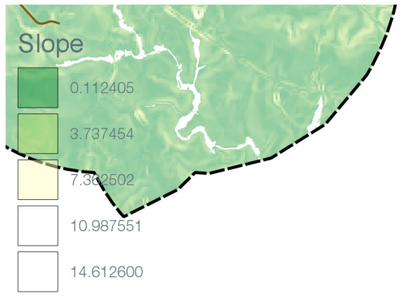

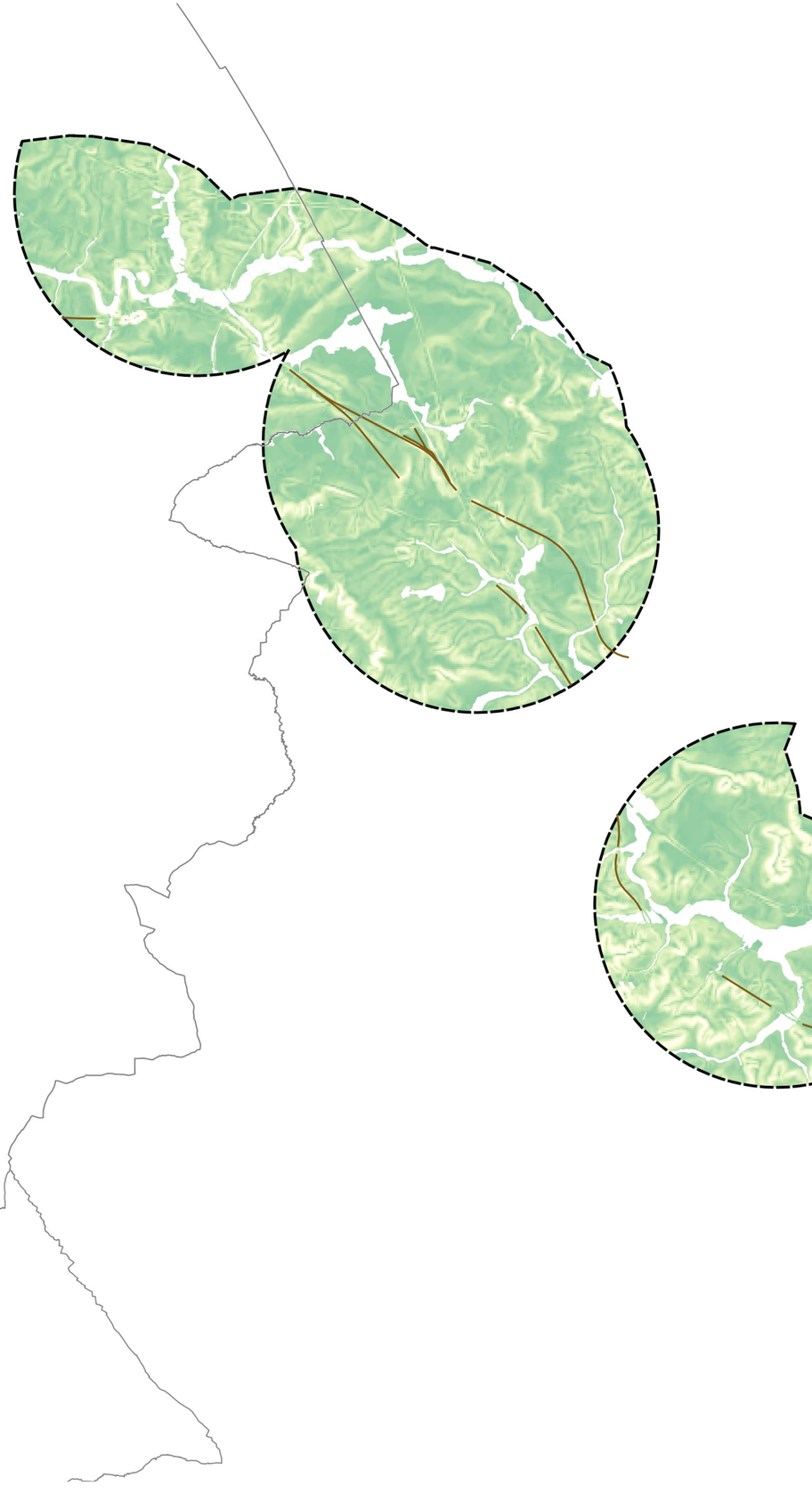

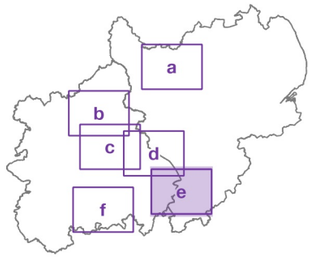

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Excluded Environmental Designations (White Areas)

Search Area

Rail Central Site

Region

Rail Gauge W8 and above / Greater than 795m

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 6e - Key Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_106

Date:
22_11_2016

Revision:
1.1

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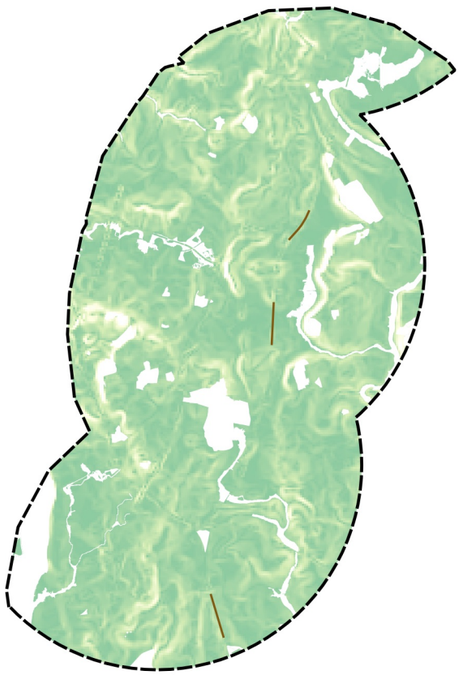
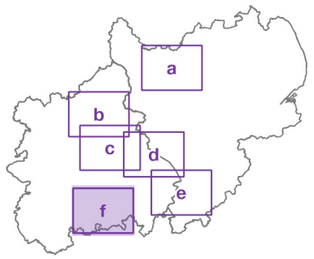
Slope

- 0.112405
- 3.737454
- 7.362502
- 10.987551
- 14.612600





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Excluded Environmental Designations (White Areas)

Search Area

Region

Rail Gauge W8 and above / Greater than 795m

Client:
Ashfield Land Management Limited and Gazeley GLP Northampton s.à.r.l.

Project:
Rail Central

Drawing:
Plan 6f - Key Environmental Designations

Scale:
NTS@A3

Status:
Draft

Project Number:
ASHA3002

Drawing Number:
3002_106

Date:
22_11_2016

Revision:
1.1

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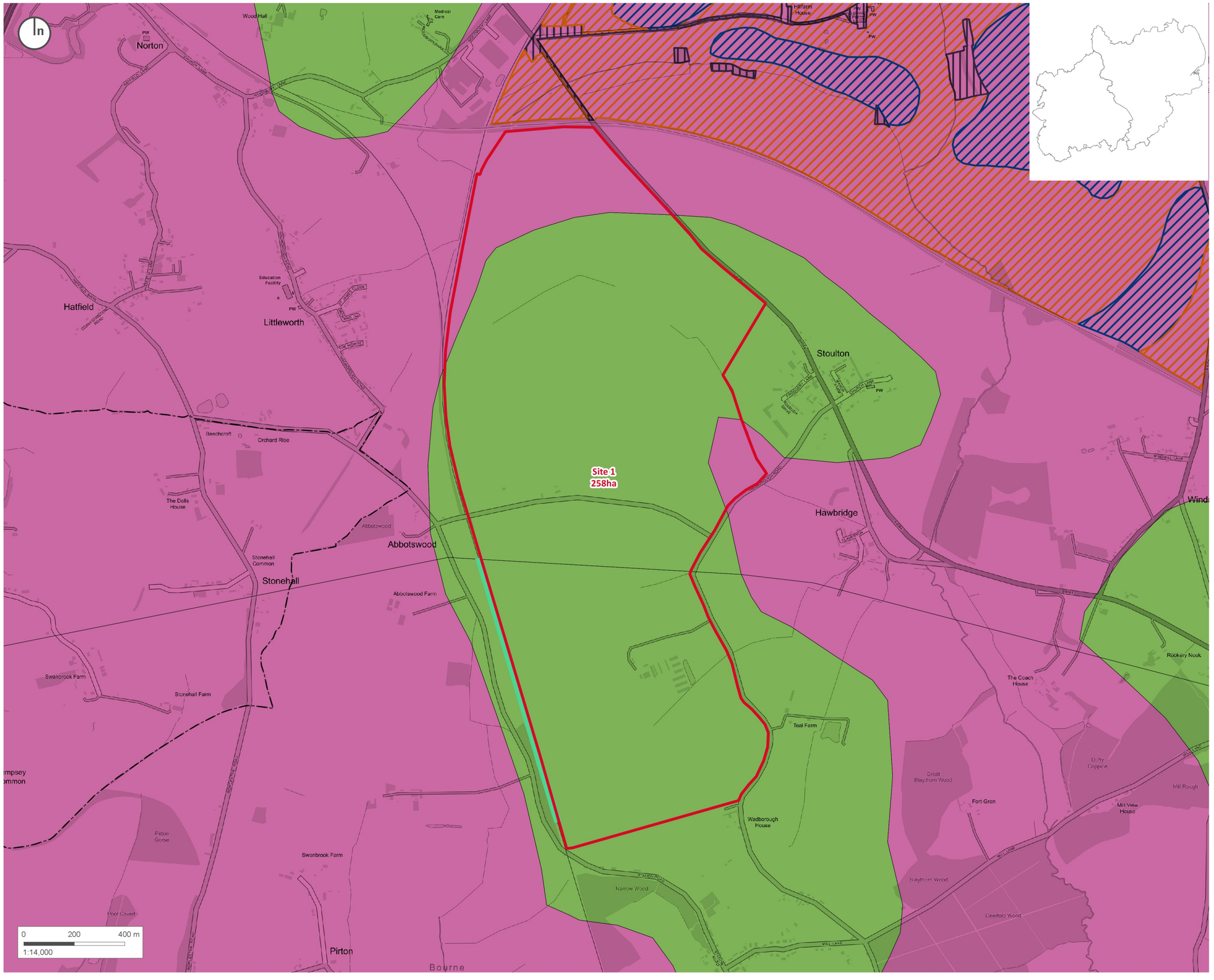
Turley

Appendix 8: Plans 7-1 to 7-25 Agricultural Land Classification



Alternative Site

Rail Gauge

W8

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

ALC- sub

Grade 3a

Grade 3b

Other

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 1
Wadborough Park Farm, near Stoulton, Worcestershire
Site Area - 258ha

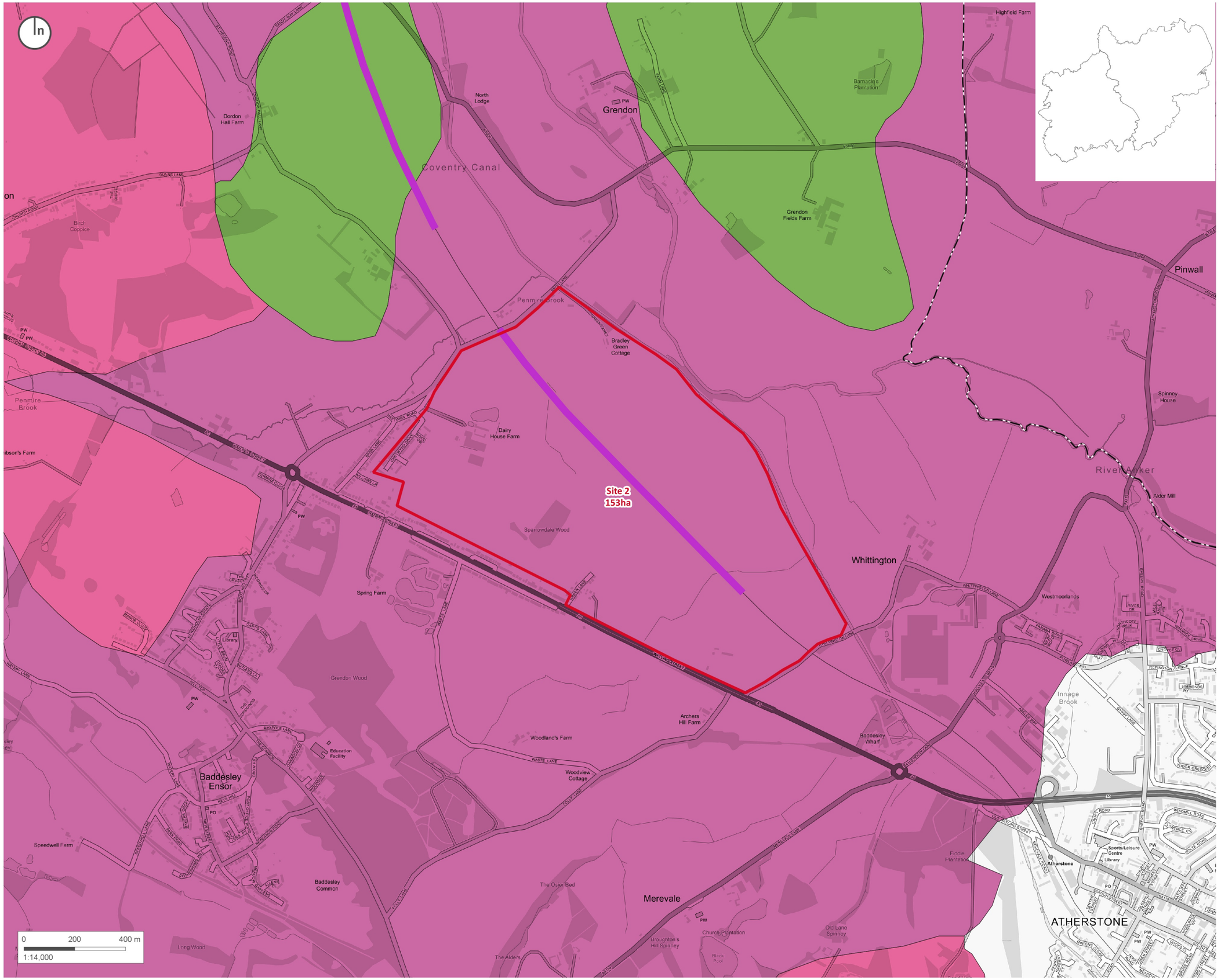
Figure No.
3002_108_(ALC) Plan 7-1

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

- Grade 2
- Grade 3
- Grade 4
- Urban

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 2 Dairy House Farm, Grendon, near Tamworth Site Area - 153ha

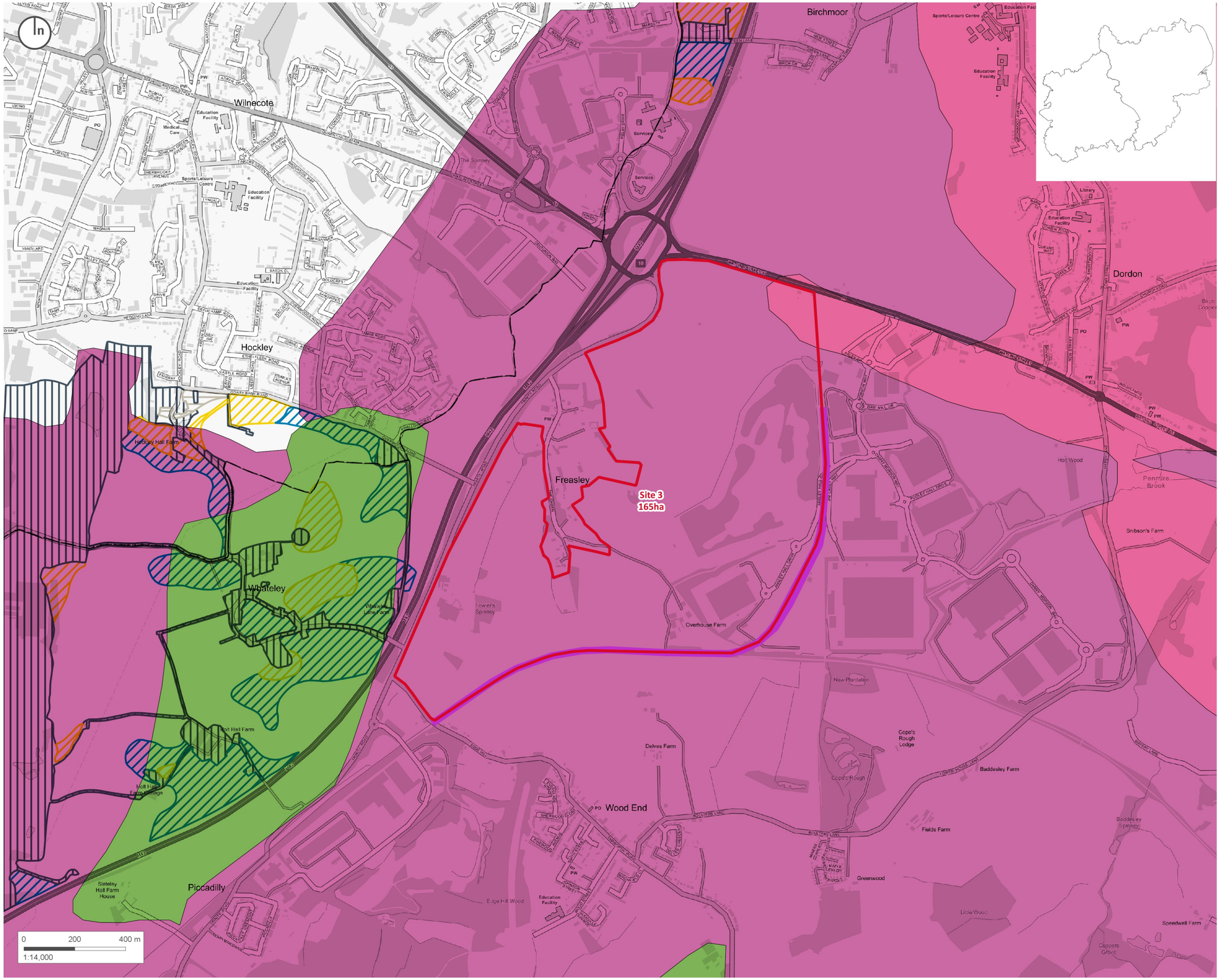
Figure No.
3002_108_(ALC) Plan 7-2

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

- Grade 2
- Grade 3
- Grade 4
- Urban

ALC- sub

- Grade 3a
- Grade 3b
- Not Surveyed
- Other

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 3 Land adjacent to Birch Coppice, near Tamworth
Site Area - 165ha

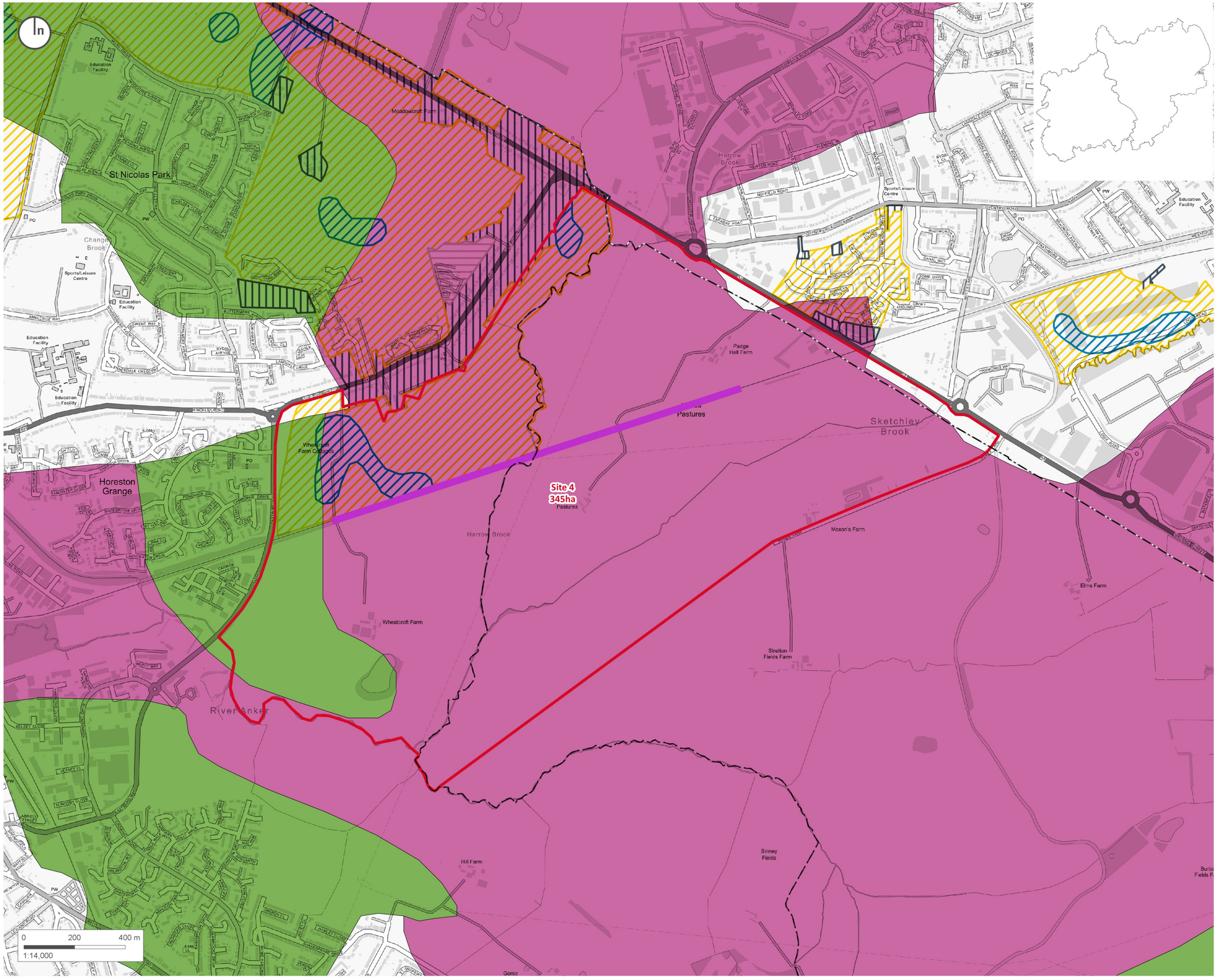
Figure No.
3002_108_(ALC) Plan 7-3

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Urban

ALC- sub

Grade 3a

Grade 3b

Not Surveyed

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 4 Land between Hinckley and Nuneaton Site Area - 345ha

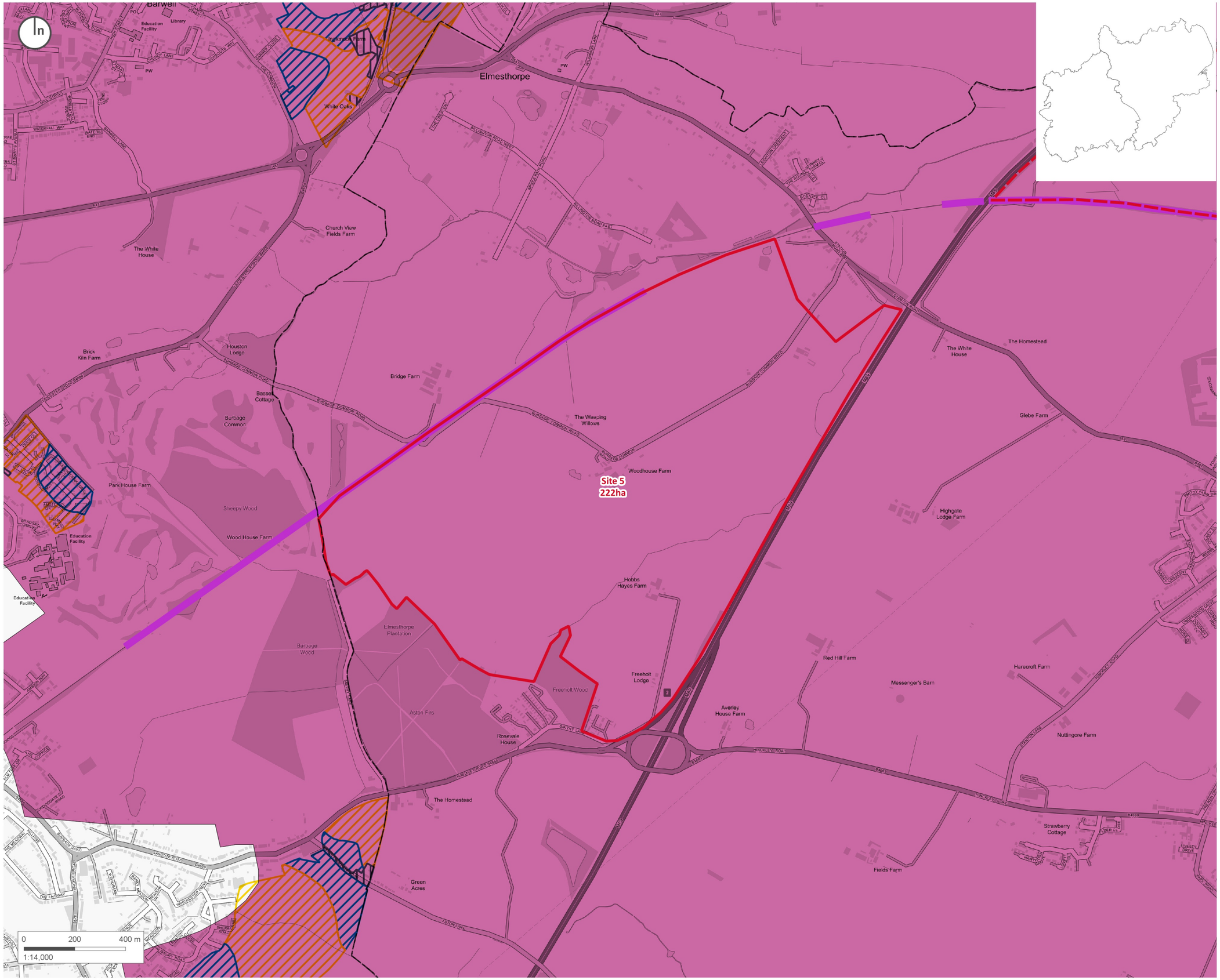
Figure No.
3002_108_(ALC) Plan 7-4

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 3

Urban

ALC- sub

Grade 3a

Grade 3b

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 5
Land at Burbage Common, Hinckley
Site Area - 222ha

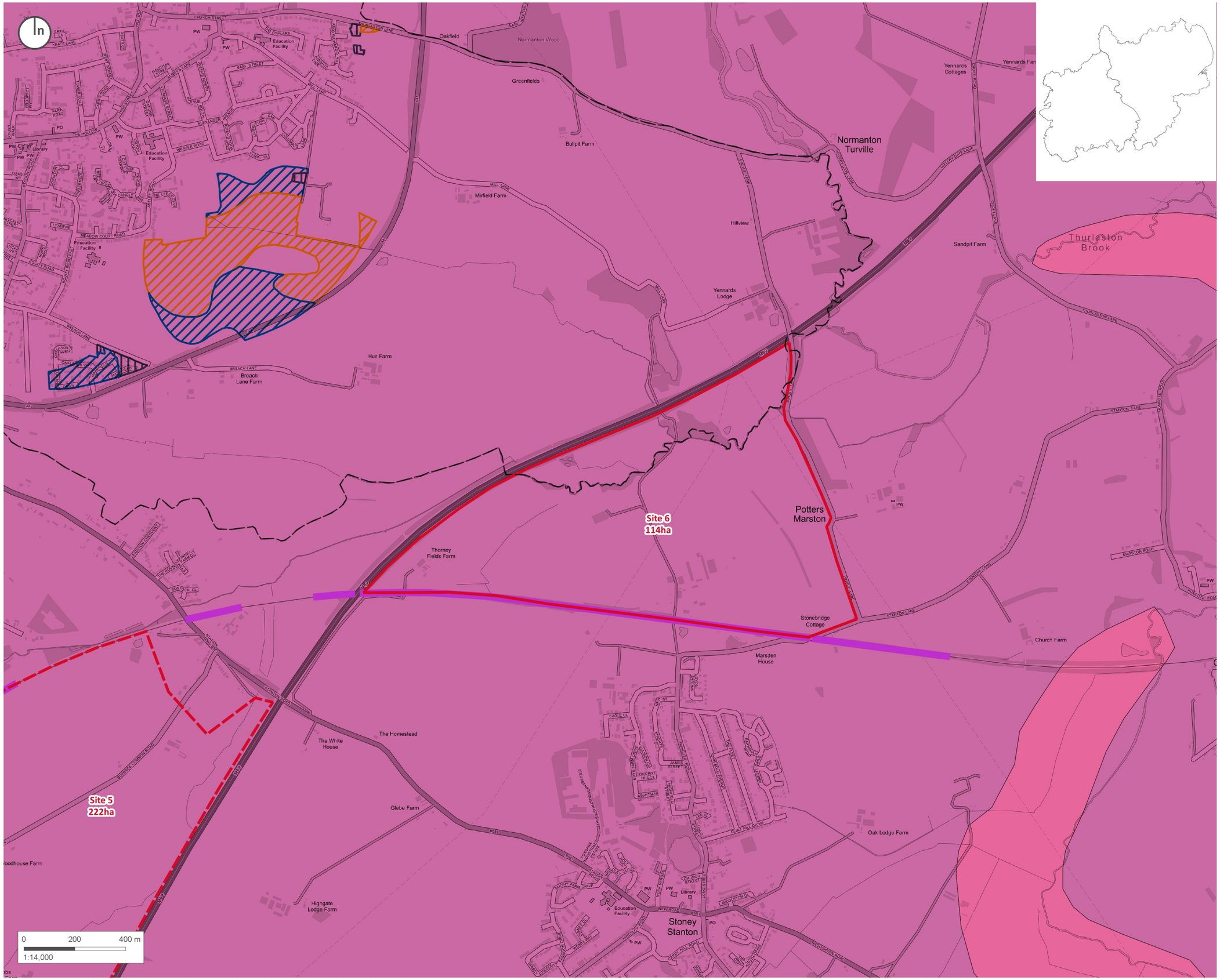
Figure No.
3002_108_(ALC) Plan 7-5

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 3

Grade 4

ALC- sub

Grade 3a

Grade 3b

Other

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 6
Land at Potters Marston
Site Area - 114ha

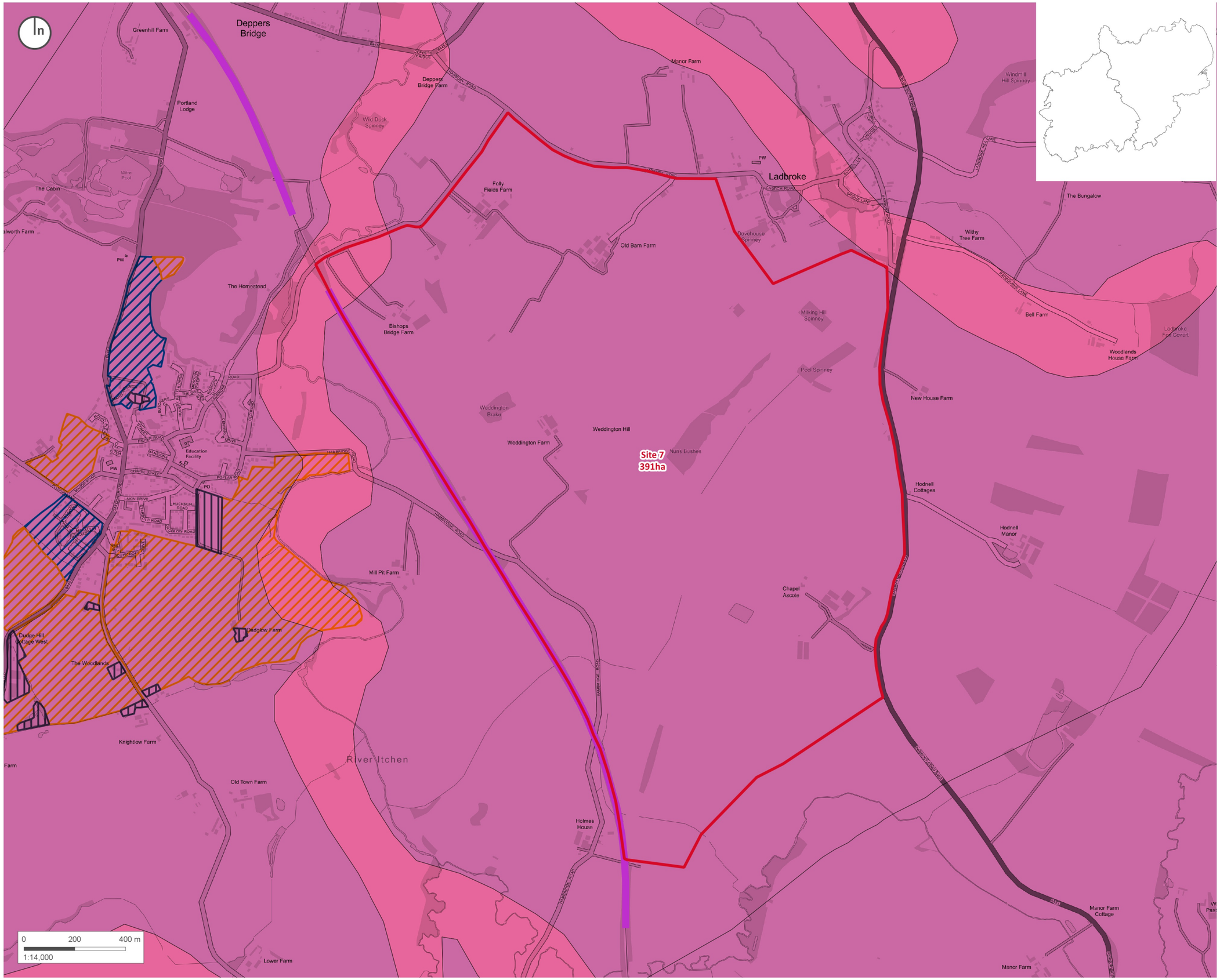
Figure No.
3002_108_(ALC) Plan 7-6

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 3

Grade 4

ALC- sub

Grade 3a

Grade 3b

Other

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 7
Land between Ladbroke and Bishops Itchington
Site Area - 391ha

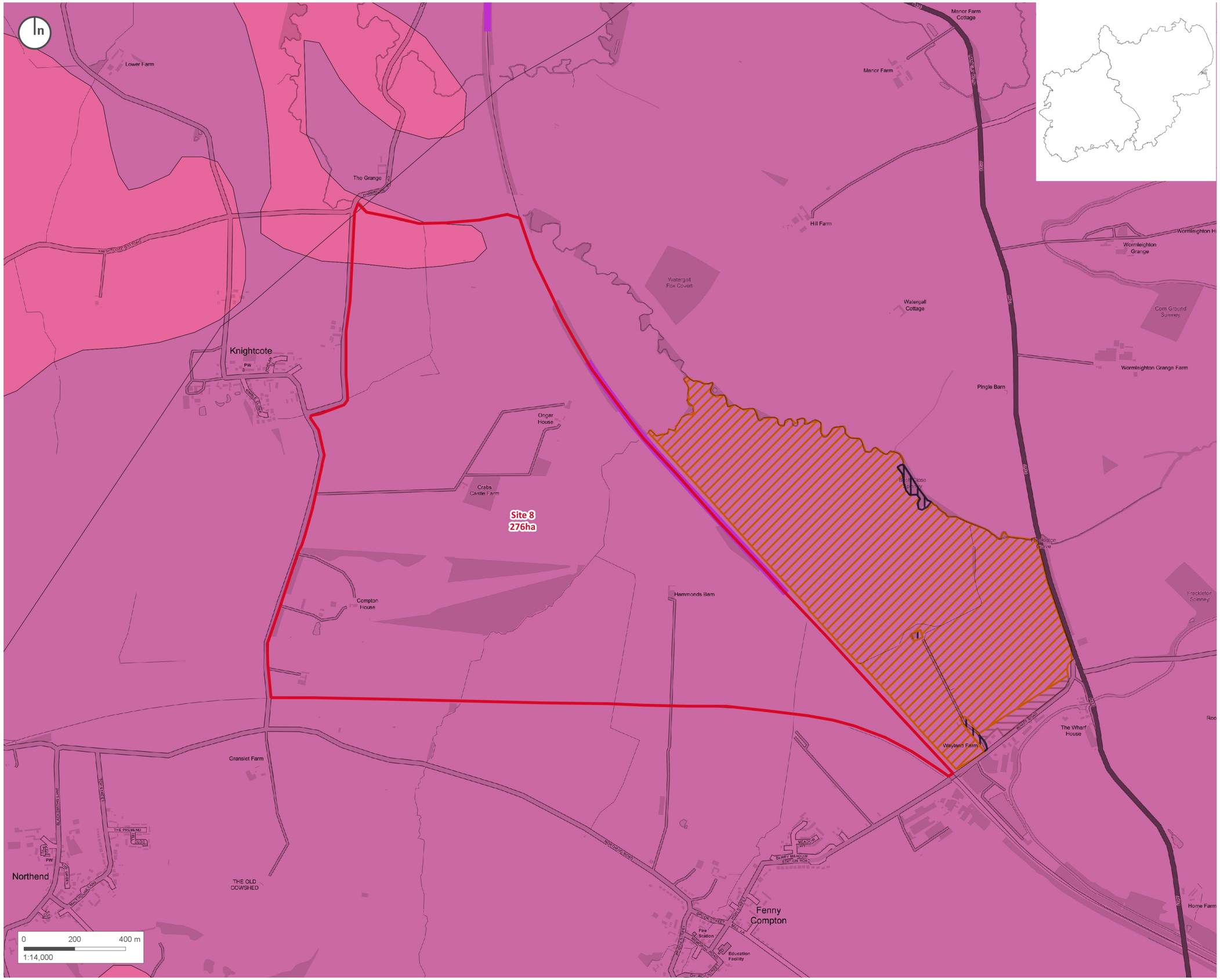
Figure No.
3002_108_(ALC) Plan 7-7

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 3

Grade 4

ALC- sub

Grade 3b

Not Surveyed

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 8 Land between Knightcote and Fenny Compton Site Area - 276ha

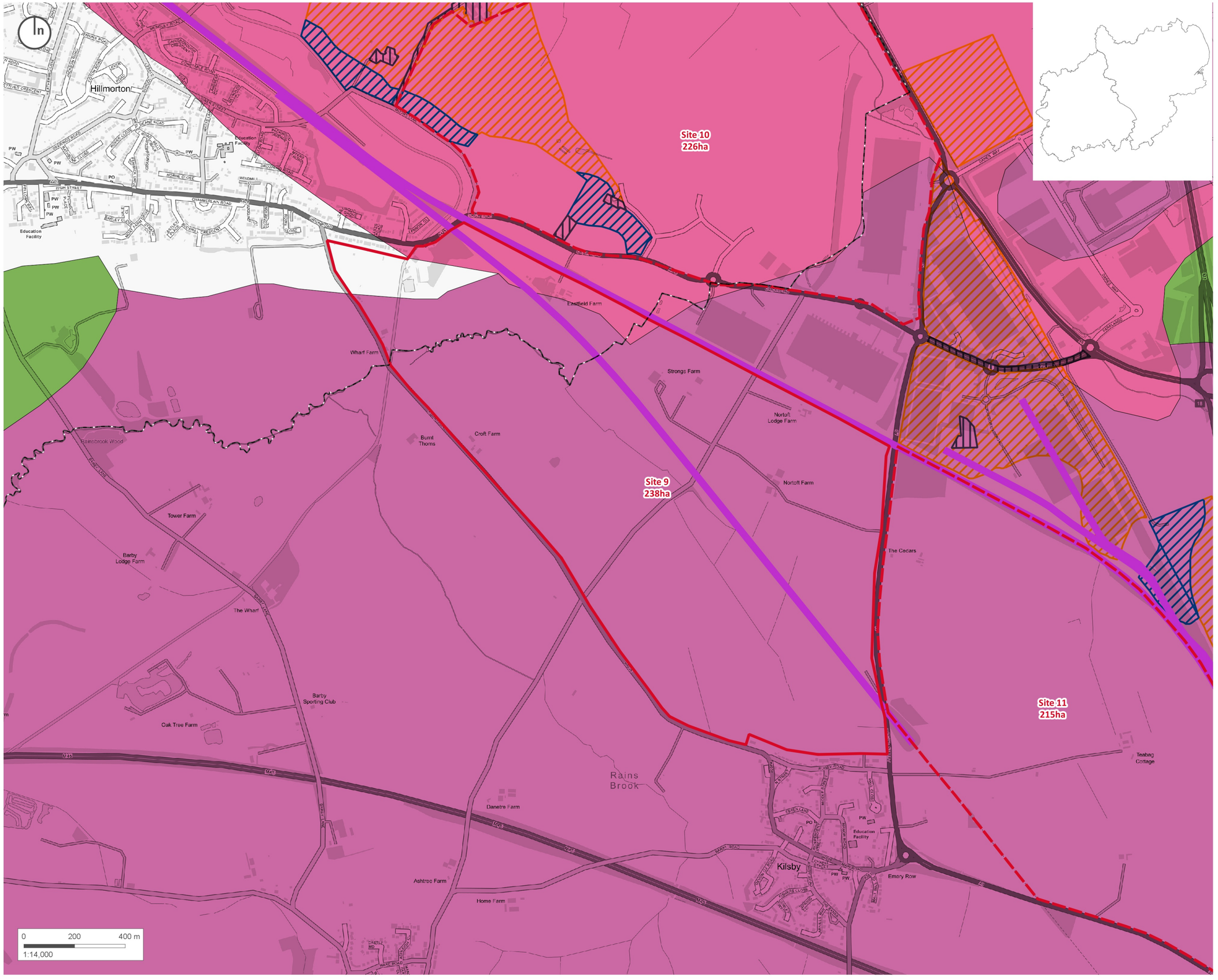
Figure No.
3002_108_(ALC) Plan 7-8

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Grade 4

Urban

ALC- sub

Grade 3a

Grade 3b

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 9 Kilsby North
Site Area - 238ha

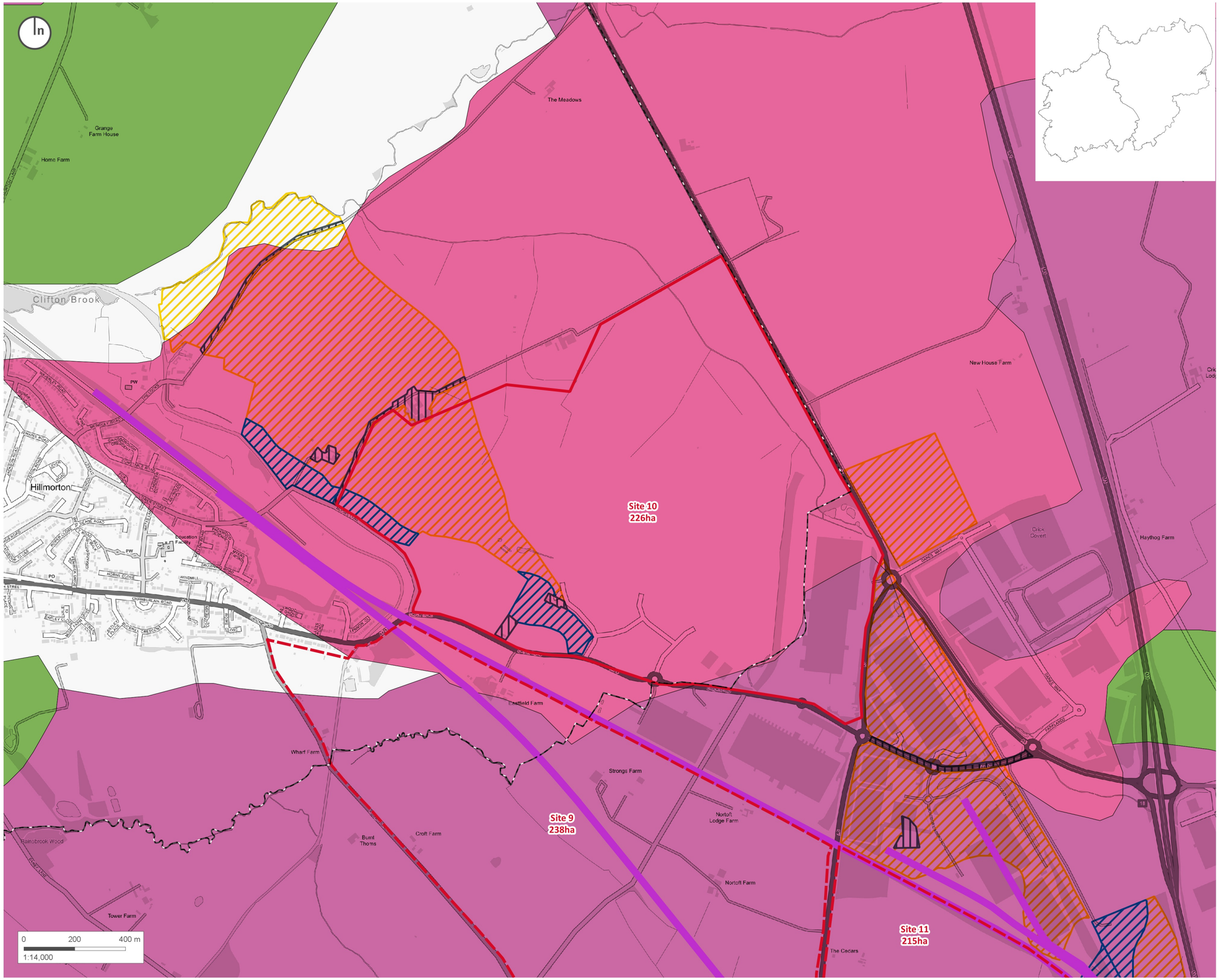
Figure No.
3002_108_(ALC) Plan 7-9

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Grade 4

Urban

ALC- sub

Grade 3a

Grade 3b

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 10
Part of Rugby Radio Station West
Site Area - 226ha

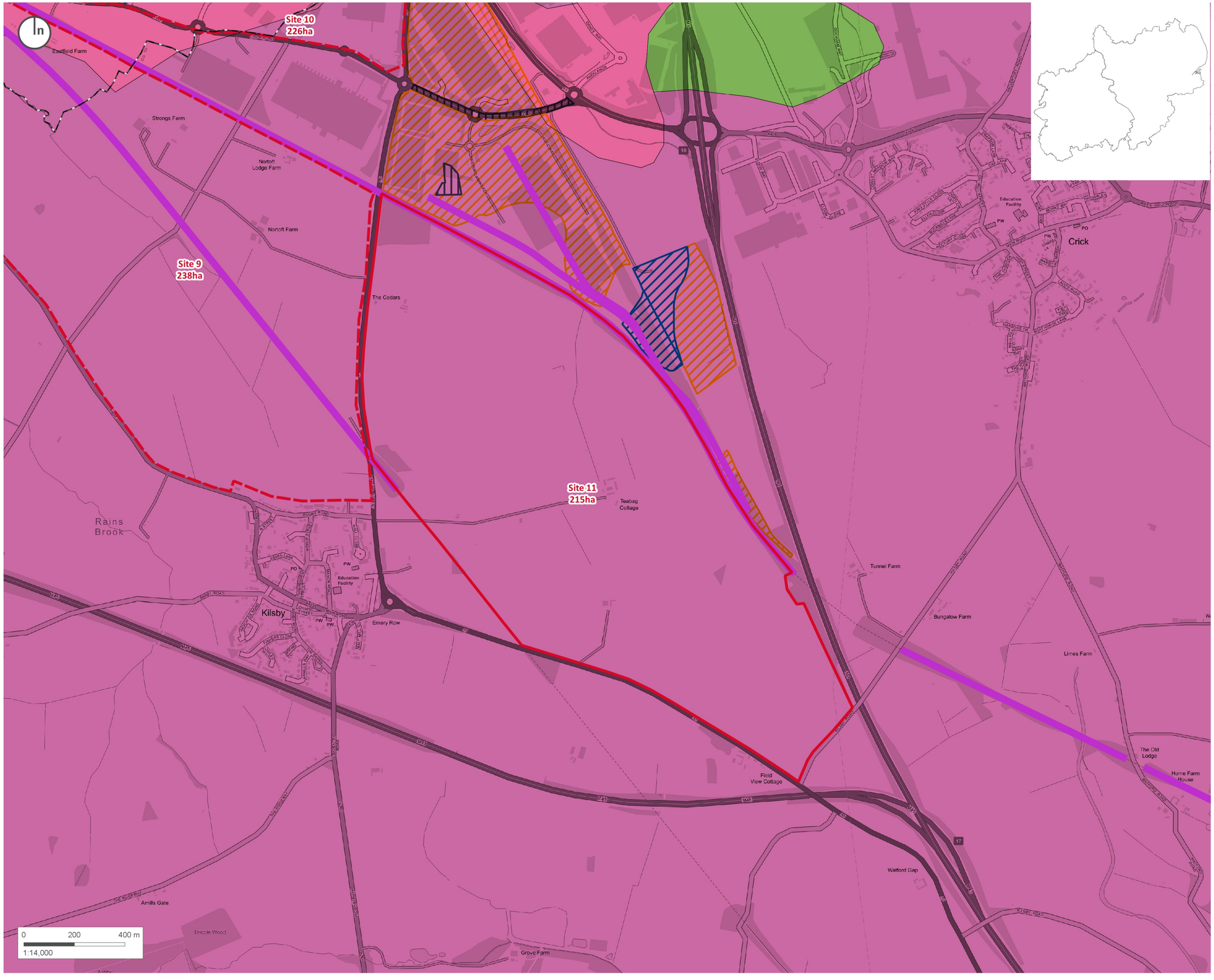
Figure No.
3002_108_(ALC) Plan 7-10

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Grade 4

ALC- sub

Grade 3a

Grade 3b

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 11
Kilsby East
Site Area - 215ha

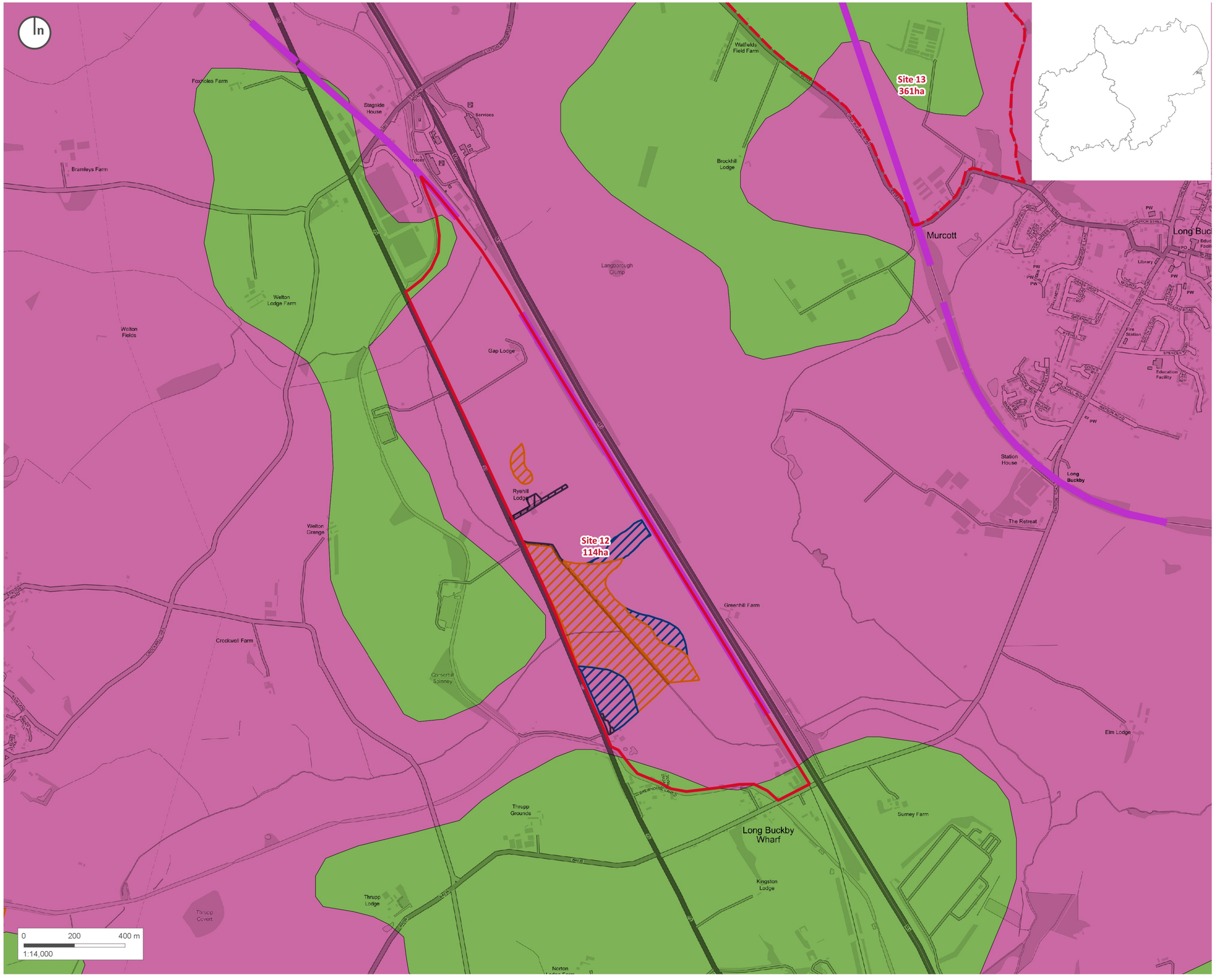
Figure No.
3002_108_(ALC) Plan 7-11

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

ALC- sub

Grade 3a

Grade 3b

Other

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 12
Land North of Long Buckby Wharfe
Site Area - 114ha

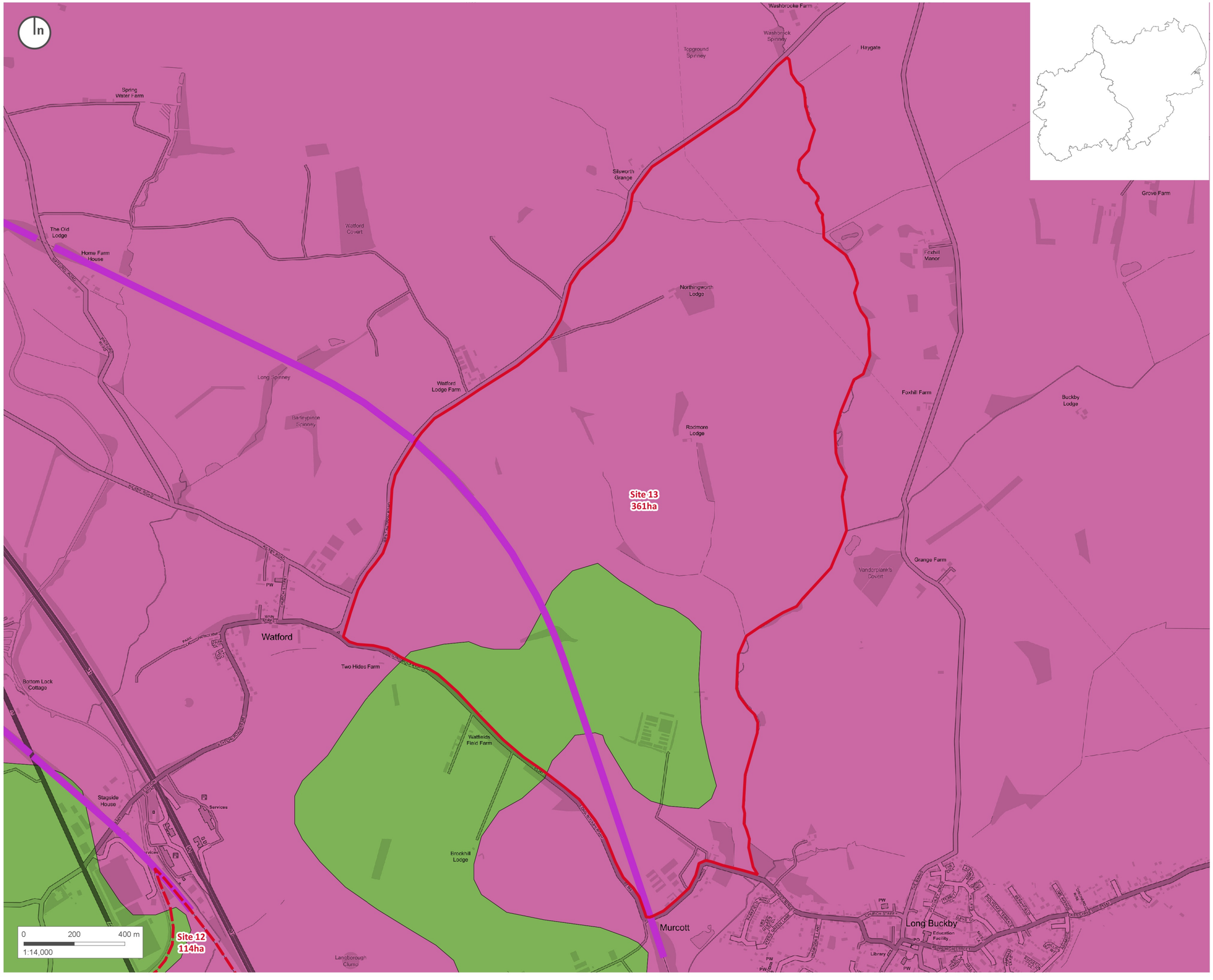
Figure No.
3002_108_(ALC) Plan 7-12

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 13 Land to the North East of Long Buckby Site Area - 361ha

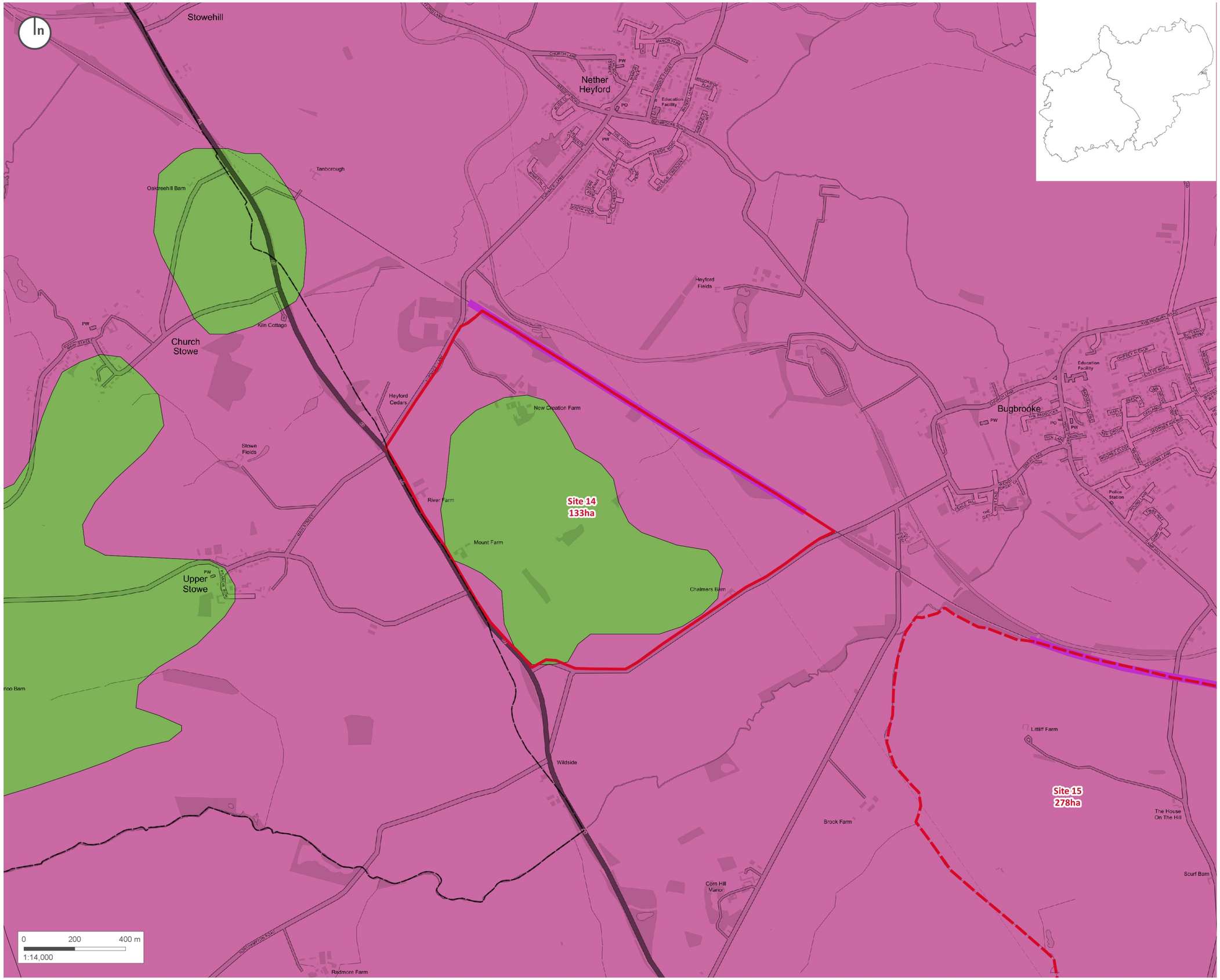
Figure No.
3002_108_(ALC) Plan 7-13

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

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Client reference:
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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 14 Land to the West of Bugbrooke and South of Nether Heyford
Site Area - 133ha

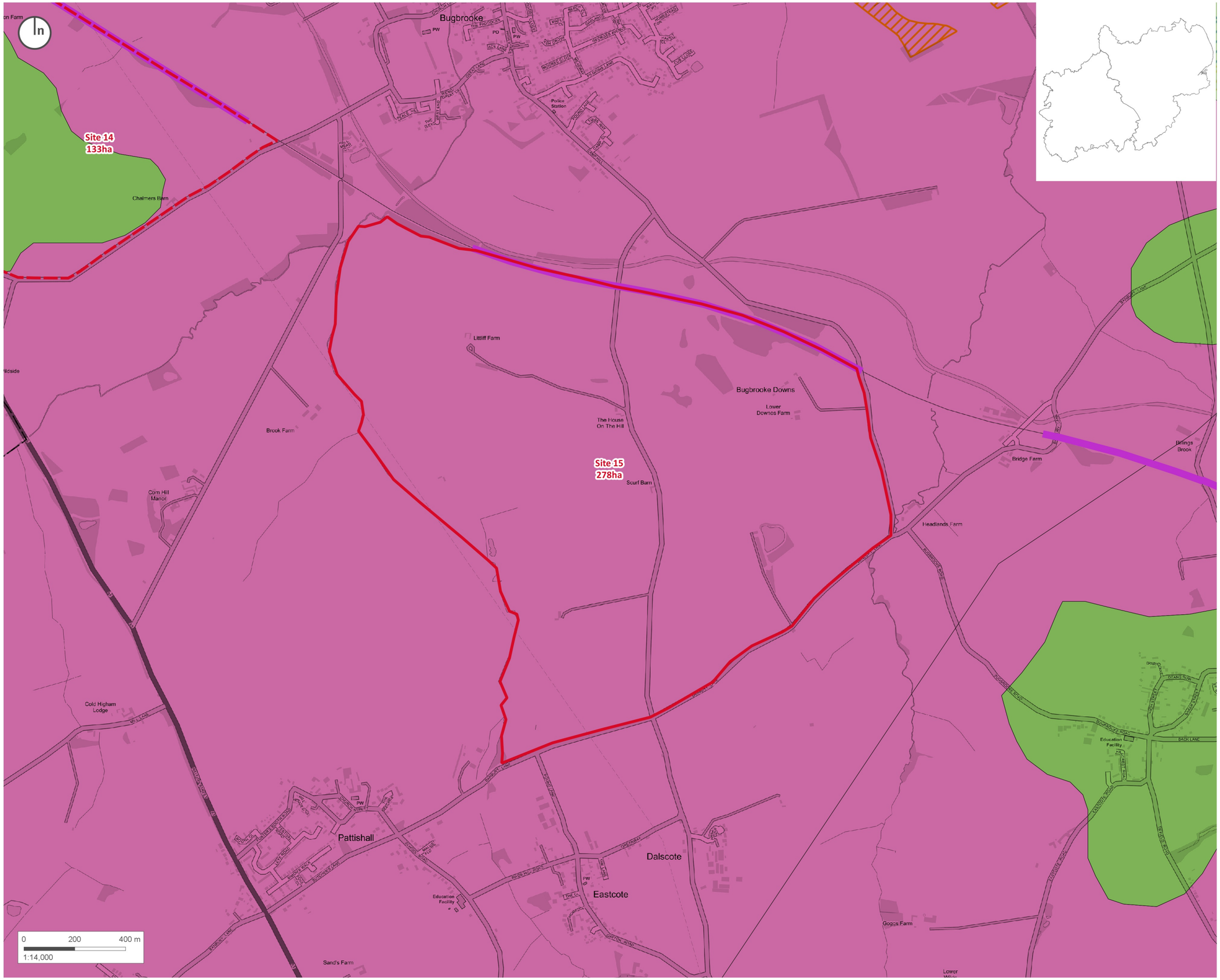
Figure No.
3002_108_(ALC) Plan 7-14

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

ALC- sub

Grade 3a

Grade 3b

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 15
Land South of Bugbrooke
Site Area - 278ha

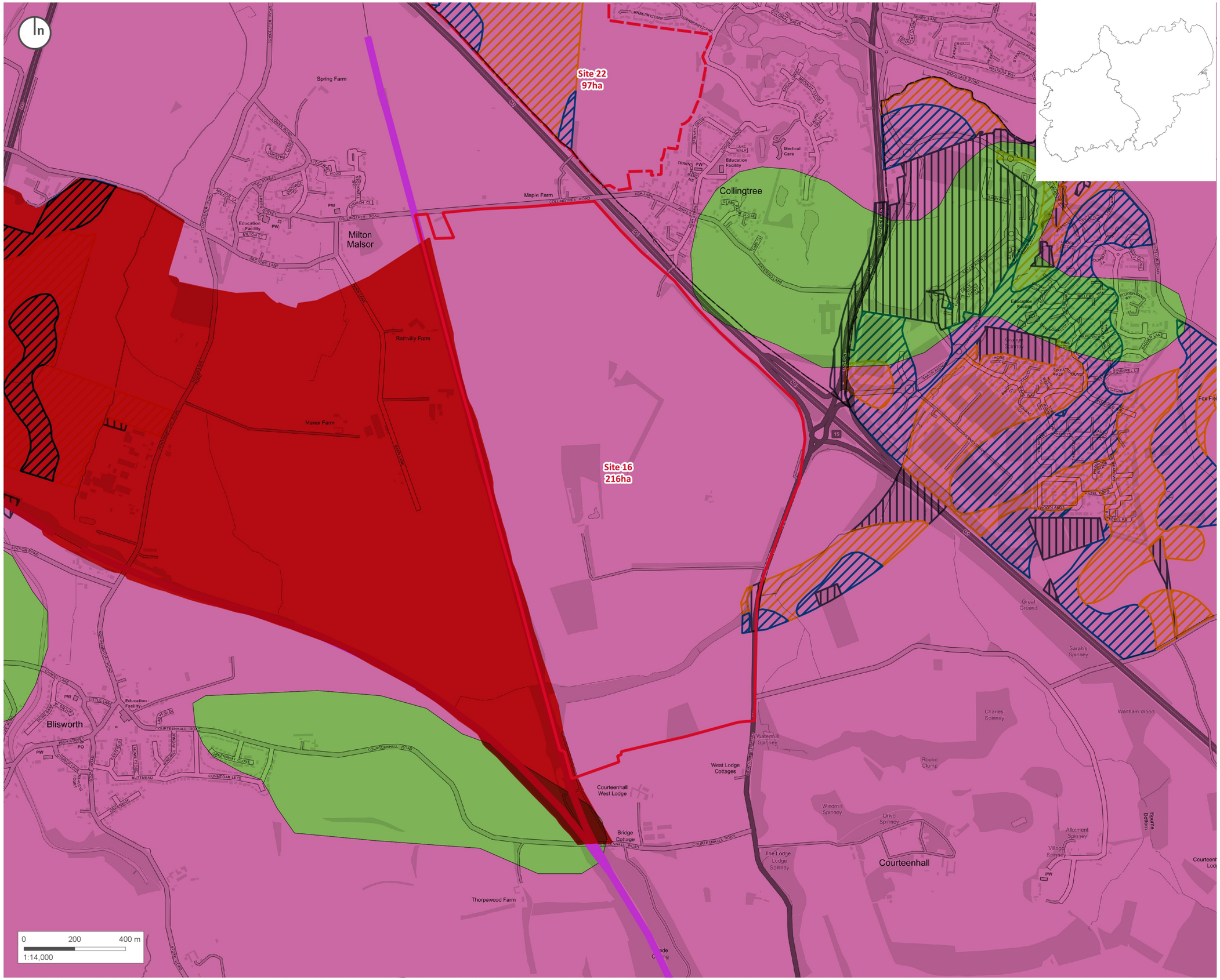
Figure No.
3002_108_(ALC) Plan 7-15

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Central Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

ALC- sub

Grade 3a

Grade 3b

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 16 Northampton Gateway Site Area - 216ha

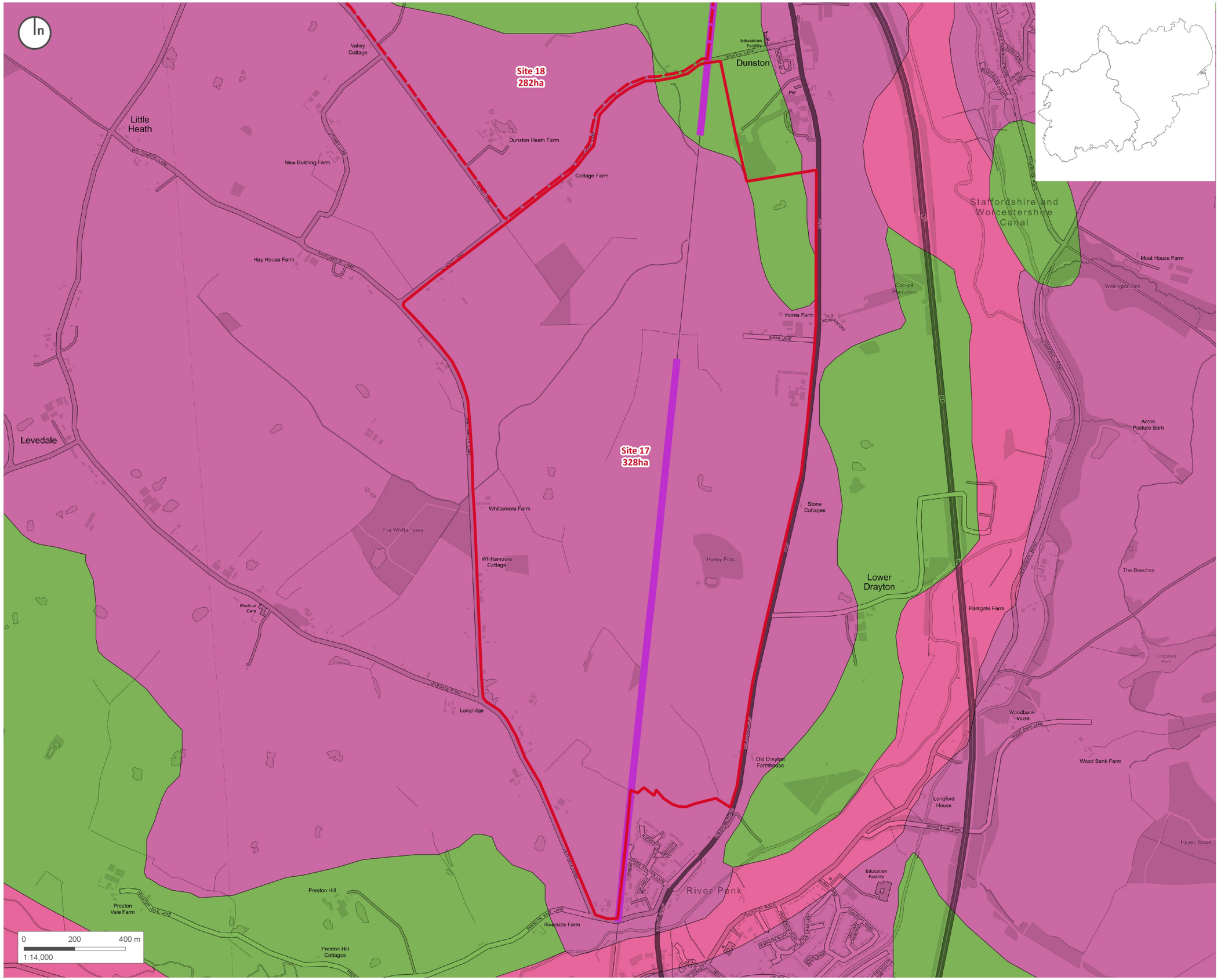
Figure No.
3002_108_(ALC) Plan 7-16

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Grade 4

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Project:
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Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 17
Land North of Penkridge
Site Area - 328ha

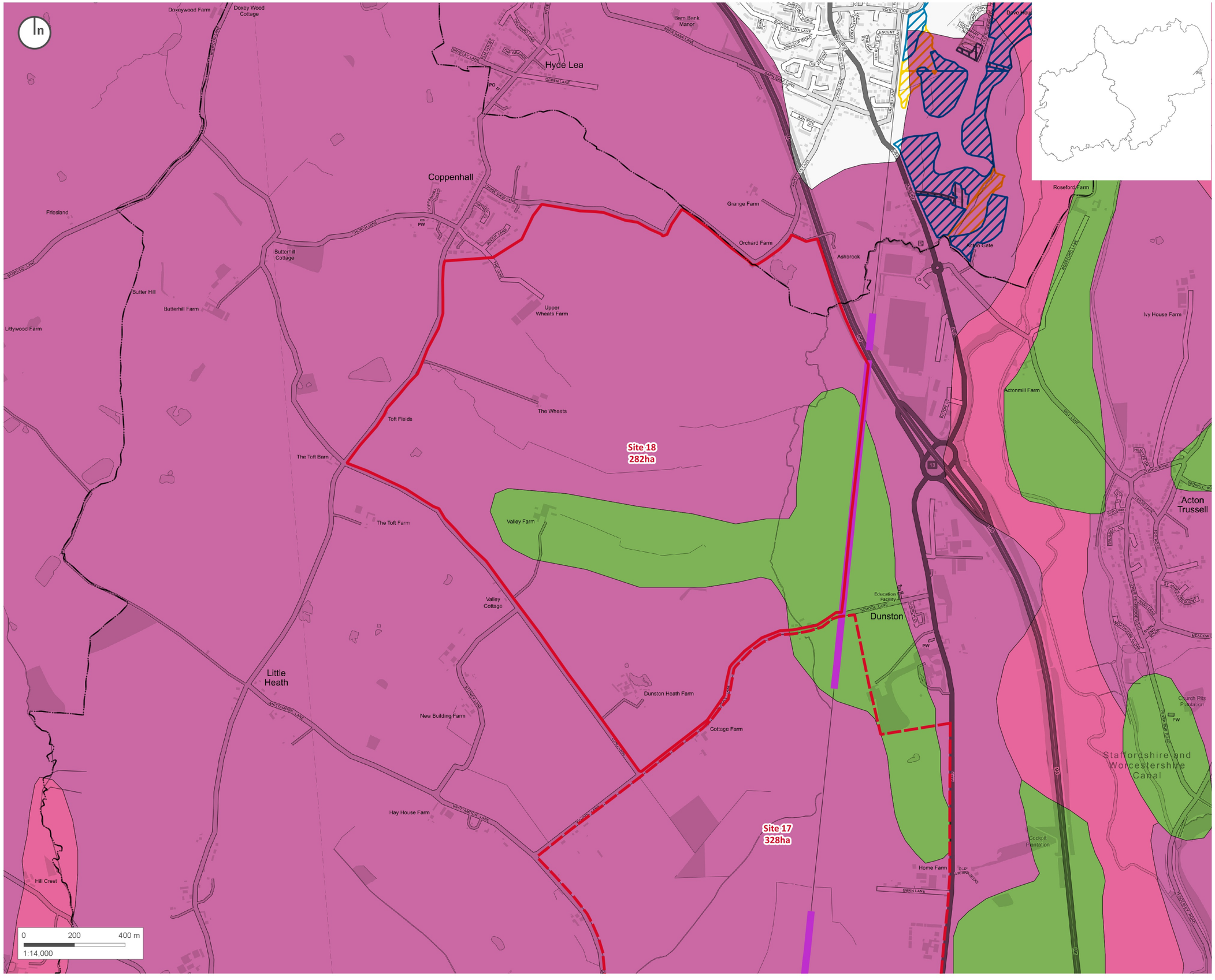
Figure No.
3002_108_(ALC) Plan 7-17

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Grade 4

Urban

ALC- sub

Grade 3a

Grade 3b

Not Surveyed

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 18
Land to the South of Stafford
Site Area - 282ha

Figure No.
3002_108_(ALC) Plan 7-18

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
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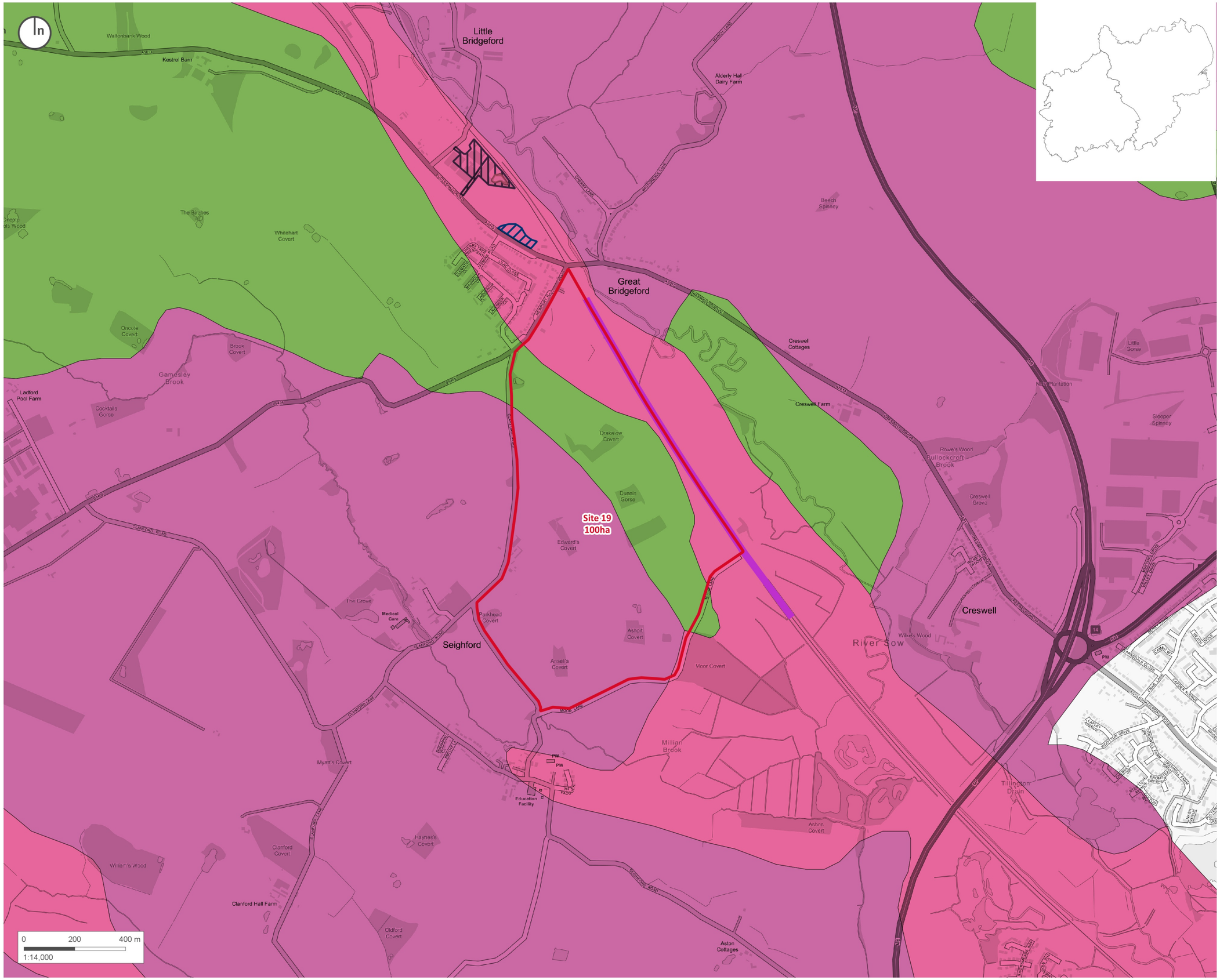

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 19
Land South of Great Bridgeford
Site Area - 100ha

Figure No.
3002_108_(ALC) Plan 7-19

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
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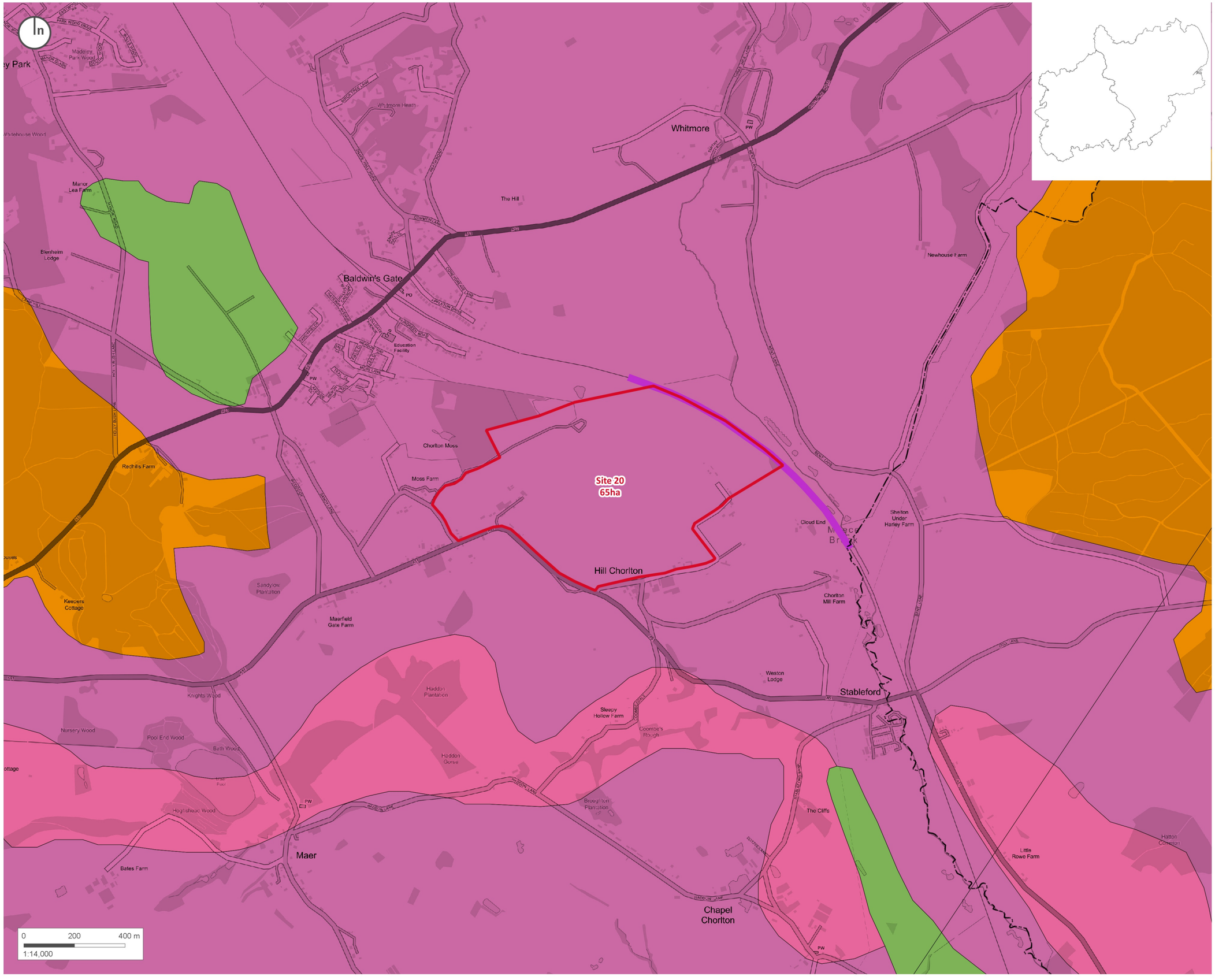

Alternative Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Grade 4

Non Agricultural

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Project:
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Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 20
Land at Baldwin's Gate
Site Area - 65ha

Figure No.
3002_108_(ALC) Plan 7-20

Revision:
1.2

Author:
MS

Date:
March 2018

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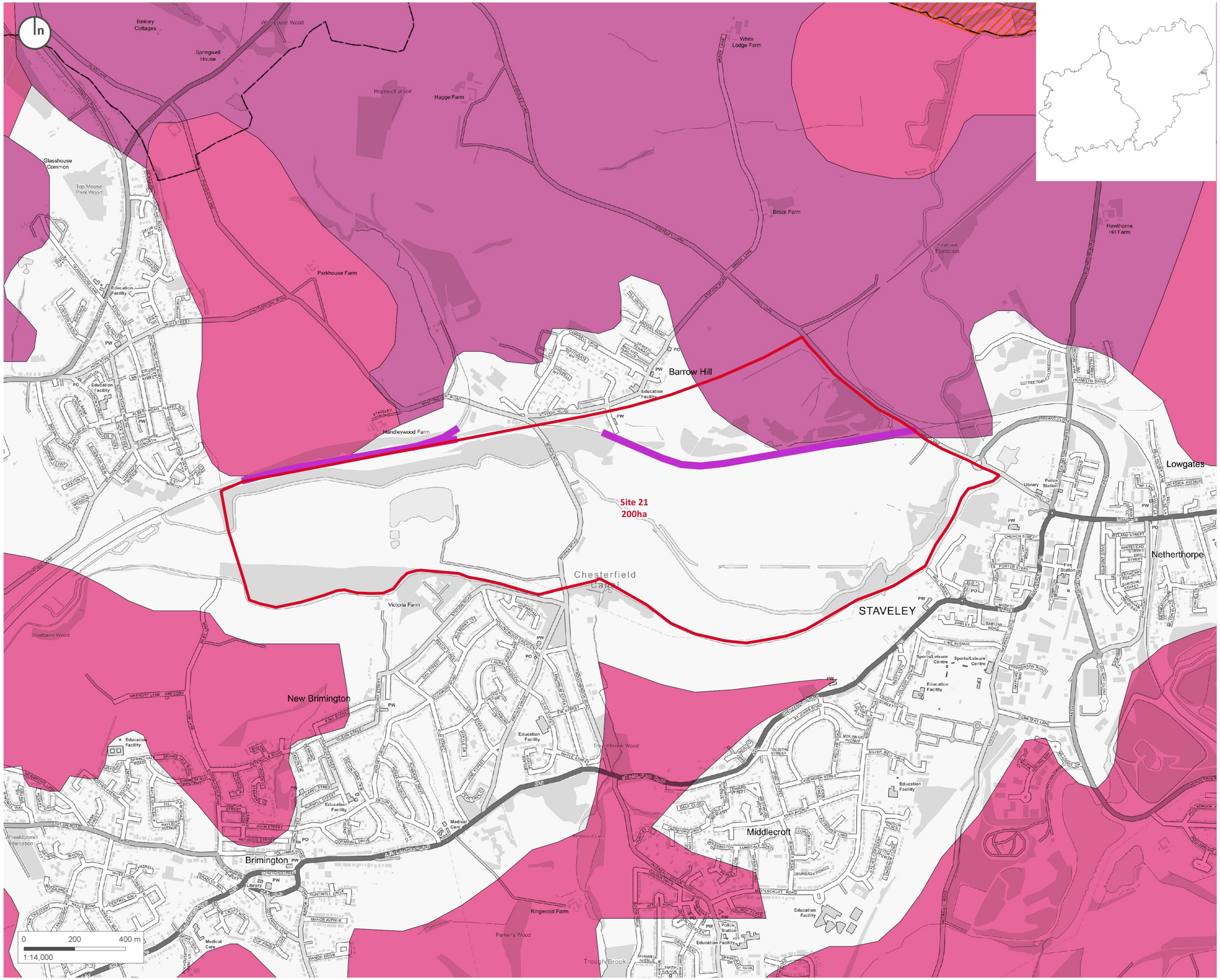

Alternative Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 3

Grade 4

Urban

ALC- sub

Grade 3b

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 21 Covidien, Staveley
Site Area - 200ha

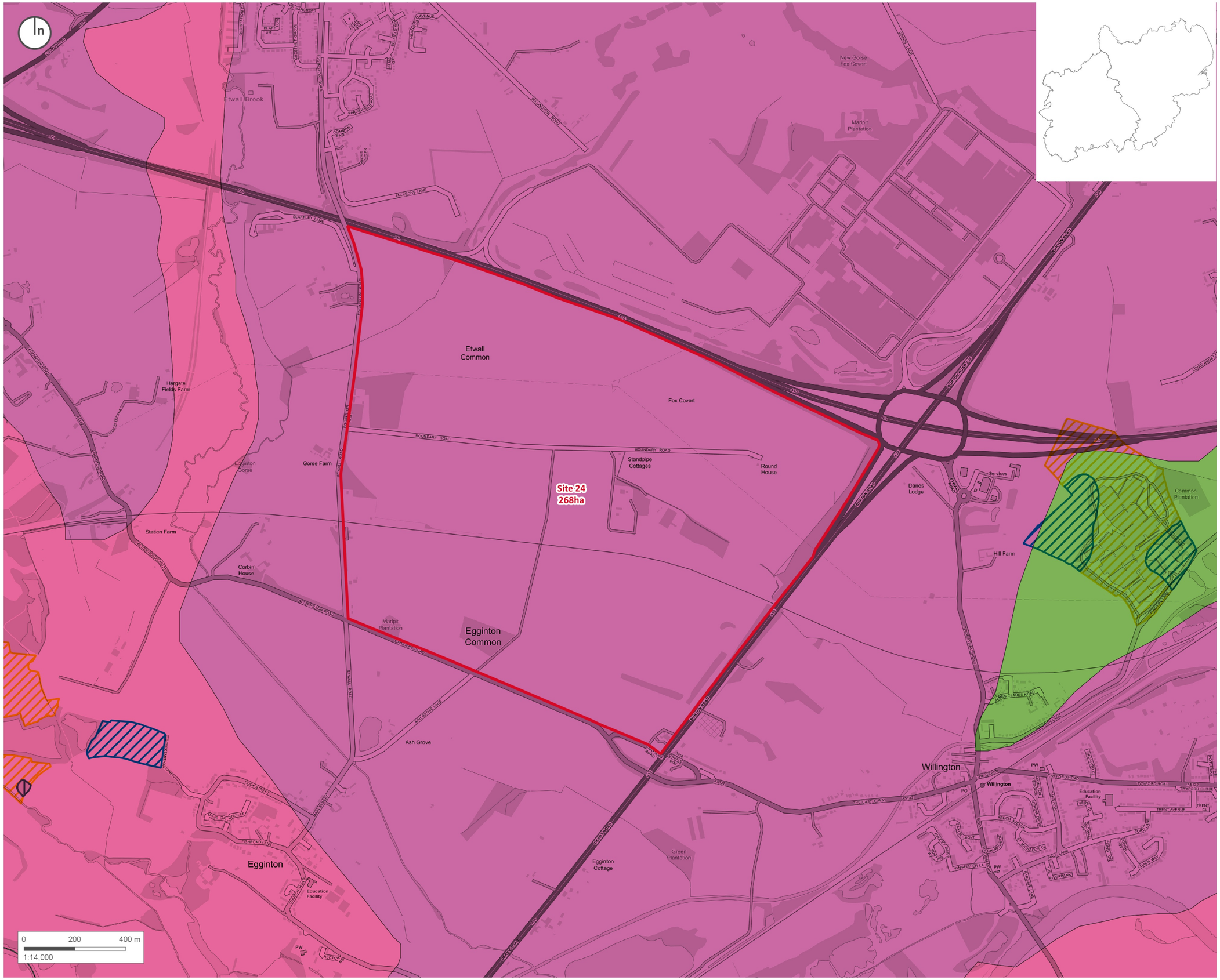
Figure No.
3002_108_(ALC) Plan 7-21

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Background EA LIDAR (DSM)

ALC

- Grade 2
- Grade 3
- Grade 4

ALC- sub

- Grade 3a
- Grade 3b
- Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 24 Etwall Common (East Midlands Intermodal Park)
Site Area - 268ha

Figure No.
3002_108_(ALC) Plan 7-24

Revision:
1.2

Author:
MS

Date:
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Scale:
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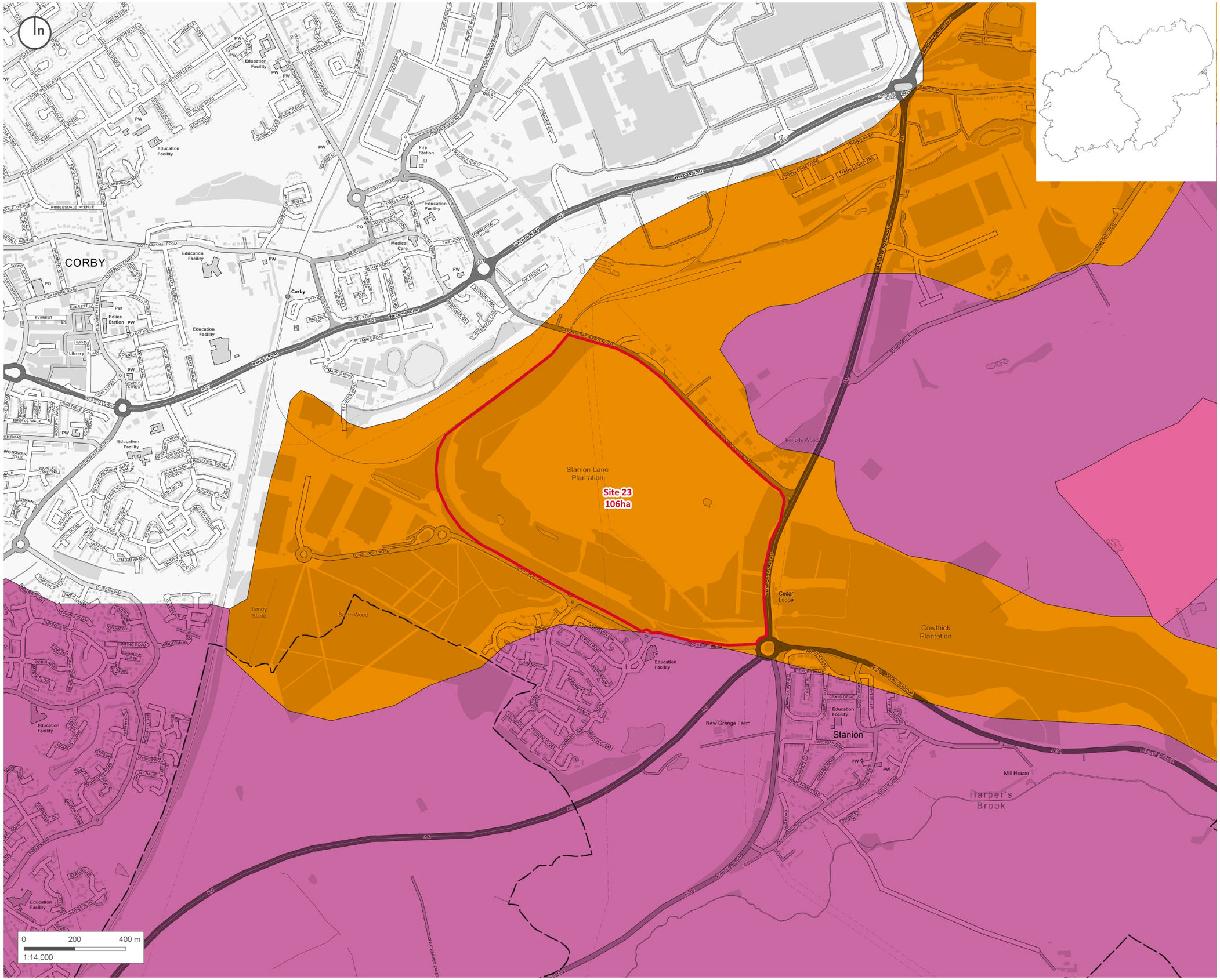

Alternative Site

Background EA LIDAR (DSM)

ALC

- Grade 3
- Grade 4
- Non Agricultural
- Urban

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 23 Eurohub, Corby
Site Area - 106ha

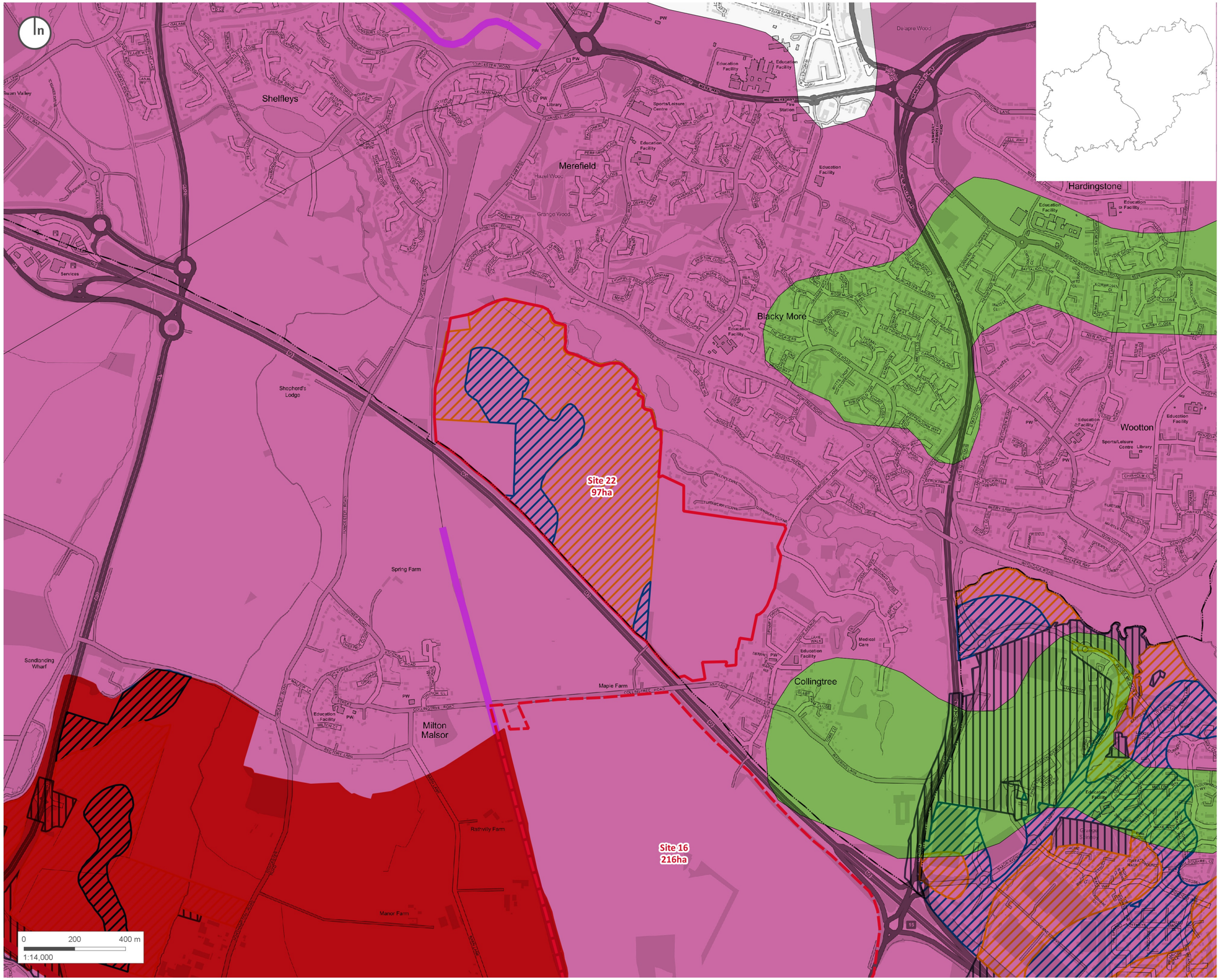
Figure No.
3002_108_(ALC) Plan 7-23

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Other Alternative Sites

Rail Central Site

Rail Gauge

W10

Background EA LIDAR (DSM)

ALC

Grade 2

Grade 3

Urban

ALC- sub

Grade 3a

Grade 3b

Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 22 Land to the East of Northampton Loop, North of M1 (Northampton South SUE) Site Area - 97ha

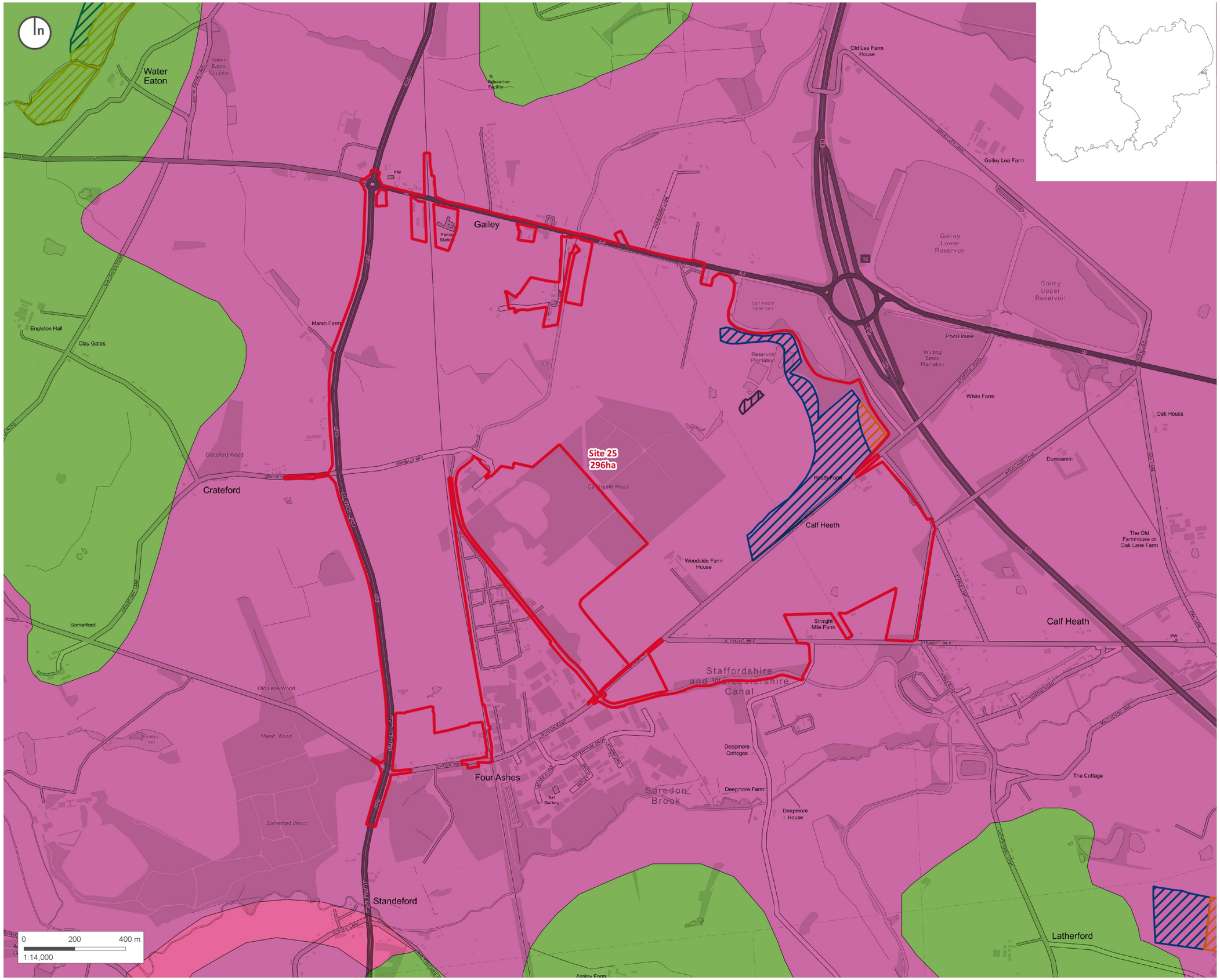
Figure No.
3002_108_(ALC) Plan 7-22

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)



Alternative Site

Background EA LIDAR (DSM)

ALC

- Grade 2
- Grade 3
- Grade 4

ALC- sub

- Grade 3a
- Grade 3b
- Other

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Project:
Rail Central, Northamptonshire

Document:
Environmental Statement

Title:
Alternative Sites Red Line (ALC) - Site 25
West Midlands Interchange
Site Area - 296ha

Figure No.
3002_108_(ALC) Plan 7-25

Revision:
1.2

Author:
MS

Date:
March 2018

Scale:
As shown (A3)

Appendix 9: Labour Market Availability Data

ID	Site Name	Local authority area	Contiguous local authorities	Total JSA claimants	Economically inactive people wanting a job
Site 1	Wadborough	Wychavon	Bromsgrove, Malvern Hills, Redditch, Worcester, Stratford-on-Avon, Wyre Forest, Cotswold, Tewkesbury	3,485	22,900
Site 2	Atherstone	North Warwickshire	Nuneaton and Bedworth, Lichfield, Tamworth, Birmingham, Coventry, Solihull, Hinckley and Bosworth, North West Leicestershire	29,900	61,900
Site 3	Freasley	North Warwickshire	Nuneaton and Bedworth, Lichfield, Tamworth, Birmingham, Coventry, Solihull, Hinckley and Bosworth, North West Leicestershire	29,900	61,900
Site 4	Nuneaton	Rugby	Nuneaton and Bedworth, Stratford-on-Avon, Warwick, Coventry, Blaby, Harborough, Hinckley and Bosworth, Daventry	5,645	35,200
Site 5	Hinckley	Blaby	Leicester, Rugby, Harborough, Charnwood, Oadby and Wigston, Hinckley and Bosworth	4,220	38,100
Site 6	Stoney Stanton	Blaby	Leicester, Rugby, Harborough, Charnwood, Oadby and Wigston, Hinckley and Bosworth	4,220	38,100
Site 7	Bishops Itchington	Stratford-on-Avon	West Oxfordshire, Bromsgrove, Redditch, Rugby, Warwick, Wychavon, Solihull, Cotswold, South Northamptonshire, Cherwell, Daventry	4,170	22,400
Site 8	Knightcote	Stratford-on-Avon	West Oxfordshire, Bromsgrove, Redditch, Rugby, Warwick, Wychavon, Solihull, Cotswold, South Northamptonshire, Cherwell, Daventry	4,170	22,400

ID	Site Name	Local authority area	Contiguous local authorities	Total JSA claimants	Economically inactive people wanting a job
Site 9	Kilsby	Daventry	Rugby, Stratford-on-Avon, Harborough, Northampton, South Northamptonshire, Wellingborough, Kettering	3,995	22,800
Site 9a	DIRFT 4 (Shed Only)	Rugby	Nuneaton and Bedworth, Stratford-on-Avon, Warwick, Coventry, Blaby, Harborough, Hinckley and Bosworth, Daventry	5,645	35,200
Site 10	Ashby St Ledgers	Daventry	Rugby, Stratford-on-Avon, Harborough, Northampton, South Northamptonshire, Wellingborough, Kettering	3,995	22,800
Site 11	Kilsby (East)	Daventry	Rugby, Stratford-on-Avon, Harborough, Northampton, South Northamptonshire, Wellingborough, Kettering	3,995	22,800
Site 12	Long Buckby Wharf	Daventry	Rugby, Stratford-on-Avon, Harborough, Northampton, South Northamptonshire, Wellingborough, Kettering	3,995	22,800
Site 13	Long Buckby	Daventry	Rugby, Stratford-on-Avon, Harborough, Northampton, South Northamptonshire, Wellingborough, Kettering	3,995	22,800
Site 14	South West of Long Buckby	Daventry	Rugby, Stratford-on-Avon, Harborough, Northampton, South Northamptonshire, Wellingborough, Kettering	3,995	22,800
Site 15	South of Nether Heyford	South Northamptonshire	Milton Keynes, Aylesbury Vale, Stratford-on-Avon, Northampton, Wellingborough, Cherwell,	6,070	33,400

ID	Site Name	Local authority area	Contiguous local authorities	Total JSA claimants	Economically inactive people wanting a job
			Daventry		
Site 16	South of Bugbrooke	South Northamptonshire	Milton Keynes, Aylesbury Vale, Stratford-on-Avon, Northampton, Wellingborough, Cherwell, Daventry	6,070	33,400
Site 17	Roxhill	South Northamptonshire	Milton Keynes, Aylesbury Vale, Stratford-on-Avon, Northampton, Wellingborough, Cherwell, Daventry	6,070	33,400
Site 18	Penkridge	South Staffordshire	Telford and Wrekin, Shropshire, Bromsgrove, Wyre Forest, Cannock Chase, Stafford, Dudley, Walsall, Wolverhampton	16,660	59,500
Site 19	Coppenhall	South Staffordshire	Telford and Wrekin, Shropshire, Bromsgrove, Wyre Forest, Cannock Chase, Stafford, Dudley, Walsall, Wolverhampton	16,660	59,500
Site 20	Great Bridgeford	Stafford	Stoke-on-Trent, Telford and Wrekin, Shropshire, Cannock Chase, East Staffordshire, Lichfield, Newcastle-under-Lyme, South Staffordshire, Staffordshire Moorlands	8,040	50,700
Site 21	Baldwins Gate	Newcastle-under-Lyme	Stoke-on-Trent, Shropshire, Stafford, Staffordshire Moorlands, Cheshire East	6,595	38,400
Site 22	Staveley	Chesterfield	Bolsover, North East Derbyshire	1,830	8,700

ID	Site Name	Local authority area	Contiguous local authorities	Total JSA claimants	Economically inactive people wanting a job
Site 23	Land to the East of Northampton Loop, North of M1 (Northampton South SUE)	Northampton	Daventry, South Northamptonshire, Wellingborough	2,945	14,400
Site 24	Eurohub, Corby	Corby	Harborough, Kettering, East Northamptonshire, Rutland	1,440	11,000
Site 25	Etwall Common (East Midlands Intermodal Park)	South Derbyshire	North West Leicestershire, East Staffordshire, Lichfield, Amber Valley, Derbyshire Dales, Erewash, Derby	4,285	26,700
Site 26	East Midlands Distribution Centre, Castle Donnington	North West Leicestershire	North Warwickshire, Charnwood, Hinckley and Bosworth, Lichfield, Erewash, South Derbyshire, Rushcliffe	2,920	19,100
Site 27	East Midlands Gateway	North West Leicestershire	North Warwickshire, Charnwood, Hinckley and Bosworth, Lichfield, Erewash, South Derbyshire, Rushcliffe	2,920	19,100
	Rail Central	South Northamptonshire	Milton Keynes, Aylesbury Vale, Stratford-on-Avon, Northampton, Wellingborough, Cherwell, Daventry	6,070	33,400

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Turley

Rail Central
Northamptonshire

The Rail Central Rail Freight Interchange

Northampton Gateway Examination

Written Representation of Ashfield Land Management Limited and Gazeley GLP Northampton s.a.r.l.

Appendix 12 - Supplement to the October 2013 Strategic Business Case for HS2 – Technical Annex: Demand and Capacity Pressures on the West Coast Main Line, Department for Transport, November 2015

Northampton Gateway PINS Reference Number
TR050006

6 November 2018

Department for Transport

Supplement to the October 2013 Strategic Case for HS2

Technical Annex: Demand and Capacity Pressures on the West Coast Main Line

November 2015

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Executive summary

Purpose of this report

1 "The Strategic Case for HS2", published by the Department for Transport (DfT) in October 2013, set out the need for the scheme. At the heart of the Strategic Case were issues around route capacity (the number of train services) and train capacity (the number of passengers each service can carry) on the West Coast Main Line (WCML).

2 Following on from the publication of the Strategic Case, DfT has undertaken further work to keep up to date its analysis of route capacity and train capacity issues on the WCML. The purpose of this report is to bring together the evidence that has been captured by DfT's updated analysis of WCML capacity issues. The report covers the following topics:

- **The strategic importance of the WCML** – explaining how the WCML serves a number of the UK's most critical rail markets, highlighting how these markets have grown over the last 20 years and illustrating how the major upgrade of the WCML between 1998 and 2008 has supported this
- **The WCML today** - covering the existing capacity and performance pressures on the WCML and the growth in freight and passenger demand that is anticipated
- **Route capacity** - setting out the key constraints on each section of the WCML, the trade-offs that would be required in order to run additional trains and the potential alternative options for relieving these constraints
- **Train capacity** - analysing future crowding issues on the two key WCML operations, the West Midlands franchise and Inter City West Coast, under different demand growth and investment scenarios
- **Freight -** exploring the potential of the different phases of HS2 to accommodate the anticipated increase in demand for freight services along the WCML

The strategic importance of the West Coast Main Line

3 The WCML is one of Britain's most important rail corridors. It links four of Britain's biggest conurbations and serves all rail markets: inter-city; commuter; regional; and freight. Three of Britain's top six rail business flows (London to each of Manchester, Birmingham and Liverpool) are served by the WCML.

4 Inter City West Coast (ICWC – currently operated by Virgin West Coast) carries around 35 million passengers annually. In peak periods it operates 10-11 trains per hour (tph) to/from London Euston.

5 The West Midlands franchise (WM - currently operated by London Midland) operates commuter trains from Crewe, Birmingham, Milton Keynes and Northampton to London. In the morning peak hour it runs 13tph: 5tph operate on the WCML Fast

[1] Virgin West Coast operates 12tph between 18:00-18:59 on Fridays.

Lines alongside ICWC services, with 8tph running on the Slow Lines.

6 Since the 2013 Strategic Case was published, overall demand for rail travel has continued to grow at a higher rate than the long term forecast that underpins DfT's Economic Case for HS2. From 2013 to 2015 (years ended 31 March) the number of rail journeys in Great Britain grew by 10.2 per cent from 1,501 million to 1,654 million. This is an annual growth rate of 5 per cent – more than double the growth of around 2 per cent assumed in the Economic Case for HS2.

7 Over this period, on the WCML:

- Virgin West Coast has seen its annual passenger journeys grow by 13.5 per cent from 30.4 million in 2013 to 34.5 million in 2015 – equivalent to 6.5 per cent annual growth
- London Midland, the key commuter operator into London Euston, has seen its passenger journeys grow by 7.9 per cent from 60.5 million to 65.3 million – equivalent to 3.9 per cent annual growth. This is against a backdrop of a doubling of commuter journeys into London on the WCML since 1996/97

8 As a result of these trends, Euston is now the fastest growing terminus in London.

9 Regional and other suburban services operate alongside inter-city trains throughout the North and Midlands. Indeed, in recent years WCML commuter flows into Birmingham and Manchester have grown as quickly as those into London. Peak passenger numbers at city centre stations in Birmingham and Manchester have increased by 15 per cent and 27 per cent respectively over the last four years.

10 In addition, around 40 per cent of all Britain's rail freight trains use the WCML at some point in their journey.

11 This growth has been made possible by the £9 billion WCML upgrade. This took a decade to carry out and when it was completed in 2008, it had involved one hundred million person-hours of work, and significant disruption to the travelling public. By increasing the route capacity of WCML from around 9tph to 13-14tph, this allowed a 45 per cent increase in daily services from London to Birmingham and Manchester. Notably, the scale of growth between 2008 and 2015 means that two thirds of the additional inter-city seat capacity provided by the decade-long upgrade is already being utilised.

The West Coast Main Line today

12 Today, the WCML Fast Lines (the "Fast Lines") carry 15-16[2] trains per hour (tph) at the busiest peak periods. This is more than the 13-14tph envisaged at the time of the upgrade due to the pressure to run more outer-suburban commuter services along with today's inter-city timetable. This is a higher intensity of operation than comparable major fast lines in other European countries, including purpose-built high speed lines.

13 Despite its recent modernisation, the WCML rail corridor remains highly constrained, meaning that the route is operating close to capacity in the peak and it is challenging to increase service levels still further. This is due to:

- Physical constraints with the infrastructure such as the flat junctions[3], two-track sections and bottlenecks at station approaches

[2] 15tph operate in the high peak hours of 08:00 to 08:59 and 17:00 to 17:59. On weekdays between 08:02-09:01 this rises to 16tph which is enabled by reduced calls by fast line services south of Rugby. There are also 16tph between 18:00-18:59 on Fridays.
[3] This is where a crossing move is made such that a train travelling in one direction needs to cross the track used by trains in the opposite direction at the same level. By use of flyovers and dive-unders ('grade separation'), it is possible to reduce the adverse performance and capacity effects of flat, at-grade, crossings.

- The complex mix of inter-city, commuter, local and freight traffic that operates on the rail corridor with trains having varying speeds and stopping patterns

14 It is notable that these constraints impact the traffic that can be operated all along the route. They limit how many commuter services run into Birmingham and Manchester and the ability to run additional freight trains in the North and Midlands – not just the number of passenger services that can be run into Euston in the peak.

15 Operating the WCML at this intensity makes it challenging to maintain acceptable performance levels. Both Virgin West Coast and London Midland have consistently operated below their Public Performance Measure (PPM) targets since the route upgrade, and these targets have been revised down for Control Period 5 (CP5) in the face of the difficulties experienced in delivering higher performance levels.

16 The difficulties of operating additional trains on the WCML, particularly in the peak, have previously been acknowledged by the Office of Road and Rail (ORR). Between 2011 and 2013 the ORR turned down applications from Alliance Rail, Grand Central Railway, London Midland and Virgin West Coast to run additional services. This was because the performance risk of, effectively, filling the Fast Lines from the start of the morning peak until after the end of the evening peak was considered to be too great, as the service would never have the opportunity to recover from any perturbation.

17 Two further applications have since been at least partially successful. However, the circumstances in which the additional services have been permitted lend weight to the evidence that it is difficult to operate additional trains on WCML in the peak.

18 The first of these applications was for the two further peak hour London Midland trains, introduced in December 2014, increasing the frequency on the Fast Lines during peak hours to 15-16tph[4]. ORR could only grant access because the additional services were timetabled by operating faster 110mph rolling stock and 'flighting' two 110mph trains in a path previously occupied by one 100mph service. Making this timetabling solution work also required reducing commuter stops south of Rugby.

19 The second, and most recent award (August 2015), is the 10 year track access rights granted to Alliance Rail to operate six daily (five on a Sunday) off-peak return services between Blackpool and Queens Park station in London from December 2017. This means that some of the limited capacity available in off-peak periods (when frequency falls to 12tph) will be taken up. However, no additional peak services will be run.

20 Long term forecasts point to continued growth in the passenger and freight rail markets. Accommodating this demand on the WCML will be increasingly challenging.

Route capacity issues

21 The route capacity on the WCML is constrained at several points along the corridor, and each section of the route has different individual capacity constraints. However, because most trains need operating paths across several of these route sections, any solution to introduce more trains needs to be developed in a joined-up way along the route. With the route used so intensively, a constraint in one section can affect the timetabling of trains a considerable distance away in another section of line. Because of this, investing in the WCML corridor to allow more services to operate, whether they be passenger or freight, is complex.

22 To illustrate the range of constraints along the corridor, the table below splits the WCML into nine route sections, and summarises the key constraints in each section,

[4] 15tph operate in the high peak hours of 08:00 to 08:59 and 17:00 to 17:59. On weekdays between 08:02-09:01 there are 16tph which is enabled by reduced calls by Fast Line services south of Rugby. There are also 16tph between 18:00-18:59 on Fridays.

along with the implications this has for the service levels that can operate. The combination of these network constraints, and operating the WCML at such a high level of intensity, is having clear implications for the performance of the network, as identified in the October 2013 Strategic Case.

Section	Constraint	Impact on services
London Euston to Rugby	• The mix of traffic. Fast Lines carry 125mph inter-city trains and 110mph outer suburban trains. More paths would be available if trains operated at uniform speed • Flat junctions at Ledburn and Hanslope where commuter trains have to slow down to 60 mph to cross over from the Fast Lines to the Slow Lines, requiring precise timing of trains • Capacity is lost due to the uneven stopping patterns of London Midland trains, and two intercity trains stopping at Milton Keynes/Watford Junction • On the Slow Lines, there are no places for trains to pass each other between Wembley and Northampton	• Peak service level limited to 15-16tph so very limited ability to address crowding once existing peak trains are extended to full length • No capacity to give more towns and cities, particularly from the North West, direct services into London in the peak other than by starting existing trains further out • Calls by inter-city trains at Watford Junction and Milton Keynes have had to be reduced to accommodate 3tph London to Birmingham/Manchester timetable. In addition, direct links between Watford Junction and Liverpool, North Wales and Scotland have been withdrawn
Rugby to Birmingham New Street	• Coventry station, which has flat junctions at each end and is on the main freight route from the port at Southampton the Midlands and North West. Passenger and freight services need to be carefully planned through these junctions • The approach to Birmingham New Street where five routes join together • Knitting together the local West Midlands services with the Cross Country and West Coast timetable	• To accommodate the inter-city timetable, stopping trains between Coventry and Birmingham have been split into two services and the stopping trains from Coventry–Wolverhampton are no longer cross- linked meaning a change of train is needed for many cross-city journeys • Inter-city services that used to run between Coventry/Birmingham International and the East Midlands/Yorkshire/the North East have been withdrawn
Rugby to Stafford	• Brinklow – Attleborough Junction – Northbound 60-75mph freight services have to be slotted in around 125mph inter-city trains on a three track section • Colwich Junction – where two northbound inter-city trains per hour leave the route and cross in front of Southbound trains on a flat junction • The two-track section between Colwich Junction and the approach to Stafford. Here inter-city and freight services (with significant speed differentials) share the track	• More fast services along the Trent Valley to London from Stafford, Rugeley, Lichfield, Tamworth and Nuneaton cannot readily be provided • Constraints make it highly challenging to operate any more peak inter city services from the North West to London without reducing the reliability of other trains on the route • The number of day-time freight paths is limited
Stafford to Crewe	• Although this section is mainly four-track, the service mix and flat junctions, both at Stafford and Crewe, restrict route capacity • Crewe is a major passenger and freight hub. Complex crossing movements limit the number of available paths for passenger and freight services and the number of useable platforms for services to stop	• Limited availability of paths means that freight traffic to/from London and Birmingham needs to be held up for extended periods • Capacity constraints here and on other sections mean that the inter-city trains between Birmingham and Manchester cannot readily be accelerated. At present, the journey time is 1 hour 26 minutes for 85 miles
Crewe to Weaver Junction	• The two-track section between Winsford and Weaver Junction, where a mix of service and train types share the same track • At the North end of Crewe station, the line splits into three and there is a flat crossing	• It is difficult to increase local services because of the number of inter-city and freight trains • Extended journey times for services between Birmingham and Liverpool
Weaver Junction to Preston	• The diverse mix of service types that operate on the two-track sections between Weaver Junction and Preston, which includes a number of flat crossings. A number of regional services cross the WCML or run on it for short distances and thereby limit through capacity	• Limited ability to run additional inter-city services • Growth of freight paths to and from Scotland is constrained.
Weaver Junction to Liverpool	• The two-track section from Weaver Junction through Runcorn and over the River Mersey • The flat junction at Allerton where Liverpool-Manchester and WCML services merge	• Limited ability to increase services

Section	Constraint	Impact on services
Crewe to Manchester Piccadilly	• The two-track section between Sandbach and Cheadle Hulme, where fast long distance services from London and South Wales mix with slower stopping local trains • Flat junctions at Cheadle Hulme (where trains from London via Stoke-on-Trent join) and at Stockport (see below) • Approach to Piccadilly where the mix of stopping patterns and train origins/destinations curtails operational flexibility	• One out of every two Chester – Northwich – Manchester peak commuting trains was removed in 2008, forcing passengers to change at Stockport • Although Northern Hub will provide some more capacity in the Manchester area, it may not be sufficient to address all aspirations for improvements in services to Sheffield, Birmingham, Staffordshire, Shropshire and London • There is limited connectivity from Shropshire and from Staffordshire to Manchester Airport
Colwich Junction/ Norton Bridge to Manchester Piccadilly	• At Cheadle Hulme, the lines from Crewe and Stoke-on-Trent converge into a busy two-track section • The Stockport station area, where the lines from Chester, Sheffield, Hazel Grove and Buxton merge together for the approach to Manchester Piccadilly	• The Buxton –Blackpool service was split into three new services in 2008 to accommodate today's inter-city service • Services connecting Rose Hill in Manchester with Bolton via Oxford Road were also curtailed

Options for addressing these constraints

The Strategic Alternative to HS2

23 The report "HS2 Strategic Alternatives, Final Report"(DfT, October 2013) set out the alternative options for meeting the capacity and connectivity objectives set by Government when developing its plans for HS2. The most relevant option to compare against the impact of HS2 in the WCML corridor was termed "P1". This contained a package of measures, some of which had been put forward by objectors to HS2.

24 P1 assumes that all ICWC peak trains into Euston are run at 11-car length (the longest trains in the existing ICWC fleet) and reconfigured to increase Standard Class seating capacity at the expense of First Class. Likewise, all WM commuter trains are run at their maximum 12-car length. In addition to this, P1 includes a package of infrastructure enhancements that would more reliably allow 16tph into/from London Euston on the WCML Fast Lines across the peak. These have been costed at £2.5 billion and include the grade separation of junctions at Colwich and between Cheddington and Leighton Buzzard, 4-tracking between Attleborough and Brinklow and further power supply upgrades and line speed improvements.

25 Since P1 would involve major works on a live railway it would inevitably be highly disruptive to the travelling public. As with the 1998 -2008 WCML upgrade, passengers would be required to endure a prolonged period of route diversions and rail replacement bus services during weekend closures of sections of the line.

26 It is notable that since the publication of the 2013 Strategic Case, key elements of P1 have already been committed and are therefore built into the assumptions in this report. Specifically:

- Some of the proposed train lengthening is already underway and has been allowed for in the train capacity analysis within this report
- London Midland now operates some of the additional trains on the Fast Lines envisaged in the Strategic Alternative but without the need for grade separation
- Some of the infrastructure interventions are in hand, particularly the grade separated junction being built at Norton Bridge

27 Given the limitations of the Strategic Alternative in allowing additional peak trains compared to today's timetables, it is restricted in the extent to which it can address

medium-long term crowding issues on passenger services, and would do very little in terms of providing improved connectivity to a wider range of destinations, or indeed addressing freight capacity issues.

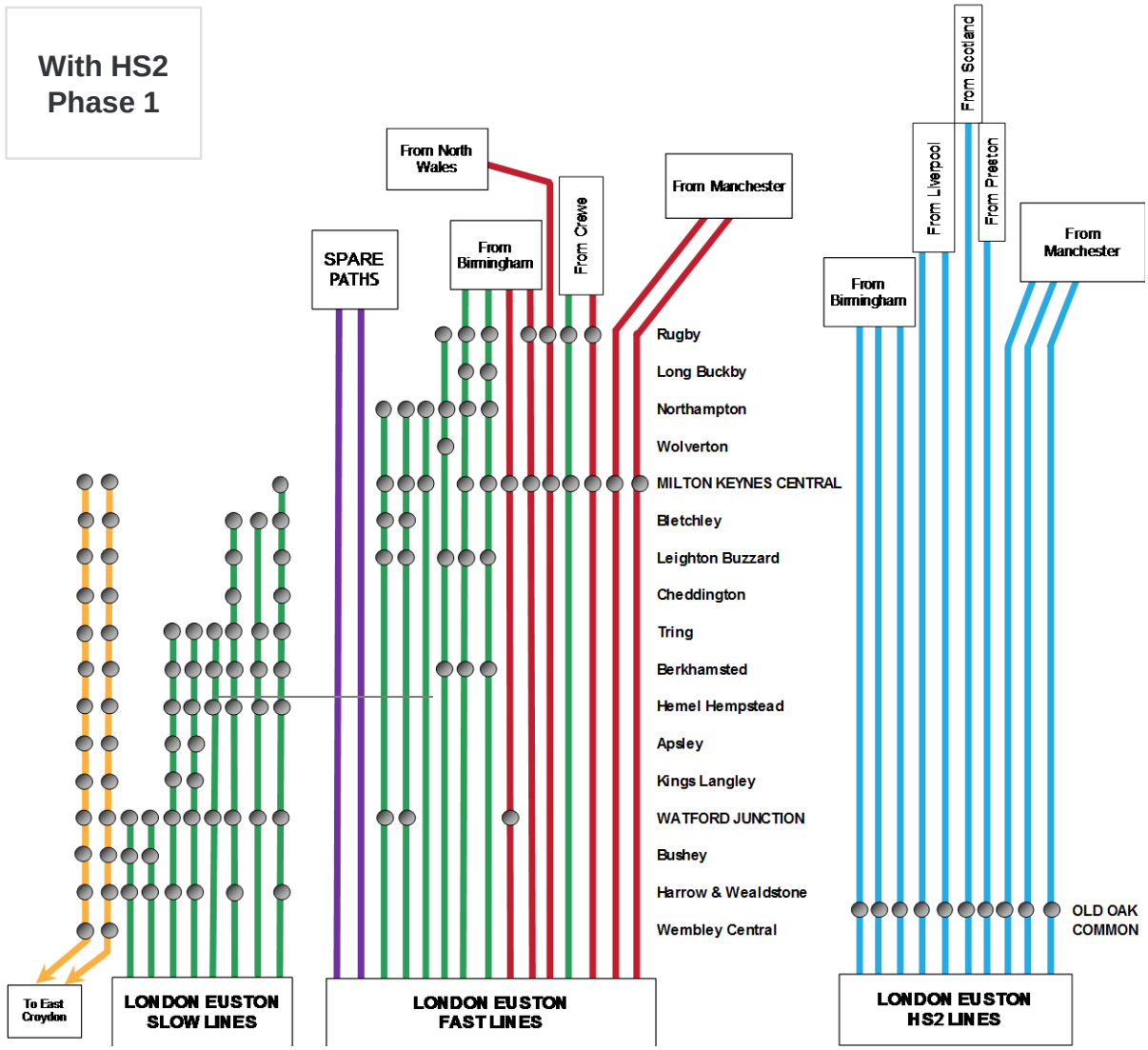
HS2

28 HS2 will impact the WCML in two phases – Phase One which is planned to open in 2026 and Phase Two which is planned to open in 2033. In March 2014, HS2 Limited published “HS2 Plus” which set out proposals for an acceleration of Phase Two, known as Phase 2a.

29 Phase One of HS2 will see a new high speed line constructed from London Euston to north of Birmingham, where it will reconnect with the existing WCML allowing fast services to serve Manchester, Liverpool, Crewe, Preston and Glasgow. New high speed trains will serve both Birmingham city centre as well as an interchange station which will serve both Birmingham Airport and the wider West Midlands. At Old Oak Common in west London, a new interchange will be built connecting HS2 with Crossrail and the Great Western Main Line.

30 The Phase Two “Y” shaped network will see the new high speed line extended to the north and east. On the western leg, the line will join up with the WCML south of Wigan and there will be a new station in Manchester city centre. The Eastern leg will join with the East Coast Main Line (ECML) approaching York.

31 The figure overleaf summarises the indicative HS2 Phase One service pattern that has been presented to the hybrid Bill Committee.



Indicative plan of services of the WCML and HS2 following Phase One[5]

32 HS2 Phase One would increase the capacity for fast trains on the HS2 and the West Coast Fast Lines combined into/from London Euston from 15-16tph to 23tph.

33 In Phase Two, the total number of fast trains into Euston will increase to 31tph. The additional 8tph will run on the WCML corridor as far as Birmingham and then operate on the Eastern leg of the HS2 "Y" network.

34 The principal impacts of this from a capacity perspective will be to:

- Increase the overall quantum of long distance inter-city services to circa 17tph, across HS2 and the WCML Fast Lines
- Provide a step change in commuter capacity on the WCML Fast Lines by using the capacity released from moving the majority of inter-city services to the dedicated HS2 route
- Potentially allow a wider range of direct connections to/from London for locations that currently have limited or no direct services
- Potentially allow a better range of services into Birmingham and Manchester, where in 2008 priority on the main routes was given to inter-city trains at the

[5] Source: HS2 Ltd. Version presented by HS2 to Hybrid Bill Committee

expense of local, regional and inter-regional services in order to get the enhanced inter-city timetable in place

How HS2 will help address train capacity issues

35 Assuming that rail passenger demand continues to grow, at some point in the future, both the existing commuter and long distance WCML services will become unacceptably overcrowded, even if all peak trains are operated at their maximum length.

36 To illustrate this issue of overcrowding, two growth scenarios have been modelled, covering the period up to 2033/34 when the full HS2 "Y" network is scheduled to open. The base data for this analysis are the latest count figures which are provided to DfT by all train operators, including London Midland and Virgin West Coast.

37 The 'Reference Case' applies the passenger growth rates from DfT's Planet Framework Model (PFM) – the model that underpins the HS2 Economic Case. Averaged out over the period from 2014/15 to 2033/34, these are growth of 1.8 per cent per annum for WM services (currently operated by London Midland) and 2.0 per cent for ICWC services (currently operated by Virgin West Coast). These growth rates take into account the impact of exogenous demand drivers such as GDP and population growth but do not take into account the initiatives of train operators to grow demand e.g. marketing, new products and service quality enhancements.

38 The 'Higher Growth Case' uses 'high sensitivity' growth rates from the DfT's Network Modelling Framework (NMF). In this scenario, the growth rates averaged out at 3.0 per cent per annum for WM services and 3.7 per cent per annum for ICWC services.

39 These 'high sensitivity' growth rates are closer to the actual growth in demand seen on Britain's railways in the period since privatisation. However, even these figures are significantly lower than the actual growth that has been witnessed. Since 1997, the number of passenger journeys on the London and the South East commuter network has grown at a rate of 4.3 per cent per annum whilst the number of inter-city journeys has grown at a rate of 4.7 per cent per annum.

West Midlands franchise crowding under today's service levels

40 In recent years, London Midland has been one of the most crowded London commuter train operating companies (TOCs). In each of the last seven years, Passengers in Excess of Capacity (PiXC), on London Midland has exceeded the London and South East average. In Autumn 2014, PiXC was 6.5 per cent across the AM and PM peaks, the second highest PiXC figures amongst London commuter train operators. This compared to PiXC of 4.1 per cent across the wider London commuter network.

41 Since the Autumn 2014 counts took place, London Midland has introduced a new timetable in December 2014 which added two additional services into London Euston in the AM peak hour in order to relieve some of these crowding issues.

42 The analysis in this report shows that even with this intervention, continuing to operate the current train service up to 2033/34 would lead to estimated PiXC levels of 18 per cent in the Reference Case and 30 per cent in the 'Higher Growth Case' - three to five times greater than levels seen today.

43 It is notable that these crowding levels would also be significantly higher than the most crowded TOC in Autumn 2014, which was Greater Western - with PiXC of 10.1 per cent. A series of major investments are in progress to mitigate this crowding including the re-modelling of Reading station and the introduction of new higher capacity Inter-city Express trains.

Impact of different interventions on West Midlands franchise crowding

44 To determine how this passenger crowding might be mitigated, three options have been considered:

- Extending all WM trains to 12-cars from the current mix of predominantly 8-car and 12-car trains
- The “Strategic Alternative”. The Strategic Alternative builds on the all 12-car option by adding sufficient route capacity to allow two further fast services between 07:00–08:00 (increasing the current 28 AM peak trains to 30)
- “With HS2”: With HS2 Phase One, route capacity released from running fewer inter-city services on the WCML allows the number of WM AM peak arrivals to increase from 28 to 41

45 The table below illustrates that the infrastructure investment contained within the Strategic Alternative only allows a 4.7 per cent increase in WM AM peak capacity into Euston over and above running all of today’s services with 12-cars.

Scenario	Number of services	Standard Class seats	Standard Class capacity
December 2014	28	15,132	20,234
All 12-carriage	28	19,344	25,884
Strategic Alternative	30	20,580	27,120
With HS2	41	30,330	41,103

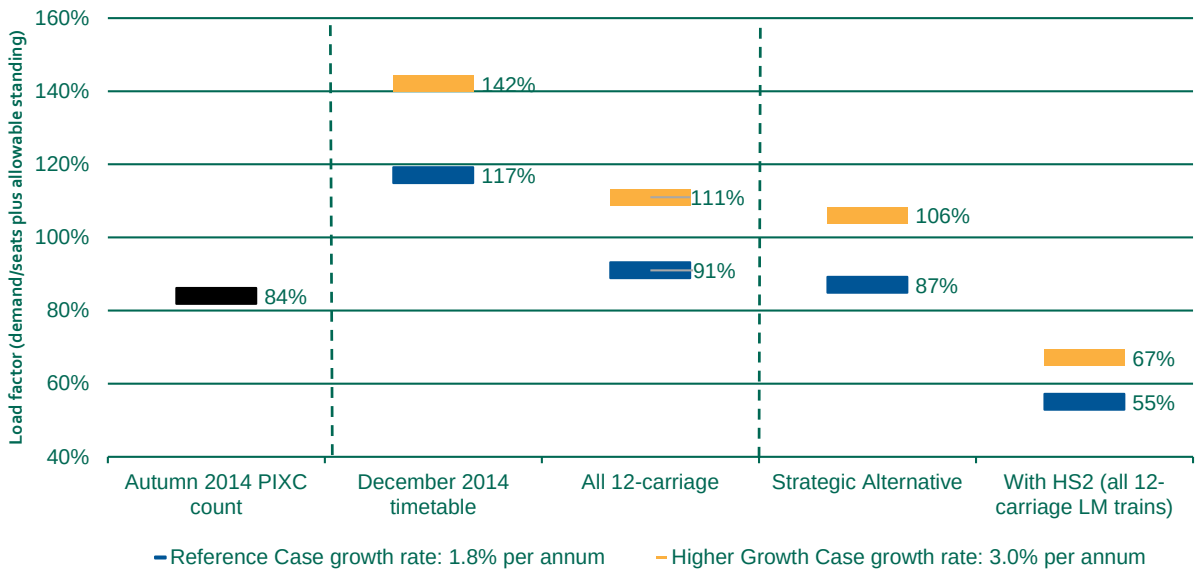
West Midlands franchise AM Peak capacity into Euston (07:00–09:59)[6]

46 HS2 conversely provides a step change in commuter capacity on the WCML corridor. This is because capacity released by operating much of today’s inter-city services on dedicated high speed lines could allow the number of WM services in the AM Peak to increase from 28 to 41, resulting in a 59 per cent increase in AM peak capacity into Euston.

47 The figure overleaf sets out the crowding impact of each of these scenarios by forecasting average load factors on WM across the AM peak in 2033/34. This covers all Euston arrivals between 07:00 and 09:59 with the load factor defined as demand divided by capacity under DfT’s PiXC measure (seating plus a standing allowance).

48 For each option, the yellow bars represent forecast load factors under the ‘Higher Growth Case’ and the blue bars under the Reference Case growth rates.

[6] Data source: Analysis of the December 2014 timetable; “The Strategic Case for HS2” (DfT 2013)



Forecast West Midlands franchise 2033/34 AM Peak load factors arriving at Euston (demand/seats and allowable standing)

49 The analysis demonstrates that:

- Operating the existing train service in 2033/34 would result in average load factors in the AM peak of 117 per cent in the Reference Case and 142 per cent in the Higher Growth Case'. This would translate into estimated PiXC across the AM and PM peaks of 18 per cent and 30 per cent respectively compared to 6.5 per cent in Autumn 2014
- Operating every service with 12 cars would reduce load factors to 91 per cent and 111 per cent respectively. This would translate into estimated PiXC of 11 per cent and 19 per cent
- The infrastructure investment contained within the Strategic Alternative only provides a marginal increase in WM capacity over and above running today's services with 12-cars. Average load factors in 2033/34 would be 106 per cent across the AM peak in the 'Higher Growth Case.' In the Reference Case, loadings would exceed today's levels
- Due to the release of WCML route capacity for commuter services, the "with HS2" option allows future growth on WM to be accommodated in both the 'Reference Case' and the 'Higher Growth Case.' With this additional capacity, average loadings across the AM Peak would not return to today's loads until 2063 in the 'Reference Case' and 2041 in the 'Higher Growth Case'

Crowding on ICWC today

50 In Autumn 2014, average weekday Standard Class load factors (number of passengers divided by number of seats) on Virgin West Coast were 68 per cent in the AM Peak (arrivals at London Euston between 07:00-09:59) and 67 per cent in the PM Peak (departures from London Euston between 16:00-19:59). On Fridays, PM Peak load factors are 79 per cent.

51 Because loads are not evenly distributed across train services, even with average load factors of less than 100 per cent there are some individual services with more passengers than seats. Autumn 2014 count data indicates that at present, 0.7 per cent of Virgin West Coast passengers across the AM and PM peaks are standing as trains arrive at/depart Euston. This rises to 2.4 per cent on a Friday PM peak.

Future crowding levels if all ICWC trains are lengthened and reconfigured

52 Standing will become a major issue on ICWC services by 2033/34. This is the case even if all peak trains are operated with11-cars and trains are reconfigured such that they provide eight cars of Standard capacity and three cars of First Class capacity instead of the seven cars of Standard capacity and four cars of First Class capacity provided today.

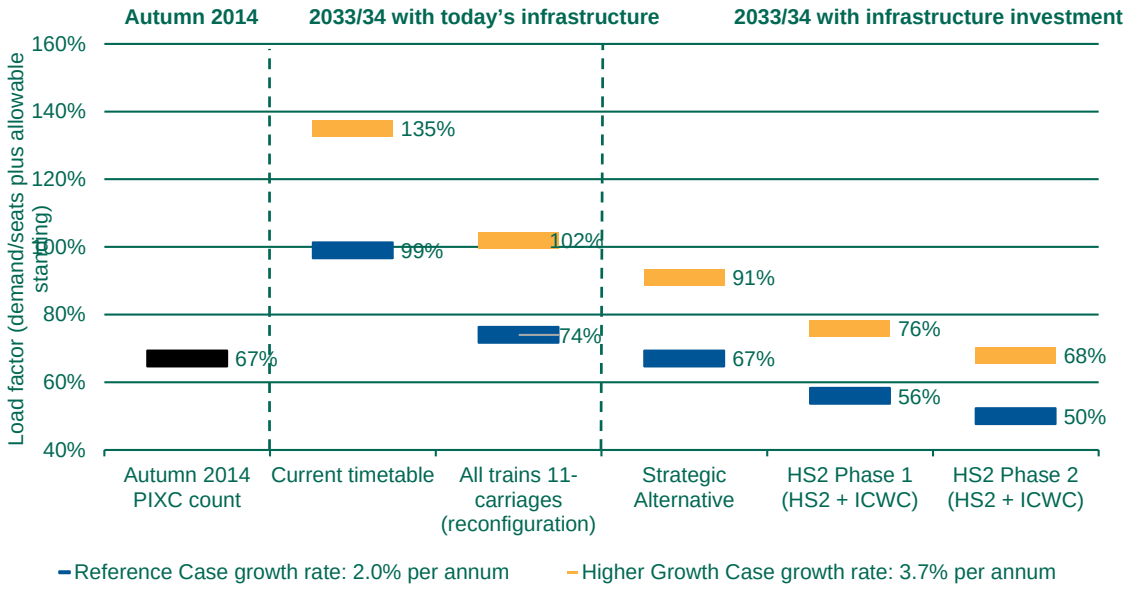
53 This report, shows that even with longer, reconfigured trains, by 2033/34:

- **Under the 'Reference Case'**, an average of 2 per cent of peak passengers will be standing on arrival at/on departure from Euston during AM and PM Peaks, with 9 per cent of passengers standing on departure from Euston in the Friday PM Peak
- **Under the 'Higher Growth Case'**, an average of 15 per cent of peak passengers will be standing on arrival at/on departure from Euston. This rises to 23 per cent of passengers standing in the Friday PM Peak on trains leaving Euston
- The long distance nature of the ICWC services means that many of the standing passengers identified in this analysis will be standing for an hour or more. In the 'Higher Growth Case' it is estimated that by 2033/34 on an average weekday, 3,200 passengers will stand on ICWC trains departing London in the PM peak. Of these, 1,350 (40 per cent) will be on trains with a first stop that is 59 minutes or more outside of London

54 On a typical Friday, when passenger volumes rise further, it is estimated that 5,900 passengers will be standing on departure from Euston. Of these, 3,500 (60 per cent) will be on trains with a first stop 59 minutes or more outside London, of which 1,300 (22 per cent) will be standing for 90 minutes or more to stations such as Crewe and Warrington.

Impact of different infrastructure interventions on ICWC crowding

55 The figure below illustrates estimated ICWC PM peak weekday load factors in 2033/34 under different investment scenarios.



Forecast ICWC and HS2 2033/34 weekday PM Peak (16:00–19:59) load factors)

56 This shows that:

- Operating every service with reconfigured 11-car trains leaves average load factors over 100 per cent in the 'Higher Growth Case.' In the 'Reference Case' weekday average load factors are 74 per cent, approaching the loadings conditions currently experienced on a Friday
- The Strategic Alternative provides some increase in ICWC capacity by providing a limited number of additional trains in the AM and PM peaks. However, average load factors are forecast to be 91 per cent by 2033/34 in the 'Higher Growth Case', rising to 102% by 2036/37
- The step change in route capacity provided by HS2 allows crowding issues on inter-city services on the WCML corridor to be solved for the long term, whilst accommodating the increase in demand that is predicted to be generated by the introduction of HS2
- Phase Two – which delivers the same quantum of services as Phase One to WCML destinations but would allow longer trains to run north of Birmingham – gives the potential to accommodate further long-term growth in demand

Freight

57 Network Rail anticipates that rail freight volumes will grow by over 40 per cent by 2023 compared with 2011 and by around 90 per cent by 2033. Notably for the WCML, the intermodal segment (much of which is traffic to/from ports to distribution centres in the North and Midlands) is expected to continue to grow the fastest.

58 Network Rail's overall forecasts, suggest that the requirement for WCML paths could increase from 42 today to 80 by 2033. Given the capacity constraints on the existing network, this additional pressure for freight paths would be challenging to accommodate without infrastructure investment.

59 As it adds limited additional route capacity, the Strategic Alternative offers very little in helping meet the increase in demand for WCML freight paths that is forecast by Network Rail.

60 In contrast, by releasing capacity on the WCML, HS2 could facilitate North-South freight movements, particularly intermodal traffic from the ports of the South East and Liverpool. Any decisions around increases in paths available for freight would be subject to established statutory, regulatory, and administrative processes that take place ahead of the introduction of any timetable change.

61 The Train Service Specification (TSS) presented to the hybrid Bill committee in January 2015 suggests that at least one extra freight train could operate each hour, in each direction, post Phase One between London and Handsacre and that a second might be possible as well.

62 The key additional benefit of Phase 2a for freight is that it would allow fast passenger trains to bypass three bottlenecks (the junction at Colwich, the two-track section south of Stafford and the junctions at Stafford itself) thus opening up more capacity that could be used for freight trains (and slower passenger trains) in these areas.

63 The 2013 consultation for Phase Two proposes a further extension of the high speed line from Crewe to Golborne Junction, just south of Wigan - as well as to Manchester. This could release capacity for freight traffic between Crewe and Weaver Junction, where the route to Liverpool leaves the WCML. This could be utilised for freight services to the West Midlands, Daventry and London from any potential future expansion in port facilities at Liverpool, once complete.

1. Introduction

Background - the 2013 Strategic Case for HS2

1.1 The Strategic Case for HS2, published by the Department for Transport (DfT) in October 2013, set out the need for the scheme and explained how it would strengthen the UK's transport network. At the heart of the Strategic Case were issues around route capacity (the number of train services) and train capacity (the number of passengers each service can carry) on the West Coast Main Line (WCML). It is the combination of these two measures of capacity that determines travel conditions.

1.2 The two phases of HS2 provide the means to address capacity issues on the WCML. Phase 2 also addresses capacity issues on the Midland Mainline (MML) and East Coast Mainline (ECML). However, this report is focused on the WCML corridor.

1.3 The WCML is Britain's single most important rail route serving a number of markets – all of which are of strategic national importance:

- Inter-city services on the WCML (Inter City West Coast operated by Virgin West Coast) link the major cities of London, Birmingham, Manchester, Liverpool and Glasgow
- At the southern end of the route, the West Midlands franchise (WM – currently operated by London Midland) operates commuter trains along a corridor through Milton Keynes to London
- Throughout the North West and the Midlands, commuter trains and other regional and inter-regional services operate to serve the major cities of Birmingham, Liverpool and Manchester (as well as many other regional centres such as Coventry, Crewe, Warrington, Preston, Chester, Stoke-on-Trent and Wolverhampton)
- The WCML is the most important freight route on Britain's rail network carrying around 40 per cent of all rail freight services at some point in their journey. Many of the freight services are time-critical and carry containers to and from major ports and provide essential links in retail distribution chains

1.4 The WCML has already been the subject of a major renewal and modernisation programme. This cost £9 billion and was completed in 2008 after a decade of major works. The upgrade allowed around 1,000 additional trains to run each week and reduced key long distance journey times, such as those between London and Manchester, by around 20 per cent.

1.5 The October 2013 Strategic Case for HS2 noted the following important points in respect of route capacity on the WCML:

- The WCML modernisation programme envisaged that following the upgrade, there would be a maximum of 13-14 trains per hour (tph) using the Fast Lines into and out of London Euston. By October 2013, plans were being developed to squeeze in extra fast commuter services which would take the peak service level

on the Fast Lines up to 15tph[7]. At this level of utilisation, the WCML would be operating more fast passenger trains than comparable main lines in other European countries – this despite its complex mix of commuter, freight and inter-city traffic

- Operating the WCML at this level of intensity was making it challenging to achieve target levels of punctuality. In 2013, long distance services on the WCML were achieving 85 per cent punctuality – around 4 per cent points worse than average for other long distance services. The performance of the relevant parts of the London Midland franchise was also around 85 per cent. This was 6 per cent below the national average for equivalent commuter services. Since October 2013, the punctuality of Virgin West Coast has remained at around 85 per cent and London Midland performance has deteriorated to 83 per cent as the extra commuter services have been added

1.6 The Strategic Case went on to set out the medium to long term consequences for train capacity, or overcrowding, on trains using the WCML.

1.7 Passenger crowding is already a major issue on Britain's railways. Over the past 20 years, passenger journeys have more than doubled. The Strategic Case described the problems already experienced by commuters at Euston. However, crowding problems are not unique to the London end of the route or limited to the traditional morning and evening peaks. For example:

- In 2014, more than 10 per cent[8] of passengers arriving on peak hour services into Birmingham and Manchester were standing
- Inter-city services experience significant surges of demand on Friday and Sunday afternoons and evenings when people make leisure trips for the weekend in addition to business/work travel

1.8 The 2013 "Economic Case for HS2" assumed demand would continue to grow at a rate equivalent to around 2 per cent per year for the period until 2036. However, noting that rail demand had actually grown by 4.4 per cent per year over the preceding decade (5.2 per cent on inter-city routes), the Strategic Case set out indicative projections of train load factors (demand divided by seats) in a range of growth scenarios (demand growth of 1.5 per cent, 2.5 per cent and 5 per cent per annum). This analysis highlighted that there was a risk of serious overcrowding by 2026 on both commuter and inter-city routes serving London, Birmingham and Manchester.

1.9 The Strategic Case then considered how both HS2, and the Strategic Alternative – an alternative investment programme that would rely on upgrading the existing route – would address the route and train capacity issues anticipated on the WCML.[9] It concluded that the Strategic Alternative, besides failing to provide the connectivity gains that HS2 would bring from improved journey times:

- Did not provide sufficient additional capacity to meet the long term needs for the railway

[7] This would be achieved by increasing commuter services top speed to 110 miles per hour (mph) and so reducing their speed differential against the inter-city trains running at 125 mph.
[8] "Rail passenger numbers and crowding on weekdays" (RAI02) (DfT) at https://www.gov.uk/government/statistical-data-sets/rai02-capacity-and-overcrowding
[9] The report "HS2 Strategic Alternatives, Final Report" (DfT, 28 October 2013) sets out the work that was undertaken on alternative options for meeting the capacity and connectivity objectives set by Government when developing its plans for HS2. The work was undertaken by DfT and Network Rail and supported by consultants Atkins. We summarise the Strategic Alternative at the end of Chapter 3 of this report.

- Did not release significant additional capacity for commuter and freight traffic on the WCML
- Would be very disruptive and costly to develop
- Failed to solve the problem of resilience and performance on the WCML

Work completed following the publication of the Strategic Case

1.10 Following on from the publication of the October 2013 Strategic Case, DfT has undertaken further work to keep up to date its analysis of route capacity and train capacity issues on the WCML. This takes into account subsequent trends in passenger demand and train loadings, revised estimates of future growth and the impact of measures being taken to ease crowding, including the introduction of longer trains.

1.11 This update has examined each route section of the WCML and identified:

- Where the route is running close to capacity and the constraints that prevent the operation of additional services (without potentially significant adverse impacts on other key service attributes such as spare punctuality and journey times)
- The apparent demand for additional services (long distance, commuter, regional and freight)
- The potential of both HS2 and the Strategic Alternative to provide the capacity required to allow additional services to be operated

1.12 The updated train capacity analysis has examined:

- The scale of the passenger crowding that is likely to arise by 2033/34 (the year in which Phase Two of HS2 will open) on the key WCML services – ICWC, WM and the commuter services into Birmingham and Manchester
- The ability of tactical measures such as the lengthening and reconfiguration of trains to address demand growth, taking into account measures introduced since 2013 and further potential measures of a similar nature, in the years ahead
- The impact of any further increase in capacity, beyond these tactical measures, provided by the Strategic Alternative
- The ability of HS2 to provide a long term, sustainable solution to passenger crowding issues across all key WCML markets

1.13 In addition, DfT has investigated further the potential freight benefits provided by each of Phase One, Phase 2a and Phase 2b of HS2.

1.14 In undertaking this work, DfT was supported by consultants KPMG and Steer Davies Gleave. Network Rail has reviewed and validated the analysis in respect of route capacity and freight.

Purpose of this report

1.15 The purpose of this report is to bring together the evidence captured by DfT's updated analysis of WCML capacity issues. The report follows the structure set out below:

- **The strategic importance of the WCML**: this chapter explains how the WCML serves a number of the UK's most critical rail markets. It highlights how these markets have grown, and increased in their importance over the last 20 years and how the major upgrade of the WCML has been critical in supporting this
- **The WCML today**: this chapter explains, at a high level, the existing capacity and performance pressures on the WCML, the growth in freight and passenger demand that is anticipated and the alternative options that exist for providing additional capacity
- **Route capacity**: taking the WCML section by section, this chapter sets out where the network is constrained, the trade-offs that would be required in order to run further trains and the impact of HS2 and the Strategic Alternative in providing additional route capacity to allow more trains to be operated
- **Train capacity**: for the major WCML operations, WM and ICWC, this chapter sets out future crowding issues under two scenarios of demand growth. It considers the potential of a number of investment options to accommodate future growth
- **Freight**: this chapter explores the potential of the different phases of HS2 – Phase One, Phase 2a and Phase 2b to accommodate the anticipated increase in demand for freight services along the WCML

2. The strategic importance of the West Coast Main Line

- The WCML is one of our most important rail corridors; it links four of Britain's biggest conurbations and serves all rail markets: inter-city; commuter; regional; and freight
- Since 1996/97, inter-city passenger journeys on the WCML have increased by 162 per cent
- Three of Britain's top six business rail flows (London to each of Manchester, Birmingham and Liverpool) are served by the WCML; a significant inter-city leisure market also exists
- The number of commuter journeys into London on the WCML has doubled since 1996/97. Taken together with inter-city traffic, Euston is the fastest growing of all London termini
- In recent years, commuter flows into Birmingham and Manchester have grown as quickly as those into London. Peak passenger numbers at city centre stations in Birmingham and Manchester have increased by 15 per cent and 27 per cent respectively over the last four years
- Rail freight is estimated to deliver £1.5billion per annum of economic benefits to UK plc; 40 per cent of all freight trains use the WCML at some point in their journey
- The £9 billion WCML upgrade, allowed a 45 per cent increase in daily services from London to Birmingham and Manchester. However, since completion in 2008, over 60 per cent of the additional inter-city seat capacity provided by the decade-long upgrade has already been filled

Overview

2.1 Figure 1 illustrates the main WCML corridor and the sub-routes that lie within it.

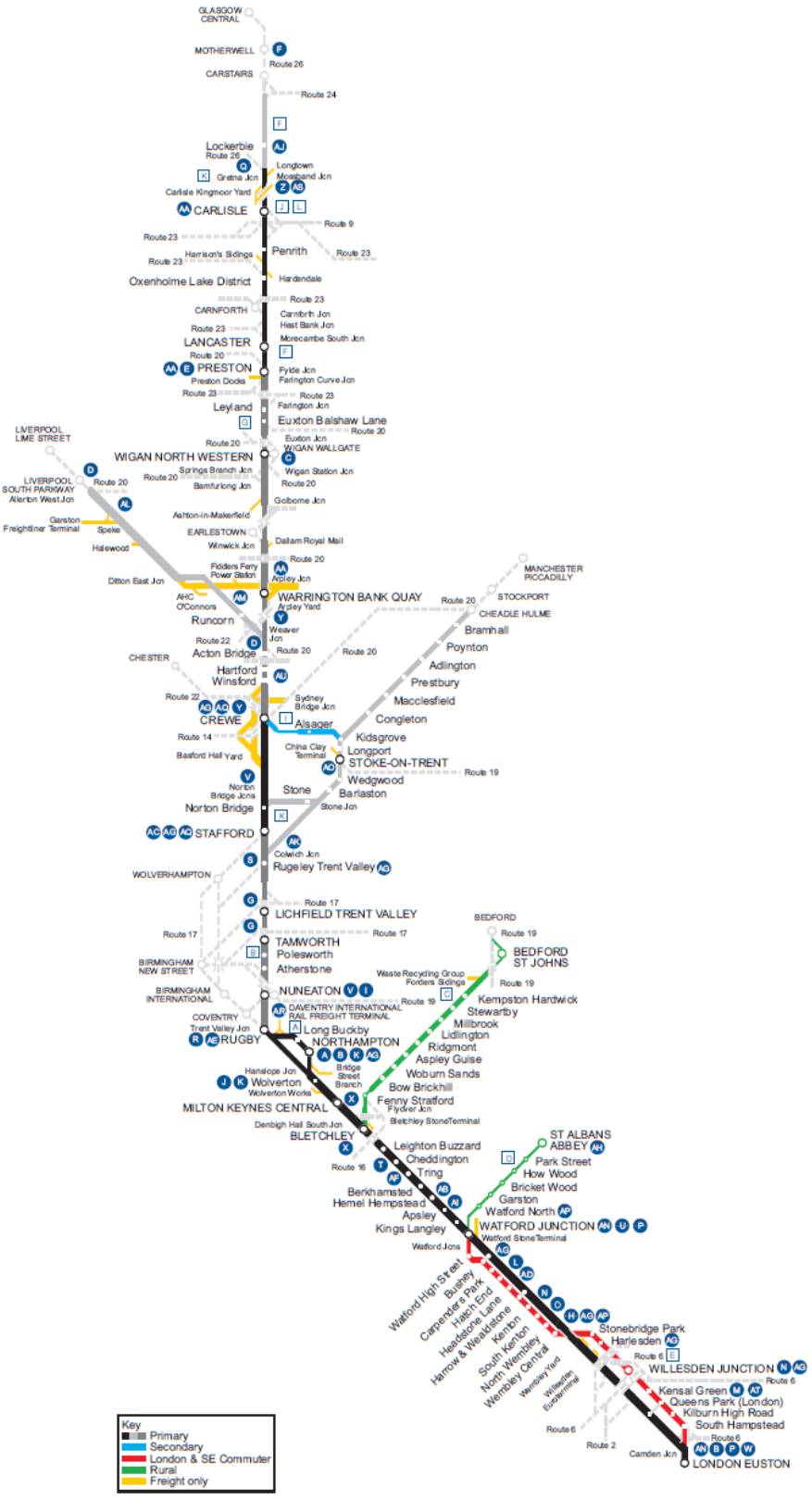


Figure 1: Illustration of the West Coast Mainline (WCML) corridor [10]

[10] Source: Network Rail

2.2 The WCML is predominantly a four-track railway between London and Crewe – albeit with a two-track section between Colwich Junction and Stafford. It comprises one pair of Fast Lines carrying a mix of long distance and outer suburban commuter services and one pair of Slow Lines carrying a mix of 'inner' commuter and freight services. This separation of train services helps maximise the utilisation of available capacity at the Southern end of the WCML. However, the service types cannot be fully separated. Some outer suburban services switch between the Fast and the Slow Lines; other services come together on two-track feeder sections of route or north of Crewe at key junctions.

2.3 The feeder branches are at Rugby (to Coventry, Birmingham and Wolverhampton) and branches at both Colwich Junction and Crewe which run to Manchester. There are further branches to North Wales, to Liverpool (from Weaver Junction) and to Blackpool. North of Crewe to Scotland, the WCML is mostly a two-track railway carrying a mix of fast inter-city services, local/regional services and freight traffic.

2.4 As Figure 2 illustrates, the WCML serves a complex mix of markets.

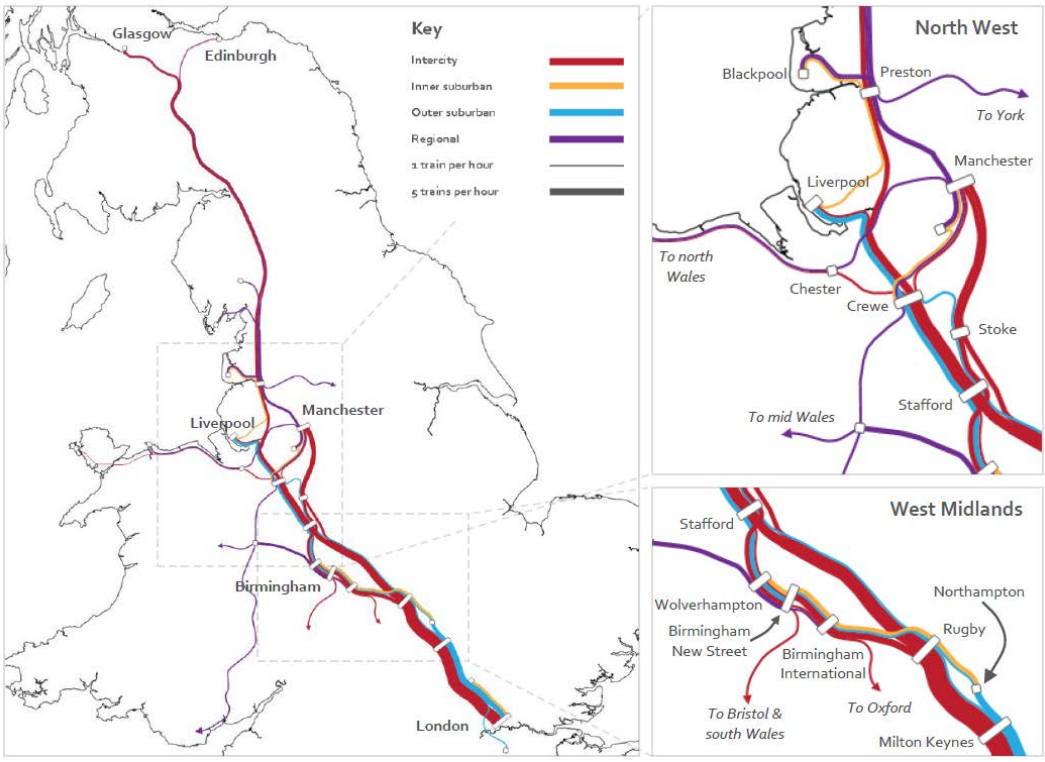


Figure 2: Overview of the passenger markets served by the WCML

2.5 The Inter City West Coast franchise – currently operated by Virgin West Coast - connects Britain's four largest conurbations and carries around 35 million passengers annually. In peak periods it operates 10-11tph[11] to/from London Euston.

2.6 The West Midlands franchise – currently operated by London Midland - operates commuter trains from Crewe, Birmingham, Milton Keynes and Northampton into London. In the morning peak hour it runs 13tph: 5tph operate on the WCML Fast Lines alongside ICWC services, with 8tph running on the Slow Lines.

[11] Virgin West Coast operates 12tph between 18:00-18:59 on Fridays.

2.7 Regional and other suburban services operate alongside inter-city trains throughout the North and Midlands. For example:

- London Midland runs a commuter service of 4tph into Birmingham New Street in the peak. There are also services operated by Arriva Trains Wales and Cross Country using the two-track Coventry corridor into Birmingham New Street
- The southern approaches to Manchester Piccadilly carry services operated by Virgin West Coast, Cross Country, Northern, TransPennine Express and East Midlands Trains

2.8 In addition to this, the WCML also accommodates up to four freight services per hour in each direction (42 services per day).

Inter-city services

2.9 ICWC services have been operated by Virgin West Coast since 1996/97. As illustrated in Figure 3, services are categorised into five service groups.

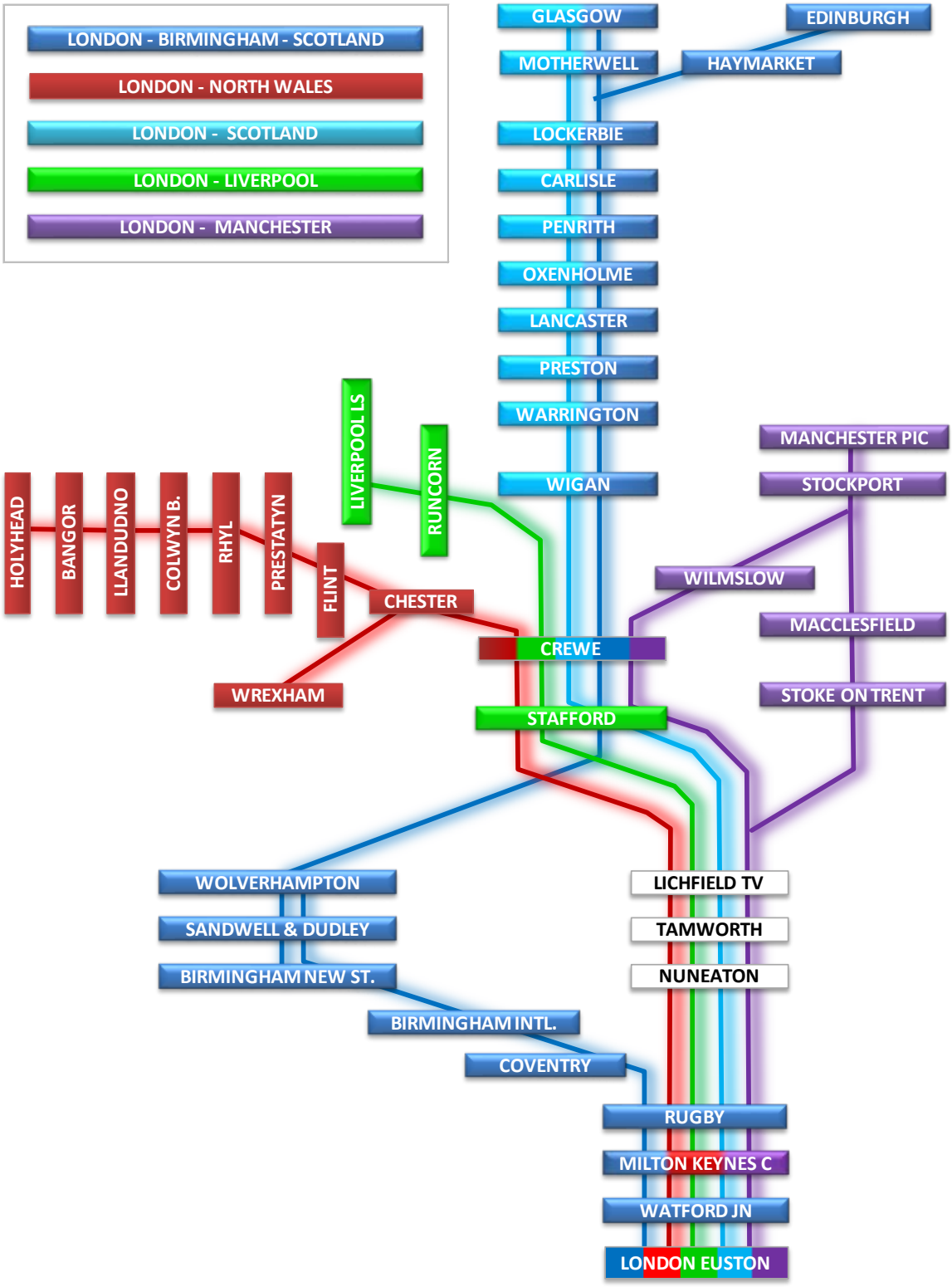


Figure 3 Summary of ICWC service groups

2.10 In the weekday AM peak, defined as between 07:00 to 09:59, ICWC runs 27 services to London Euston. In the evening (PM) peak period (between 16:00 and 18:59) 32 trains run from Euston. In the standard (normal) off-peak hour, nine services operate. Figure 4 sets out frequencies by service group - both Birmingham and Manchester have three services per hour throughout the day.

Service group	Off-peak standard hour	AM Peak hour (08:00-08:59)	PM Peak hour (17:00-17:59)
London - Birmingham/Wolverhampton	3	3	3
London - Manchester	3	3	3
London - Liverpool	1	2	2
London - Glasgow	1	1	2
London - Chester	1	1	1
Total	**9**	**10**	**11**

Figure 4 Summary of ICWC service frequency by service group[12]

2.11 Figure 5 illustrates the growth in passenger journeys that Virgin West Coast has experienced since 1996/97. Between 1999 and 2004, major works were carried out along the line of route to implement the West Coast Route Modernisation (WCRM) renewal and upgrade works, and demand levelled off. However, this has been followed by a period of extraordinary growth following the improvement in service and this has continued every year since – despite the economic downturn from 2008. In total, passenger journeys have grown from 13.2 million in 1996/97 to 34.5 million in 2014/15. Growth of 162 per cent since 1996/97 is over 50 per cent higher than the average growth rate observed on the wider Great Britain rail network, which is 106 per cent.

Figure 5 Historic growth in journeys on Virgin West Coast[13]

[12] Data source: DfT analysis of December 2014 timetable
[13] Data source: ORR data portal, ORR National Rail Trends

2.12 Figure 6 presents the demand growth that has been achieved on key WCML inter-city flows since 1995. London to/from Birmingham leads the way with growth of 255 per cent, followed by London to/from Manchester with growth of 210 per cent.

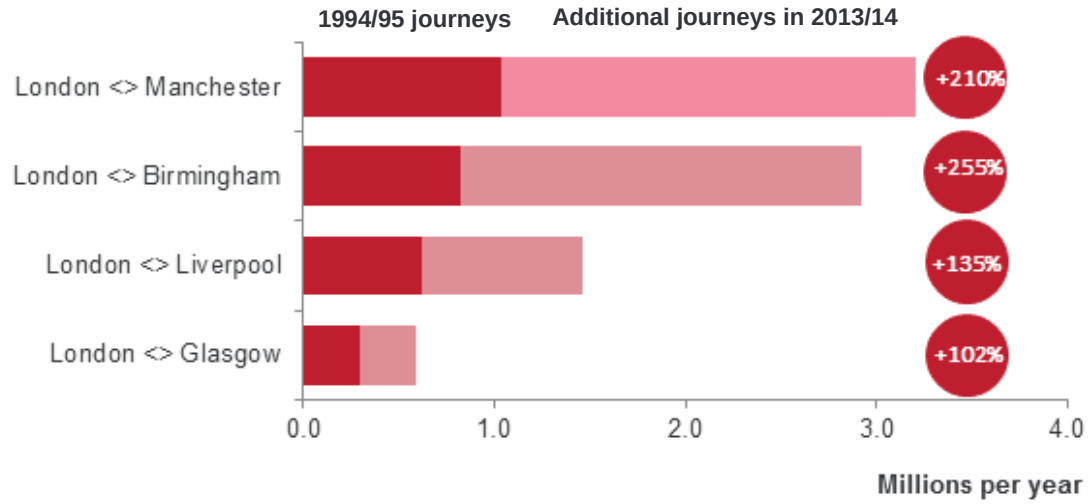


Figure 6 Historic growth on key ICWC flows[14]

2.13 The WCML inter-city market is particularly important for business travellers as it provides regular and fast services between Britain's major cities. Figure 7 compares the types of journey being made on the WCML inter-city flows with Britain's rail network as a whole. Journeys have been categorised into three journey-types: business, leisure and commuting.

2.14 As can be seen from Figure 7, inter-city journeys on the WCML have a much higher proportion of business trips than the average for the GB rail network. In 2013/14 it is estimated that 52 per cent of all rail journeys between London and Birmingham, Manchester, Liverpool and Glasgow were business trips.

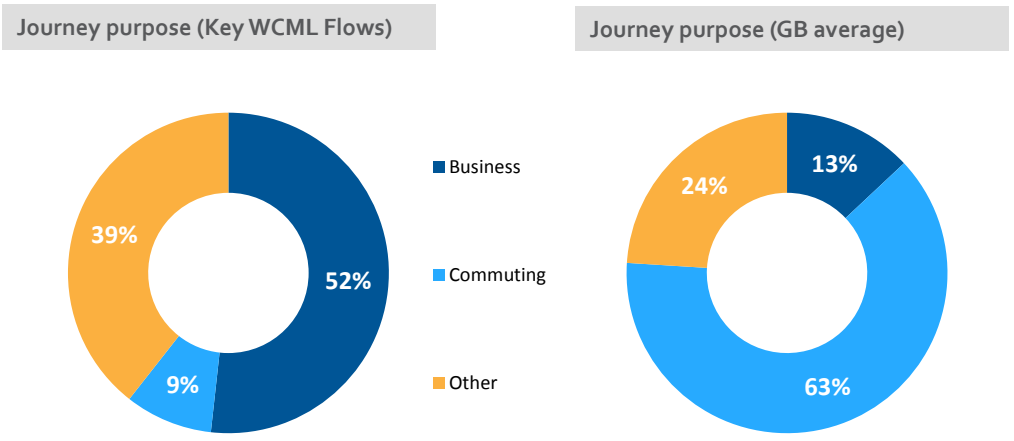


Figure 7 Journey purpose – Key WCML flows versus UK average in 2013/14 [15]

[14] Data source: RUDD (LENNON ticket sales data)
[15] Data sources: RUDD (LENNON), National Rail Travel Survey (2010, DfT), HS2 Ltd

2.15 Figure 8 provides further evidence of the importance of the WCML for business travel. The table shows the top five inter-city rail flows on the WCML for business trips together with their position in the overall list of inter-city rail flows in Britain. In 2013/14 the flows between London and Manchester and London and Birmingham were the two most significant rail business flows in Britain, with London-Liverpool and London-Coventry also featuring in the top 10.

Overall Rank	Flow (both directions)	Business trips in 2013/14
1	London <> Manchester	1,843,000
2	London <> Birmingham	1,528,000
6	London <> Liverpool	491,000
8	London <> Coventry	479,000
11	London <> Birmingham Intl	366,000

Figure 8 Top-5 WCML inter-city business corridors (London and non-London) in 2013/14[16]

2.16 In addition to the business market, the WCML also serves a number of other important inter-city markets. This includes passengers who are travelling to/from higher education; on holiday or for short breaks; visiting friends or family; making shopping trips or travelling to/from sport events. Indeed, the WCML links the top five cities in England, measured in terms of leisure visits by overseas visitors. Overall, tourism contributes £106 billion to the English economy[17].

2.17 Friday and Sunday afternoons and evenings are a particularly popular time, not only for leisure travel, but also for those who travel away for work/business reasons on a weekly rather than a daily basis – an approach that is not unusual for longer distance travellers. The combination of leisure, and passengers travelling for other purposes, means that services at these times, and in particular on Friday evenings, can be especially busy.

2.18 As explained in detail in Chapter 3, given network capacity constraints, there is limited scope for the ICWC operator to provide additional services to address these spikes in demand. Virgin West Coast has therefore sought to accommodate Friday demand by:

- Running an additional Euston-Preston service at 18:46 and Euston-Manchester service at 18:57 giving a total of 16tph on the Fast Lines (across both commuter and inter-city operations) between 18:00 and 18:59 on Fridays
- Providing more seats by re-classifying carriages. All 9-car Pendolinos are having one First Class carriage permanently converted to Standard. Voyager trains have one car that can be used as either First or Standard Class, depending on the time of day and demand levels

2.19 The pattern of travel across the evening peak period is affected by ticketing restrictions, with the highest volume of passengers departing Euston from 19:00 - 20:00. It is likely that some of the post-19:00 demand is displaced from the standard commuting peak period (taken as being 16:00-19:00) because of the non-availability of cheaper tickets.

[16] Data sources: RUDD (LENNON), National Rail Travel Survey (2010, DfT), HS2 Ltd
[17] VisitEngland.com, "The value of tourism in England" (Visit England 2014) https://www.visitbritain.org/town-data

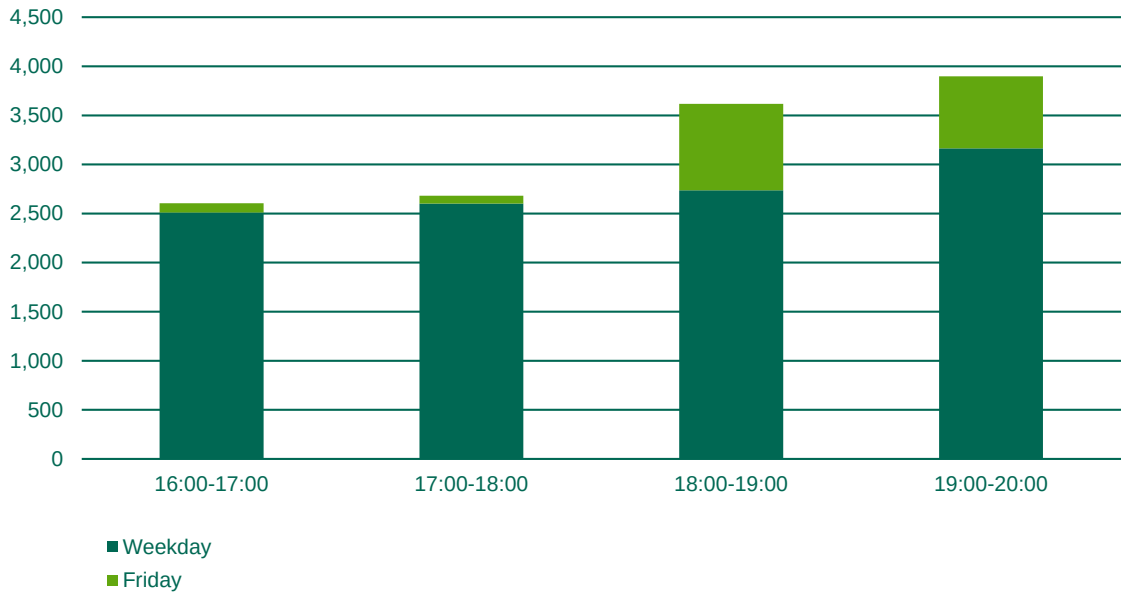


Figure 9 Comparison of passenger numbers departing London Euston on ICWC services[18]

2.20 As 19:00 to 19:59 is the busiest hour on Virgin West Coast services, analysis of the PM Peak on ICWC services has been extended to run from 16:00 to 19:59 throughout this report.

[18] Data source: DfT Autumn 2014 train counts

Commuter services

West Midlands commuter services

2.21 WM commuter services to/from London on the WCML have been operated by London Midland since 2007/08. Figure 10 illustrates the stations served by London Midland.

Figure 10 Summary of London Midland commuter routes at southern end of WCML

2.22 Inner suburban services use the WCML Slow Lines. Journeys are typically less than 40 miles from London with key stations served including Watford, Tring, Berkhamsted and Hemel Hempstead. Outer suburban services use a mix of the WCML Fast and Slow Lines. Journeys are typically more than 40 miles from London and key stations served are Leighton Buzzard, Milton Keynes, Northampton and Rugby.

2.23 Figure 11 sets out the average growth rates observed across the London and the South East (LSE) rail market during the 19 year period to 2014/15. It also shows the growth that has been experienced by the London Midland TOC since its first full year of operation in 2008/9 and compares this to wider LSE growth over the same seven year period. This chart shows that passenger journeys on London Midland have grown significantly over time, exceeding the pace of wider rail growth across the LSE area (leaving Transport for London's Overground operation aside).

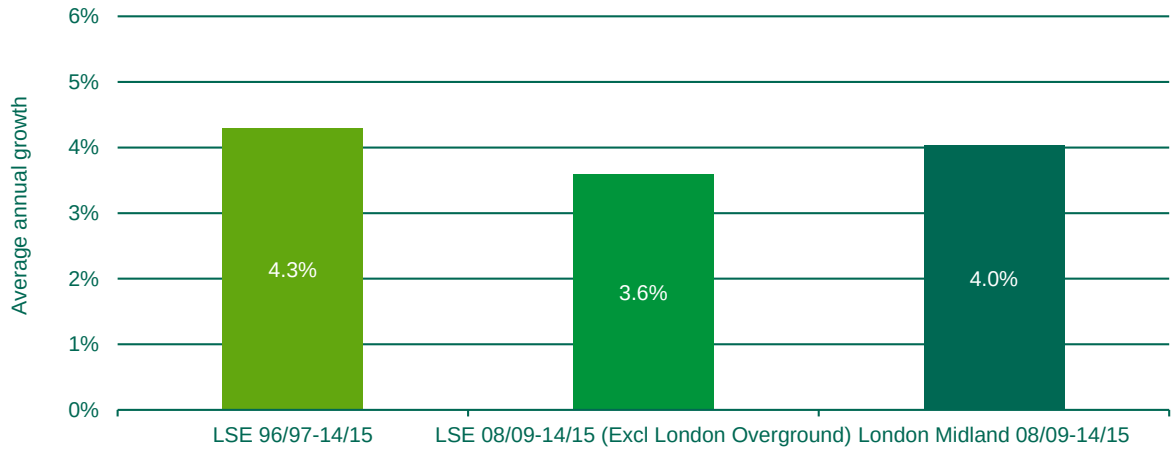


Figure 11 LSE and London Midland historic growth (average annual growth)[19]

2.24 Figure 12 analyses historic growth on six key London Midland flows in more detail. The dark green bars represent the number of passenger journeys on each flow in 1996/97, the lighter green represents the growth in journeys to 2013/14. On average, passenger demand on flows across the LSE sector has grown 102 per cent from 1996/97 to 2013/14. Growth on longer distance WM commuter flows such as Milton Keynes - London, Northampton - London, and Rugby - London has outperformed the LSE average over this period. Rugby, Milton Keynes and Northampton are some of the major stations served by those London Midland trains that operate on the Fast Lines.

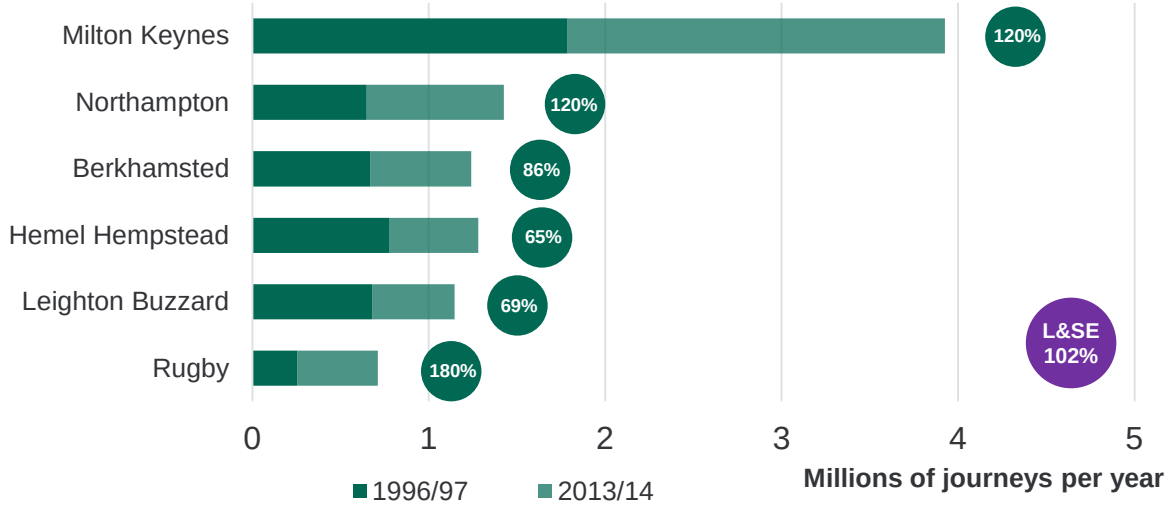


Figure 12 Growth on key London Midland flows to/from London (1996/97 to 2013/14)[20]

[19] Data source: ORR data portal. Note: London Overground has been excluded from the 2008/09-2014/15 figures as it has substantially increased its network coverage and incorporated former LUL services which would not be included in the base demand figures. Total LSE journey growth including London Overground is 5.2%

[20] Data source: DfT's RUDD (based on LENNON)

2.25 This growth is part of a wider trend of an increase in the average length of commuter journeys in the UK, and has increased the pressure for additional outer-suburban services on the WCML as shown in Figure 13. This trend reflects continued housing growth in the Milton Keynes/South Midlands area.

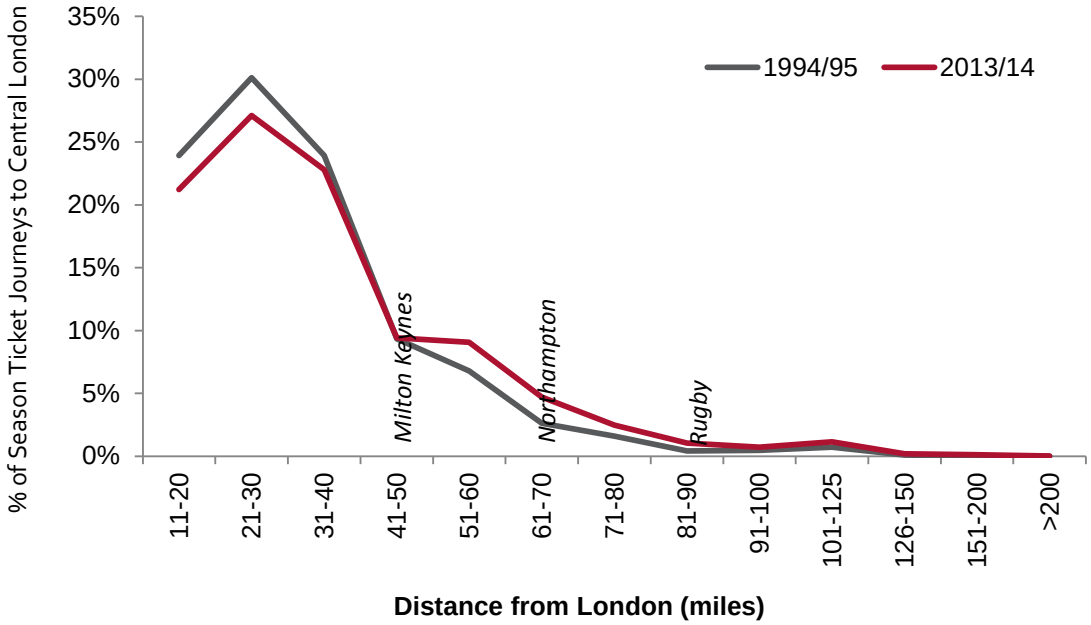


Figure 13 Distribution of season ticket journeys to Central London (outside of London Travelcard area)[21]

2.26 It should be noted that this trend is likely to continue in the WCML corridor. Milton Keynes/South Midlands is the largest planned area for additional housing provision in the South East. The Strategic Economic Plan for the South East Midlands LEP, which includes Milton Keynes and Northampton, sets out plans to deliver 86,700 new homes by 2020/21 in order to accommodate an increase in population of 151,400.

[21] Data source: DfT analysis of LENNON data

Birmingham services on the WCML

2.27 Four train companies operate a mix of fast and slow passenger services along the two-track section of the WCML into Birmingham New Street: Virgin West Coast; London Midland; Arriva Cross Country; and Arriva Train Wales. Freight services also operate on the same track. Figure 14 illustrates the service pattern that operates into Birmingham New Street station in the morning peak hour (08:00 – 09:00).

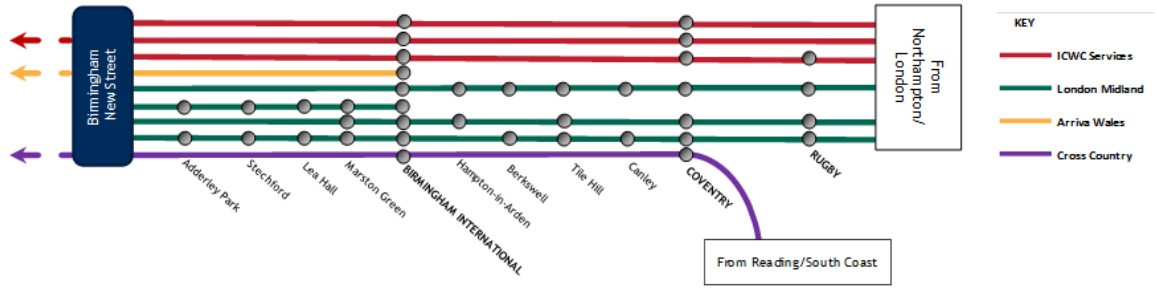


Figure 14: December 2014 AM Peak hour (08:00 – 09:00) WCML timetable into Birmingham New Street[22]

2.28 Overall peak usage of Birmingham city centre stations is growing. Figure 15 below shows that between 2010 and 2014 peak arrivals and departures increased by 15-16 per cent, or 3.6 per cent per year on average. This is comparable to the growth rate in London commuter traffic (excluding London Overground) over the same period (see Figure 11).

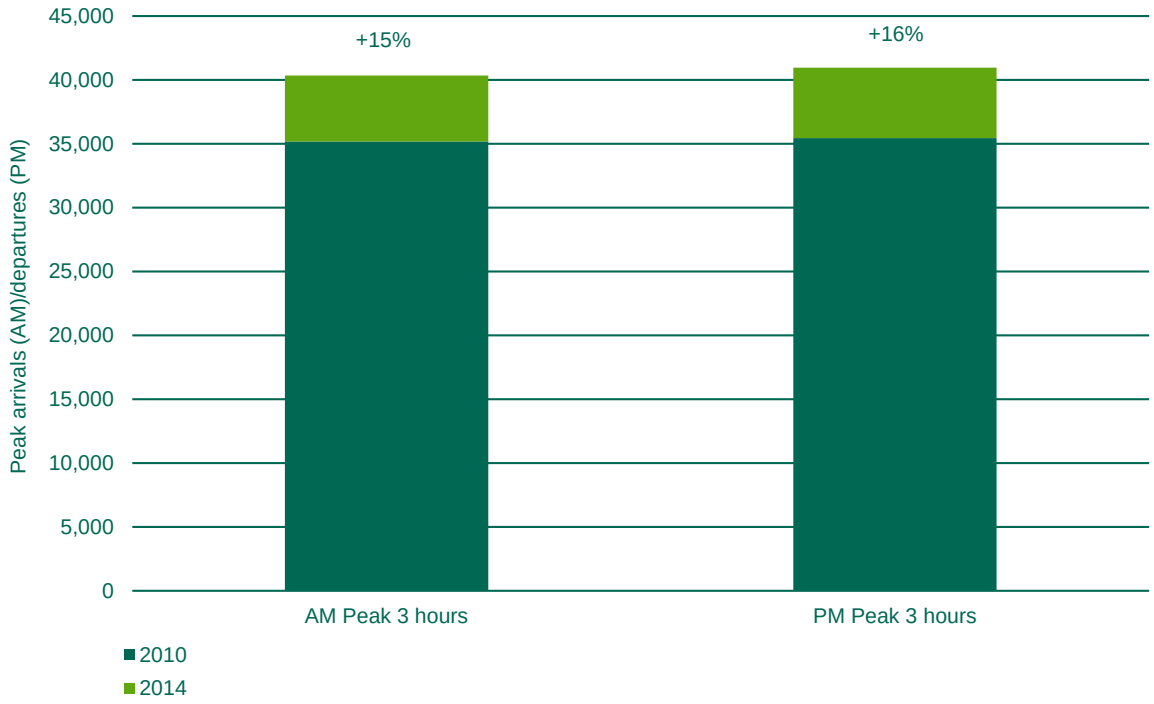


Figure 15: AM Peak arrivals and PM Peak departures from Birmingham stations (New St, Moor St, Snow Hill) 2010-14[23]

[22] Data source: DfT analysis
[23] Data source: " Rail passenger numbers and crowding on weekdays" (RAI02) (DfT) Table - RAI0212

Manchester services on the WCML

2.29 As with Birmingham, a mixture of fast and slow passenger services, plus freight, share the same WCML track into Manchester Piccadilly.

2.30 Four Northern Rail trains per hour provide the peak commuter services into Manchester Piccadilly: two operate from Crewe (one via Manchester Airport); one operates from Alderley Edge; and the other from Stoke-on-Trent. In addition to these, the following regional and inter-city services operate, and during peak hours also carry commuters into Manchester:

- Virgin West Coast - 3tph from London to Manchester
- Arriva Trains Wales - 1tph from South Wales to Manchester
- Arriva Cross Country - 2tph from Birmingham to Manchester

2.31 In addition, a number of other services join and make use of the route at Stockport – from Buxton, Sheffield, Hazel Grove and Chester.

2.32 Recently peak usage of Manchester city centre stations has grown at a faster rate than has been experienced in either London or Birmingham. Figure 16 below shows that over the period 2010-2014, arrivals and departures have increased by 27 per cent on average across the two peak periods, equivalent to 6.2 per cent per year.

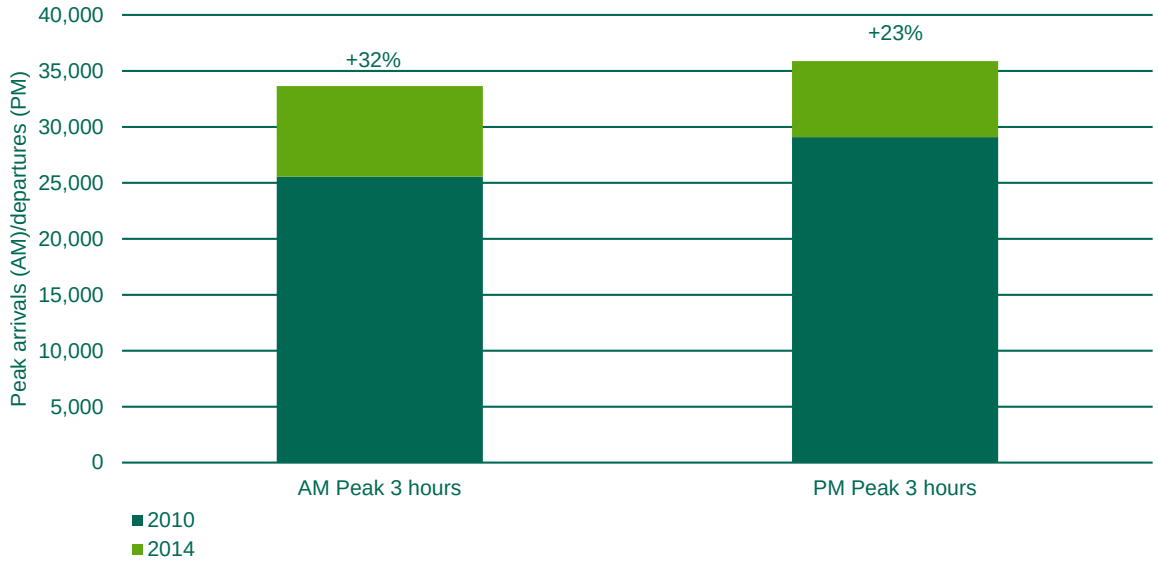


Figure 16: AM Peak arrivals and PM Peak departures from Manchester stations (Piccadilly, Oxford Rd, Victoria) 2010-14[24]

[24] Data source: "Rail passenger numbers and crowding on weekdays" (RAI02) (DfT) Table - RAI0212

Freight services

2.33 The WCML is more than a passenger railway – it is the vital artery of Britain's rail freight industry. As with the passenger railway, there has been significant growth in the demand for rail freight with volumes rising by 70 per cent since privatisation in the mid-1990s.

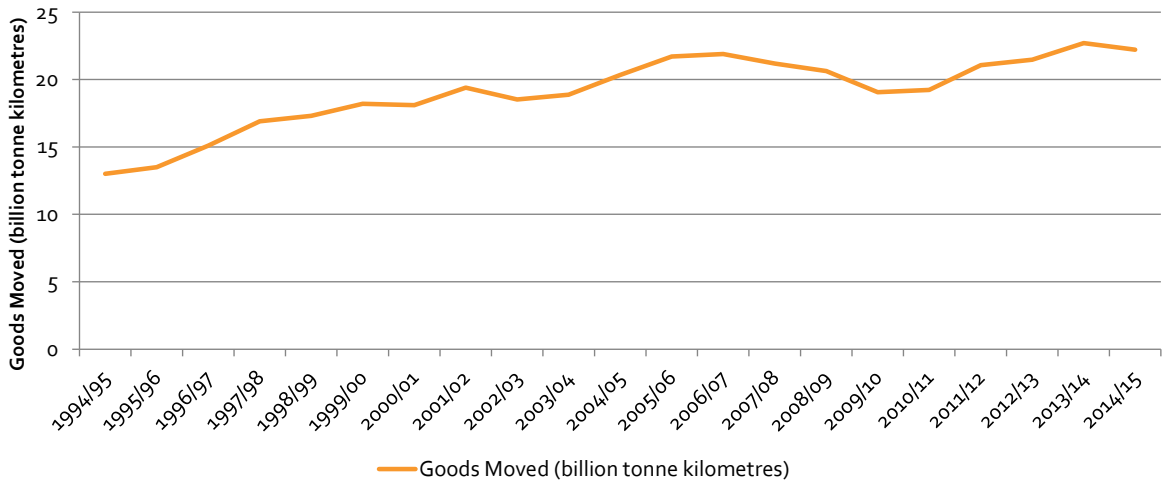


Figure 17: Freight market growth (Source: Freight Market Study, Network Rail, 2013)

2.34 The WCML has played an important role in supporting this growth in rail freight. Indeed over 40 per cent of freight trains use the WCML at some point in their journey[25]. Chapter 6 describes the different freight markets that currently operate on the WCML.

The WCML upgrade

2.35 The growth in passenger numbers and freight traffic outlined above has only been made possible by a decade long programme of upgrade works. The £9 billion WCML renewal and modernisation programme comprised £2.5 billion of investment in infrastructure upgrades and £6.5 billion of investment in infrastructure renewals.

Infrastructure upgrades

2.36 Infrastructure upgrades carried out under the modernisation programme can be summarised as follows.

2.37 Speed enhancements:

- Route wide speed improvements: Fast Line speeds were increased to 125 mph (for trains with Tilt Authorisation Speed Supervision (TASS) equipment only) and Slow Line speeds increased to 100 mph
- The line speed between Preston – Carlisle – Glasgow was increased to 125 mph for trains with TASS equipment where possible

2.38 Junction and track improvements:

- A new track arrangement was put in place at the Euston station throat, increasing route capacity

[25] Network Rail 2003 Business Plan (www.networkrail.co.uk/3176_BusinessPlan2003MixedTrafficRoutes.pdf)

- The dive-under at Willesden was upgraded for passenger use (and used by Southern services to/from Milton Keynes)
- At Bourne End, Ledburn and Bletchley, new junction crossovers were installed to provide for an increased speed of transfer between Fast and Slow Lines (up to 60 mph)
- Rugby station and its approaches from the north was totally rebuilt
- The track layout at Birmingham International was re-modelled to provide for a better turnback facility
- At Tring a new central turnback loop was laid
- The Nuneaton-Rugeley route section was four-tracked
- A new track layout and segregation of key flows with a new flyover was delivered on the Nuneaton and Leicester line
- Between Colwich – Stoke-on Trent – Cheadle Hulme, speed enhancements were delivered and the track gauge increased for freight traffic
- There was greater segregation of tracks at Wigan
- A double-track junction was built at Euxton Junction, to the south of Preston, where the Manchester line diverges
- Between Crewe – Weaver Junction – Liverpool, higher line speeds were enabled with some new bi-directional signalling from Crewe to Ditton
- Between Colwich – Stafford – Crewe, the diversionary route from Crewe to Kidsgrove was electrified and speed and capacity improvements delivered at Colwich, Stafford and Norton Bridge

Station works

- All suburban stations between London Euston and Northampton had platform extensions allowing 12 car trains to call at these stations
- Birmingham New Street has a new bay platform
- Wolverhampton benefited from a new through platform
- Rugby station was comprehensively rebuilt

2.39 Other infrastructure improvements:

- Installation across the whole route of a Tilt Authorisation Speed Supervision (TASS) system which protects against overspeeding
- Extensive re-signalling of the southern section of the line, with use of axle-counter detection systems
- New lineside fencing was put in place and a number of level crossings removed
- Power supplies were strengthened across the whole route

Disruption caused

2.40 The WCML renewal and modernisation programme lasted a decade and when it was completed in 2008, it had involved one hundred million person-hours of work. Major works of this nature on live railways are inevitably disruptive to the travelling public. The WCML programme meant that for over five years, passengers endured route diversions and rail replacement bus services during weekend closures of sections of

line. Furthermore, a section of route via Stoke-on-Trent had to be closed entirely for over two months in 2003.

Transformation of the service pattern

2.41 The upgrade was the critical factor in allowing service levels to be increased with the number of peak hour trains increasing from nine in 1994 to 11 in 2008 and 15-16tph today. The culmination of the route upgrade on the WCML was the introduction by Virgin West Coast of the 'Very High Frequency' (VHF) timetable in December 2008. This introduced an hourly service from Chester and increased the train frequency from two tph to three tph between London and Manchester and London and Birmingham.

2.42 Across the day, this increase in capacity has translated into the increase in volume of services detailed in Figure 18.

Flow	2000	2014	Change
London <> Birmingham	37	48	+11
London <> Manchester	20	48	+28
London <> Liverpool	15	18	+3
London <> Scotland	17	18	+1
London <> Chester/North Wales	3	14	+11
London <> Milton Keynes	142	141	-1
London <> Northampton	52	54	+2

Figure 18 Summary of all day (weekday) changes to service frequency on WCML services from London[26]

2.43 The increase in inter-city capacity brought about by the upgrade has allowed Virgin West Coast to broadly keep pace with the growth in demand. Overall, passenger journeys carried by Virgin West Coast grew by 51 per cent from 22.9m in 2008/09 to 34.5m in 2014/15 – equivalent to 7.1 per cent growth per annum. Figure 19 shows that:

- The upgrade, together with lengthening of a number of the original 9-car Pendolino sets to 11-car, has allowed for an additional 3,900 seats on ICWC services into London Euston in the AM Peak
- The number of passengers arriving into London Euston has increased by around 2,600 per day
- Taken together, this has resulted in the average load factor (the number of passengers on the train divided by the number of seats) staying broadly constant- 72 per cent and 70 per cent
- However, 67 per cent of the seats delivered by the December 2008 timetable are already been filled. Today's demand is higher than the total number of seats than were being provided in both the AM and PM peaks prior to the upgrade

[26] Data sources: September 1999 timetable and December 2013 timetable

	AM Peak (07:00 – 09:59)	
	Autumn 2008	Autumn 2014
Standard Class seats into Euston	7,136	11,040
Standard Class passengers into Euston	5,154	7,762
Average load factor	72%	70%
New capacity already utilised	n/a	67%
2014 load factor with 2008 seats		109%[27]

Figure 19 Utilisation of WCML upgrade capacity[28]

2.44 At the same time that the additional inter-city capacity has been rapidly filled, growth in commuter demand has meant that in recent years, London Midland has consistently been one of the most crowded London commuter operations.

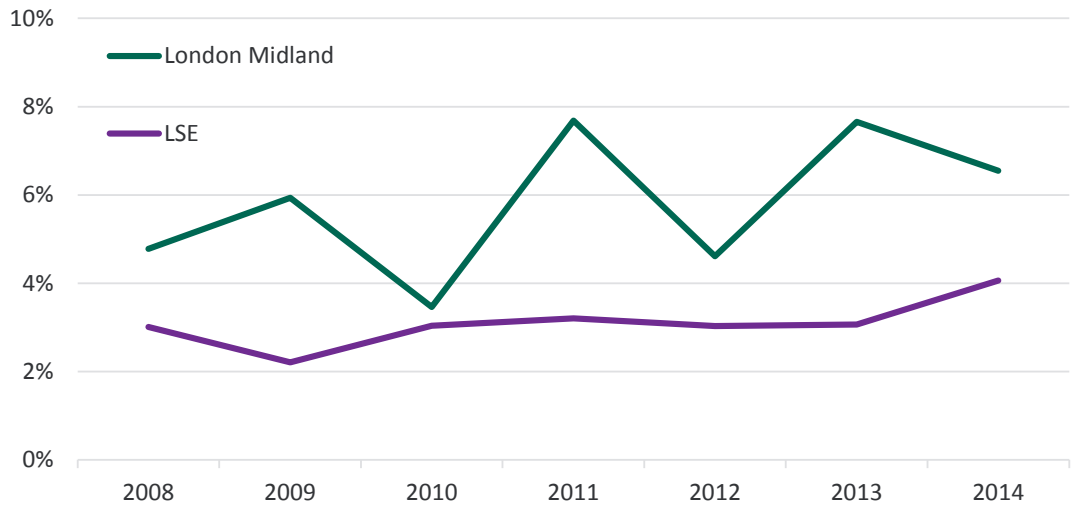


Figure 20 London Midland historic PIXC - AM and PM peak combined[29]

2.45 In Autumn 2014, London Midland had the second highest level of overcrowding of all London Commuter (LSE) TOCs at 6.5 per cent across the AM and PM peaks.

2.46 The WCML modernisation programme envisaged that following the upgrade, there would be a maximum of 13-14tph using the Fast Lines into and out of London Euston. However, in order to keep pace with passenger demand in December 2014, London Midland introduced another two peak hour services, resulting in up to 15-16tph operating during the peak.

2.47 The consequences of this are that the WCML is now operating at a higher level of intensity than many comparable fast main lines in other European countries. This is beginning to have notable consequences for performance and reliability.

[27] The PM Peak equivalent is 109%.
[28] Data source: Analysis of DfT train count data provided by Virgin West Coast.
[29] Data source: DfT Passengers in Excess of Capacity

3. The West Coast Today

The intensity of WCML operations

3.1 Following the introduction of the London Midland December 2014 timetable, 15 trains now operate on the WCML Fast Lines into Euston in most peak hours. Indeed, in one 60-minute period on weekdays between 08:02 and 09:01, 16 trains operate. This has been achieved by increasing the top speed of the London Midland commuter trains to 110 miles per hour (mph) and limiting the number of stops of these trains south of Rugby. There are also 16tph between 18:00-18:59 on Fridays.

3.2 This is more than the 13-14tph envisaged at the time of the WCML upgrade due to the pressure to run more outer-suburban commuter services along with today's inter-city timetable. This is a higher intensity of operation than major fast lines in other European countries, including purpose-built high speed lines as shown in Figure 21. This is despite the fact that the WCML has a more complex mix of long distance and commuter traffic.

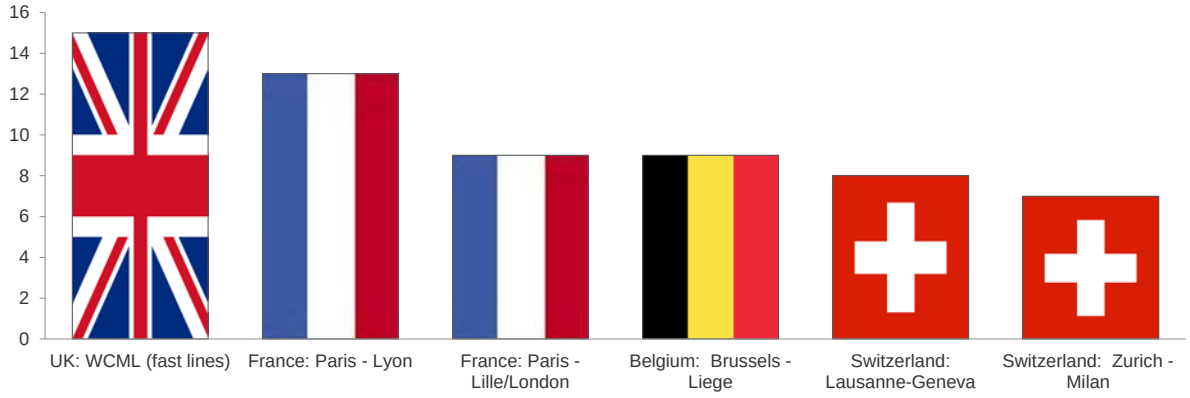


Figure 21 Comparison of intensity of operation between the WCML Fast Lines and selected major Fast Lines in other European countries [30]

3.3 It is challenging to run further services on the WCML due to a combination of:

- Physical constraints with the infrastructure. While the £9 billion modernisation and renewal programme addressed many of the constraints on the route, several still remain as set out in Chapter 4
- The complex mix of traffic that operates on this rail corridor

3.4 Figure 22 shows the key constraints that limit the services that can be operated on the WCML. It is notable that these constraints impact the traffic that can be operated all along the route. They impact upon commuter services into Birmingham and Manchester and the ability to run additional freight trains in the North and Midlands – not just upon the number of passenger services that can travel to Euston in the peak.

[30] Data source: Network Rail working timetable, www.bahn.de and the European Rail Timetable, summer 2014. Other lines on Britain's rail network operate at a higher level of intensity but they do not have services with the same top operating speed or mix of traffic.

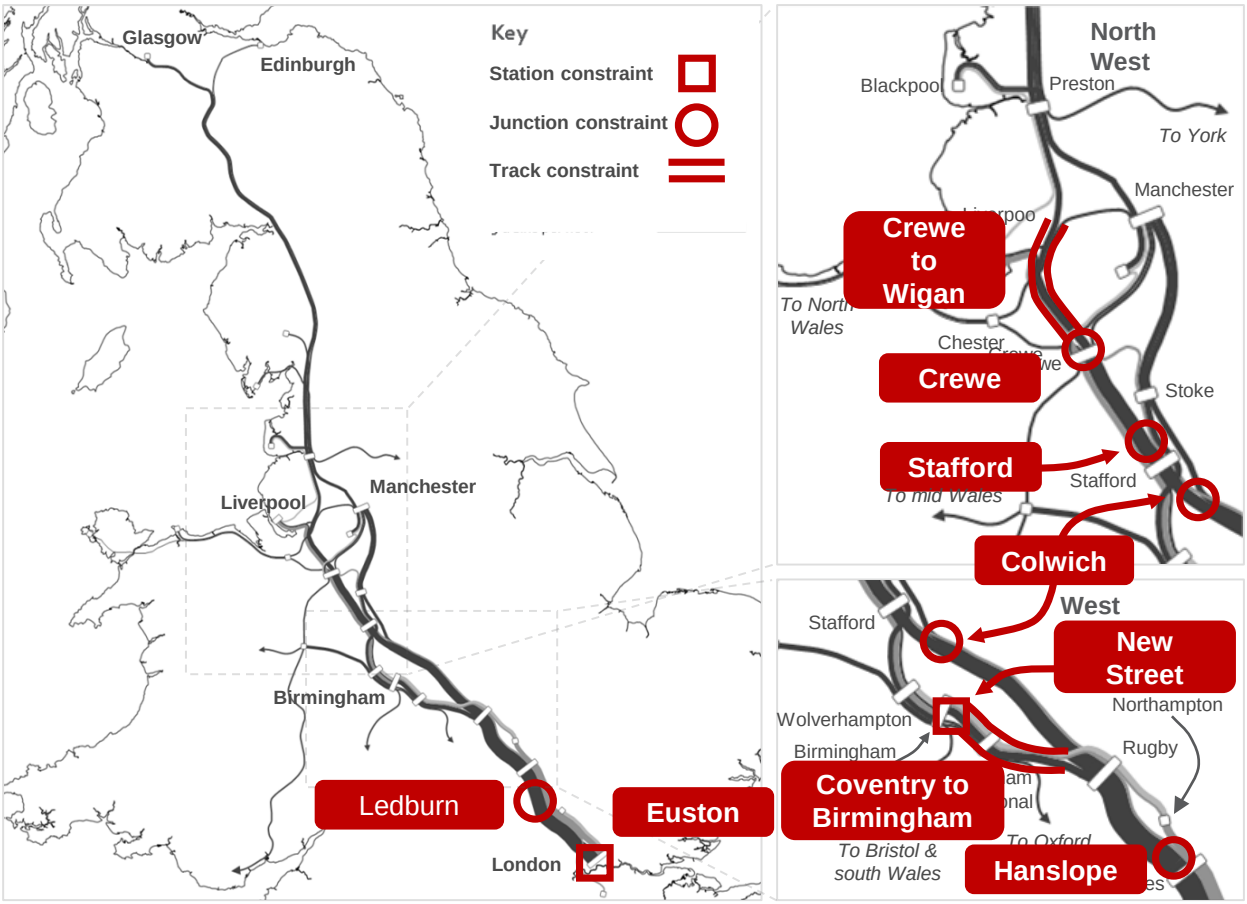


Figure 22 Location of key infrastructure constraints on the southern part of the WCML[31]

3.5 At a high level, from south to north, the main constraints that limit route capacity on the WCML are:

- **Euston** The track layout which connects the platforms at Euston to the approach tracks has been modernised. However, Network Rail has stated that the service limit of the station is 16tph given turn-round times and the pattern of services
- **Ledburn and Hanslope Junctions** These are flat junctions where outer suburban London Midland commuter trains cross over from the Fast Lines to the Slow Lines south of Leighton Buzzard and north of Milton Keynes respectively. Trains at these junctions need to be timed to match gaps in the flow of trains in the opposing direction. These junctions are also examples of where in-service timings of freight trains and fast inter-city services interact with each other on the southern part of the WCML - even though they are essentially using separate pairs of parallel tracks
- **Coventry-Birmingham** This two-track section of the route is shared by fast and slow passenger services and freight services. The slower speeds of stopping services mean that inter-city trains are delayed if they 'miss their slot'. In addition, at Coventry, north-south flows of freight trains to/from Southampton need to make conflicting moves across the WCML which runs from east to west through the station

[31] Data source: DfT analysis.

- **Birmingham New Street Station** The approaches to New Street station comprise four-tracks which are shared by a number of routes that come together for the final tunnelled approach to the city centre. Operating speeds are low and the need for certain services to access specific platforms further constrains operational capacity
- **Rugby – Nuneaton** This section of the route contains a three-track section where northbound freight and fast passenger trains share the same track. This constrains options to add further train paths in some instances
- **Colwich/Stafford Junctions** Here a mix of flat crossings and interactions between the Trent Valley section of the WCML and diverging routes to Wolverhampton and Stoke-on-Trent constrain capacity. A major scheme is under construction to resolve the constraints at Norton Bridge, one of the three junctions in the Stafford area. This will provide a flyover and reduce the number of pathing conflicts. However, the two-track section on the WCML through Shugborough tunnel and the flat crossing at the speed-limited Colwich Junction (see Figure 23) will continue to constrain capacity
- **Crewe – Wigan** This section of the route carries a heavy mix of inter-city, freight and stopping trains. At a number of locations such as Crewe and Warrington, regional services cross the route. In addition, local services join and leave the route at Winwick Junction and Spring Branch, Wigan, and freight traffic joins and leaves the route at locations including at Winsford, Hartford, Weaver, Acton Grange, and Winwick Junctions. Of these junctions, only Weaver is grade separated. As a result the capacity to add further services is constrained
- **Manchester Piccadilly** Fast and stopping trains both operate on the complex approach to Manchester Piccadilly station, limiting capacity and operational flexibility. The Northern Hub scheme, when fully implemented, will reduce some of the conflicts. In particular, re-routing Trans Pennine Express services between Yorkshire/the North East and Manchester Airport via Ordsall will ease some capacity constraints

3.6 These issues are outlined in more detail in Chapter 4, where the limitations they impose on expanding today's service levels to meet demand growth are also described.

3.7 Taken together, the constraints mean that on its busiest sections, the WCML is already operating at, or close to, capacity in the peak. This is best illustrated by the example of the Fast Lines between Rugby and London Euston.

3.8 Under Network Rail's Timetable Planning Rules, with existing signalling, the WCML Fast Lines currently could theoretically accommodate 20tph in the peak hours, although the approach to/from Euston and the station design itself effectively limit the practical capacity to 16tph with current turnaround times and service requirements. Figure 24 explains why in reality, the route capacity is effectively constrained at today's level of 15-16tph.

Figure 23 Colwich Junction[32]

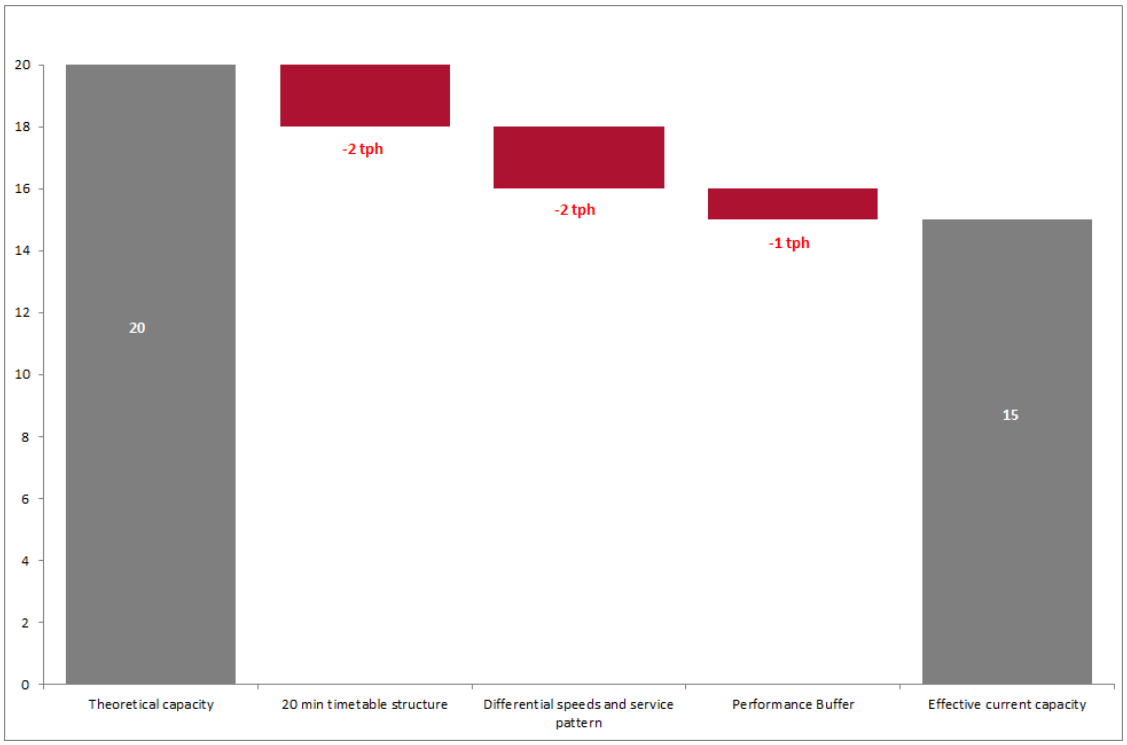


Figure 24 Reduction in theoretical capacity of the WCML[33]

[32] Source: Steer Davies Gleave
[33] Source: DfT analysis. Note: 16 arrivals are achieved between 08:02 and 09:01 which is enabled by reduced calls by fast line services south of Rugby. 16 departures from Euston are also achieved between 18:00 and 18:59 on Friday evenings.

20tph

3.9 The theoretical 20tph assumes operation of Class 390 Pendolino trains at the maximum line speed (125 mph), a minimum headway of three minutes between trains and no station calls south of Rugby.

18tph

3.10 The 20 minute timetable structure of Virgin West Coast's services between London and Birmingham and Manchester cost two paths, reducing the capacity to 18 tph. This structure, which brings significant passenger and revenue benefits, disaggregates the timetable into three 20 minute segments. Taken together with the need for a minimum headway of three minutes, this limits London Euston arrivals/departures to six per 20 minute period.

16tph

3.11 Timetable interactions with differential operating speeds and service patterns cost two further paths, reducing the capacity to 16tph. The impact of the complex service mix will vary for each hour of the timetable but in summary:

- Any 100/110mph London Midland service that crosses from the Fast to the Slow Lines south of Milton Keynes costs a path. An additional 'Up' path can be lost if the timetable is not constructed and operated in such a way as to leave a corresponding gap on the 'Up' Fast Line to facilitate a crossing movement
- Each stop at Milton Keynes or Rugby generally costs one Fast Line path. This can be mitigated if slower commuter paths are flighted together with a 100/110mph service weaving to the Slow Lines south of Milton Keynes as the inter-city train to Birmingham or Manchester is stopped at the station. The consequence being that if these slow trains miss this slot, fast trains behind can get held up and one still needs a gap southbound.
- Stopping a train at Watford Junction also costs one path, as there are no passing places.

15tph

3.12 Performance buffers in the timetable allow for recovery from perturbations – these typically cost one path per hour. At the height of the peak (for example Friday evenings) performance buffers have been relaxed.

Impact of running the WCML at today's intensity on performance

3.13 There are four factors to take into account when optimising train planning: journey time, service level (trains per hour), performance and access for maintenance (see Figure 25). Seeking to stretch one of these factors can compromise another.

3.14 The December 2008 VHF timetable, which followed the WCML upgrade, stretched two of these dimensions. Journey times were reduced at the same time as service levels (trains per hour) were materially increased. Access for a revised infrastructure maintenance programme was protected.

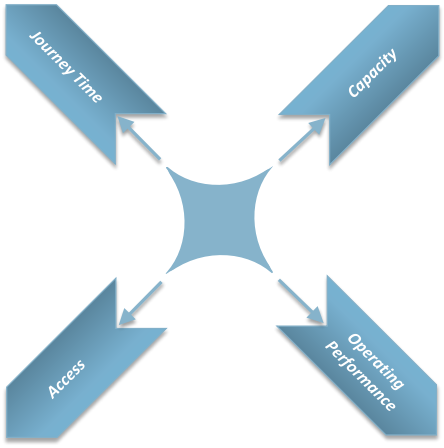


Figure 25 Journey time, capacity, performance, access diamond

3.15 The implications that this has had for the fourth factor, performance, are shown in Figure 26, which sets out on-time performance for the key WCML operators, Virgin West Coast and London Midland over the past five years. Passenger Performance Measure (PPM) is the measure used for on-time punctuality – the number of trains that arrive at the final destination 'on time' – defined as within 10 minutes of scheduled arrival time for inter-city services and within 5 minutes for commuter services.

3.16 Since the upgrade, Virgin West Coast's performance (measured as PPM) has plateaued – averaging 85.0 per cent over the four year period up Quarter 1 2015/16. Over the same period, average PPM for the long distance sector as a whole has been 87.6 per cent. On its London services, London Midland has substantially under-performed against LSE commuter sector comparators, with average PPM over the four year period up to Quarter 1 2015/16 of 84.4 per cent, compared to 90.1 per cent for the London and South East sector.

3.17 Performance targets for both operators have been revised down considerably for Control Period 5 (CP5) relative to CP4 in the face of the difficulties experienced in delivering higher performance levels.

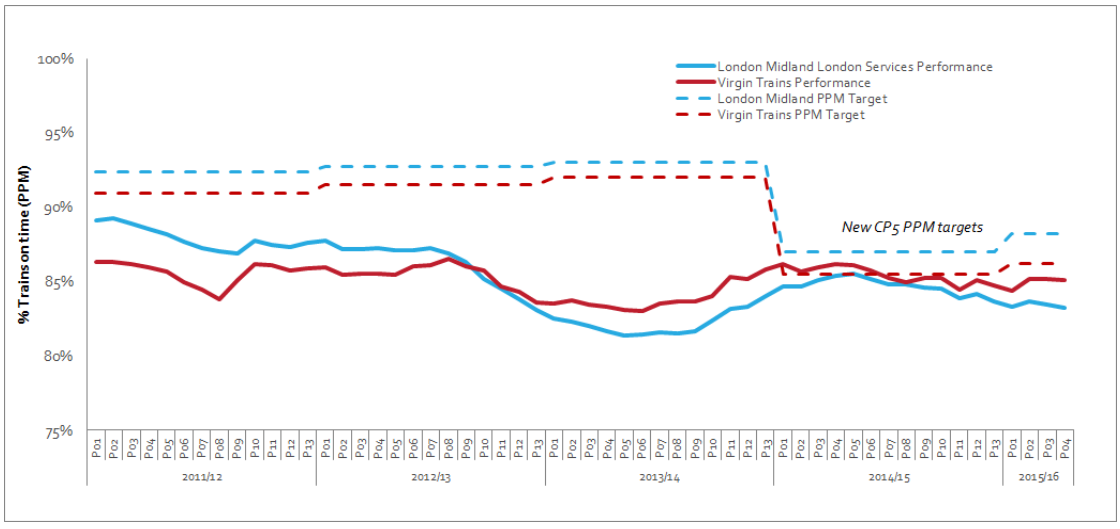


Figure 26 Performance (PPM Moving Annual Average) of Virgin and London Midland (London only services) TOCs[34]

[34] Data source: ORR

3.18 Whilst route congestion is only a partial cause of below-par PPM figures, Figure 27 suggests that it is a key contributing factor. This graph illustrates how primary and reactionary delays of long distance operators have changed over time. Primary delay is that delay directly caused to a train due to an incident on the route. Secondary delay or 'reactionary delay' is delay to a train as a result of an incident elsewhere on the route or to another train. The chart shows that the amount of reactionary delay that follows an incident on long distance operators has been increasing over the past seven years, even though the initial primary delay per train is falling. This suggests that, even though the industry has got better at responding to individual delay incidents, the knock-on impact of any given incident is likely to be greater than it was in the past, due to the higher volumes of traffic operating.

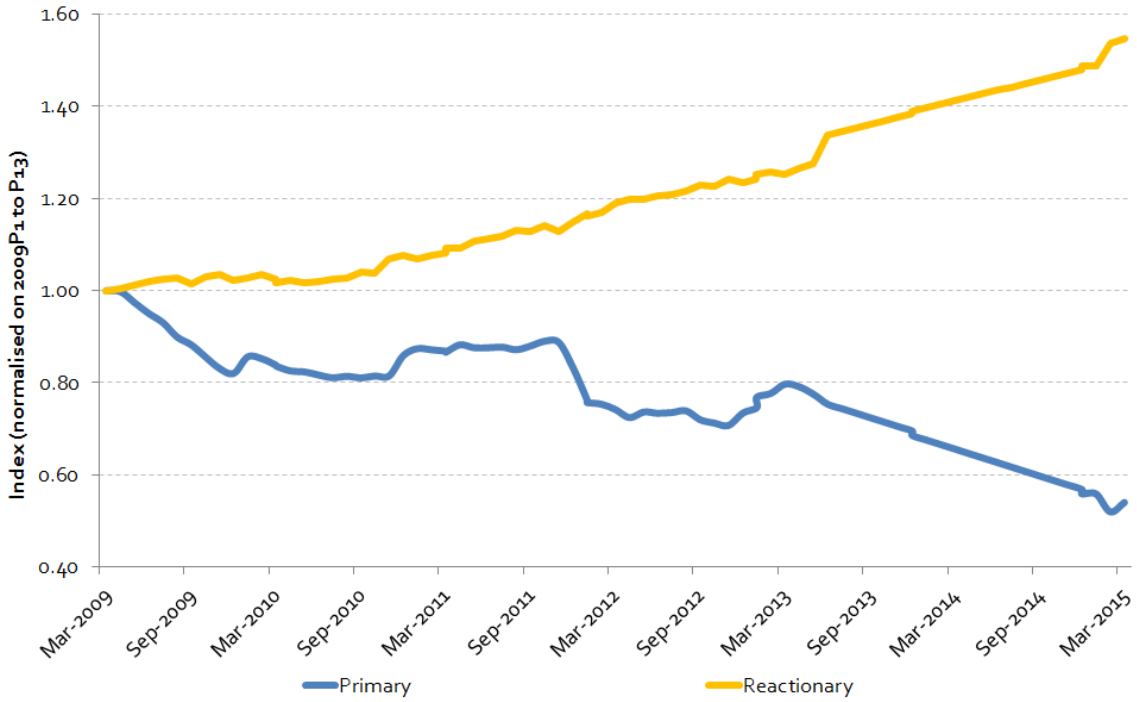


Figure 27 Changes in primary and secondary delay across long distance operators 2008/09 to 2014/15[35]

3.19 Poor performance affects a significant number of passengers on the WCML. As stated earlier, Virgin West Coast services are used by around 35 million passengers each year. Based on the last four years performance figures (PPM of 85.0 per cent), every year, approximately 5.0 million passengers are materially delayed on these services. This is some 2 million more than would be delayed under the CP4 PPM targets agreed with ORR.

Performance issues have deterred the ORR from allowing new services on the route

3.20 A number of TOCs have made applications to the ORR in recent years requesting access rights to run additional services on the WCML. Some of these applications were rejected on the basis that there was no industry business case for them – that is

[35] Data source: Network Rail TRUST data summary (up to April 2013) and Network Rail Delay Incident File (March 2014 to March 2015) – linear interpolation between the intermediate periods)

the forecast revenue on the services was deemed to be primarily abstractive (meaning it would simply be revenue transferred from other existing services).

3.21 Four applications met ORR's requirements in terms of an industry business case, but were turned down due to the potential impact that they would have on performance by adding to the level of congestion on WCML.

Applications from Alliance Rail, Grand Central Railway and London Midland turned down in March 2011

3.22 "*The performance risk of, effectively, filling the Fast Lines from the start of the morning peak until after the end of the evening peak is considered to be too great, as the service would never recover from any perturbation*" ORR, March 2011 (Note, these are three separate applications, but the ORR gave one joint response).

Application from Virgin West Coast for direct services from London to Blackpool and Shrewsbury turned down in July 2013

3.23 "*Performance on the WCML has been poor for several years and shows no signs of significant or sustained improvement. Our assessment is that even the … proposed additional services … are likely to cause a further material deterioration… We have therefore concluded that we should not approve the rights for the services requested*" ORR, July 2013.

3.24 Two further applications have been successful. However, the circumstances in which the additional services have been permitted, lend weight to the argument that it is difficult to operate additional trains on the WCML in the peak.

3.25 The first of these applications was for two further peak hour London Midland trains on the Fast Lines, increasing the peak hour frequency to five per hour. These additional services were introduced by London Midland in December 2014. ORR granted access because the additional services were timetabled by operating rolling stock at 110mph and 'flighting' two 110mph trains in a path previously occupied by one 100mph service. This timetabling solution only works because the number of London Midland stops on trains south of Rugby was reduced.

3.26 The second, and most recent (August 2015) award has been ORR granting to Alliance Rail the right to operate six daily (five on a Sunday) off-peak return services between Blackpool and Queens Park station in London from December 2017 for a period of 10 years. Whilst this award identifies that there is some limited capacity on the WCML in off-peak periods when the service pattern falls to 12tph, no additional services will operate in the peak period. Indeed, Alliance Rail did not apply for peak services in recognition of existing constraints.

Implications for future growth

3.27 Clearly the capacity constraints and performance issues highlighted above will have major implications should the growth in passenger and freight demand seen over the past 20 years, and outlined in Chapter 2 of this report, continue.

3.28 In this regard, it should be noted that DfT anticipates that there will continue to be growth over the long term in road and rail traffic. Indeed, 30 per cent and 40 per cent growth respectively is reflected in the DfT's National Policy Statement for National Networks.[36] The main drivers of the growth are rising population levels, economic growth and incomes. It is also worth noting that passenger rail volumes are expected to continue to grow at a rate faster than road traffic.

[36] https://www.gov.uk/government/publications/national-policy-statement-for-national-networks

3.29 Further, the forecasts underpinning the Phase 2a Economic Case are for around 60 per cent journey growth between 2013/14 and 2036/37 for long distance rail operators.

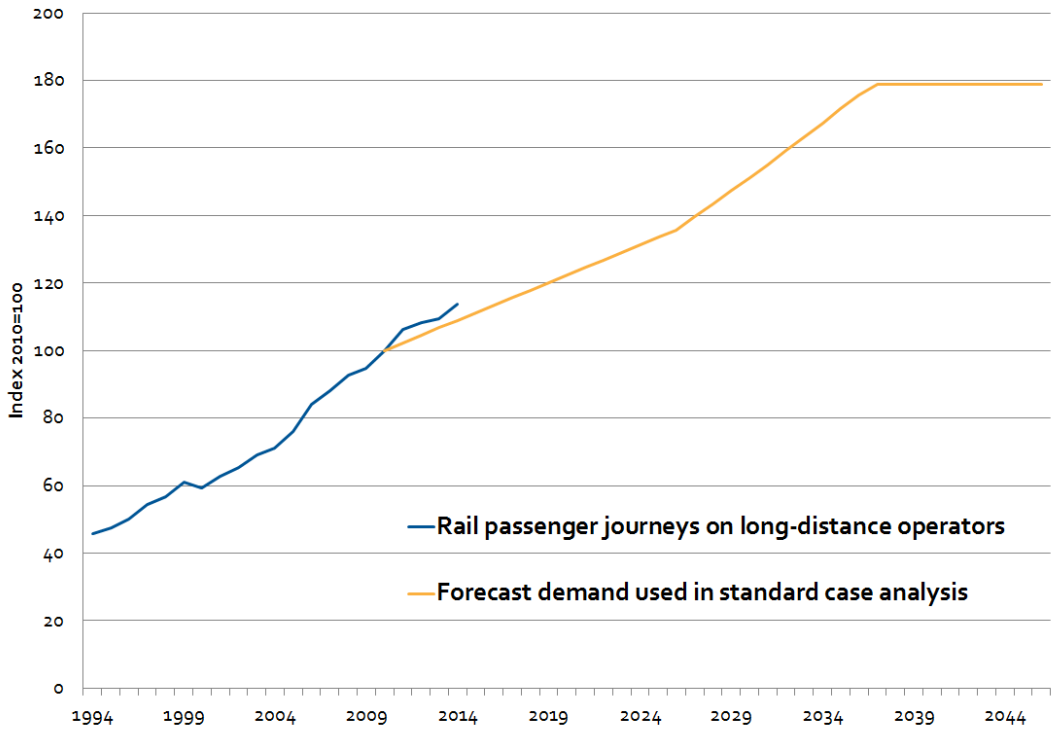


Figure 28 Rail passenger journey on long distance rail operators: forecasts vs actuals[37]

3.30 Equally, Figure 29 presents Network Rail's view of the forecast change in rail freight demand over the next 30 years. Network Rail anticipates that rail freight volumes will grow by over 40 per cent compared with 2011 levels by 2023 and by around 90 per cent by 2033. Notably for the WCML, the intermodal segment is expected to continue to grow the fastest. Much of this is traffic to/from ports, which will continue to grow as trade expands. The forecast also reflects rail's competitive advantage relative to road (fuel and drivers' wages are a lower proportion of costs for rail, than for road), and the growth of rail connected warehousing sites.

3.31 In total, Network Rail estimates that this growth in volumes will translate into an increase in demand for rail freight paths on the WCML from 42 per day today to 80 by 2033.

[37] Data source: HS2 Phase 2a Economic Case, November 2015 https://www.gov.uk/government/collections/hs2-phase-two-from-the-west-midlands-to-leeds-and-manchester

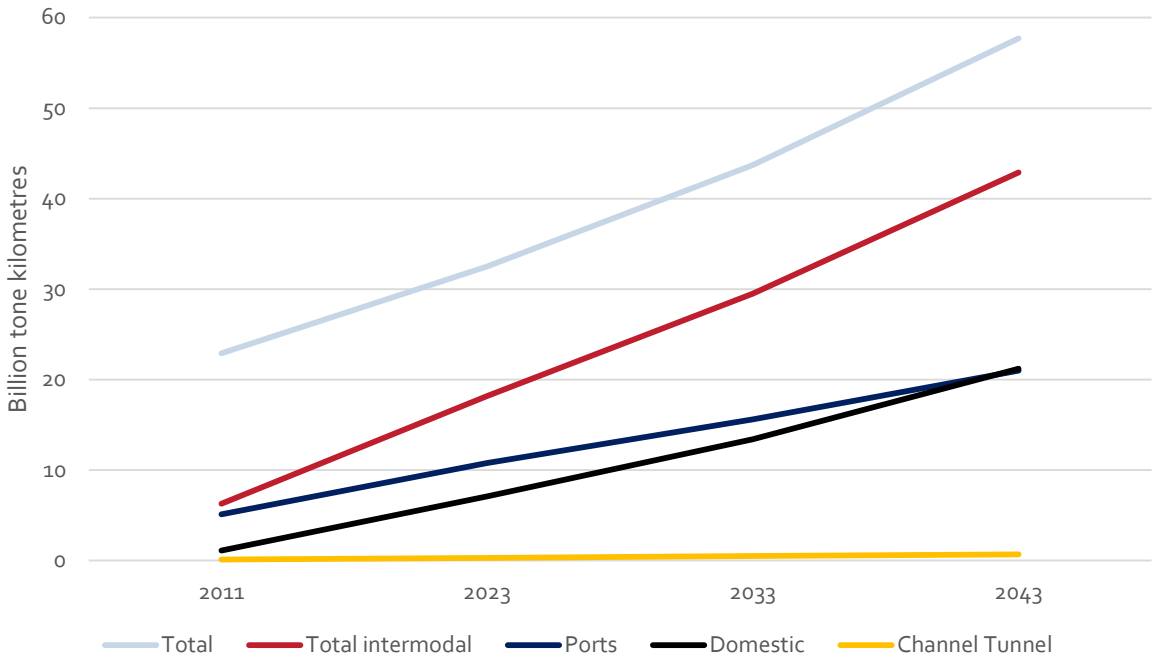


Figure 29 Forecast growth in rail freight demand[38]

3.32 Clearly, given the extent of the capacity constraints along the WCML rail corridor discussed above, it will be challenging to accommodate the expected increase in passenger and freight demand. In the short term, DfT is working with the industry, particularly via the upcoming franchise competitions for West Midlands and ICWC to seek innovative ideas to increase peak capacity. Whilst these competitions may allow some marginal capacity gains to be made through changing timetables, these gains would probably involve further compromises on the number of intermediate towns and cities served by long-distance and outer suburban services in order to ensure that punctuality and reliability are not adversely affected.

3.33 A long term solution will require further investment in the WCML infrastructure. The options for this are considered below. The potential of each of these options to accommodate future demand for route and train capacity on the WCML is then discussed in detail in chapters 4, 5 and 6.

HS2 and the Strategic Alternative

3.34 The October 2013 Strategic Case discussed the potential of both HS2 and the Strategic Alternative to provide additional capacity on the WCML corridor. These options are outlined at a high level below.

The Strategic Alternative

3.35 The report "HS2 Strategic Alternatives, Final Report" (DfT, October 2013)[39] sets out the work that was undertaken on alternative options for meeting the capacity and connectivity objectives set by Government when developing its plans for HS2. The work was undertaken by DfT and Network Rail and supported by consultants Atkins. It should be noted that whilst five packages of alternatives are described in the HS2 Strategic Alternatives report, this document focuses only on those that directly impact the WCML. This document also only considers the capacity benefits provided by the

[38] Data source: Long Term Planning Process: Freight Market Study, Network Rail, October 2013
[39] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253456/hs2-strategic-alternatives.pdf

Strategic Alternative (and HS2) – it does not consider wider Government objectives such as improving connectivity.

Package P1

3.36 Package P1 is the Strategic Alternative to HS2 Phase One – the London to Birmingham route.

3.37 In terms of **route capacity**, P1 includes a package of infrastructure enhancements that would bring a number of benefits including increasing WCML Fast Line capacity so that 16tph into/from London Euston can be delivered consistently throughout the peak rather than in exceptional single hours. These have been costed at £2.5 billion and include the grade separation of junctions at Colwich and between Cheddington and Leighton Buzzard, four-tracking between Attleborough and Brinklow and further power supply upgrades and line speed improvements. This is comparable in scale to the enhancements element of the £9 billion WCML modernisation and route upgrade completed in the decade to 2008.

3.38 To allow a frequency of 2tph to both Liverpool and Glasgow, one of the 16tph would be operated as a double 6-car Class 390 Pendolino. It would run as a 12-car train as far as Warrington and then split with one 6-car set continuing to Liverpool and the other continuing to Glasgow.

3.39 In terms of **train capacity**, P1 Package assumes that:

- On the inter-city services, all Class 390 Pendolinos are extended to 11-car operation. Within the trains, one First Class car is converted to Standard Class giving an increase in capacity of 30 seats. Under this configuration, all 11-car Pendolinos would operate with eight Standard Class cars and three First Class cars
- On the commuter services, it is assumed that all Fast Line and Slow Line services to/from London Euston are extended to 12-car operation all-day

3.40 Packages YA and YB are the Strategic Alternative to HS2 Phase Two. With respect to the WCML, the deliverables for these Packages are as those for Package P1, with the added provision that the 2tph service between Wolverhampton and London Euston is extended to/from Manchester to improve capacity, connectivity and journey times between Birmingham and Manchester. This would require further WCML infrastructure upgrades such as passing loops between Congleton and Macclesfield, and an extra platform at Manchester Piccadilly.

3.41 Since the Strategic Alternative was developed, many of the measures to increase capacity which don't require major infrastructure investment have already been introduced on the WCML in order to accommodate recent growth in demand. These include:

- Extending Pendolinos to 11-cars and converting some First Class to Standard capacity. Of the 27 morning peak period (07:00-09:59) ICWC services in the December 2014 timetable, seventeen are 11-car Pendolinos and three are 10-car Voyagers, with seven 9-car Pendolinos operating services with lower levels of demand, mainly in the shoulders of the peak. This compares to an all 9-car Pendolino fleet in December 2011
- Between 08:00 and 09:00 arriving at London Euston, London Midland is operating an increased level of service on the WCML Fast Lines (five trains per hour, up from three). This has been achieved by enabling two 110mph services to run close together ('flighting'), occupying one 100mph path that was previously used.

A programme of modifications to the rolling stock was made to allow this to happen. One of the new services is achieved through re-timetabling a service from Crewe that arrived at Euston at 08:11 having stopped at Milton Keynes and Leighton Buzzard so that it arrives at 08:05 and runs non-stop from Northampton. A new service has then been introduced from Northampton that arrives at Euston 08:11 and includes stops at Milton Keynes and Leighton Buzzard that were previously on the train from Crewe

- Increasing the number of 12-car commuter trains on London Midland. Six of the busiest of 13 London Midland services between 08:00 and 09:00 and six of the busiest 12 London Midland services between 17:30 and 18:30 are now operated as 12-car trains

HS2

3.42 The two phases of HS2 each bring benefits to the WCML corridor: Phase One planned to open in 2026, and Phase Two is planned to open in 2033.

3.43 Phase One of HS2 will see a new high speed line constructed from London Euston to north of Birmingham, where it will reconnect with the existing WCML allowing fast services to serve Manchester, Liverpool, Crewe, Preston and Glasgow. New high speed trains will serve both Birmingham city centre as well as an interchange station which will serve both Birmingham Airport and the wider West Midlands. At Old Oak Common in west London, a new interchange will be built connecting HS2 with Crossrail and the Great Western Main Line.

3.44 Phase Two will see the line extended north and east, to join up with the WCML north of Warrington. An Eastern leg is also proposed which joins with the East Coast Main Line approaching York. On the WCML corridor there will be a new station in the city centre of Manchester.

3.45 HS2 will deliver a step change in capacity on the WCML corridor. The high speed line itself will be capable of carrying 18tph in each direction, although under the current scheme assumptions, this full capability will only be used once Phase Two is operational. In addition, operating inter-city services on dedicated high speed lines will release train paths on the existing network for commuter and freight services.

3.46 It is anticipated that the combined number of trains per hour in Phase One will be 33 with 10 on HS2 and 23 on the conventional network (split as 13 on the Fast Lines and 10 on the Slow Lines). The potential reduction from 15-16tph to 13tph on the Fast Lines could bring performance benefits by providing greater resilience.

3.47 Clearly increasing Fast Line route capacity in terms of paths/hour by over 50 per cent from 15-16tph to 23tph whilst providing an additional 2tph on the Slow Lines is a much more comprehensive and long term solution to the issues of WCML route capacity than that provided by the Strategic Alternative.

3.48 The next three chapters in this report set out the latest analysis and evidence as to why it is right to make this transformational investment in rail capacity on the WCML corridor. In summary:

- **Chapter 4** considers the issue of route capacity in greater depth. It explains the services that run on each route section of the WCML today, the pressures to run additional trains, and the comparative ability of HS2 and the Strategic Alternative to allow extra services to be run and new markets to be served
- **Chapter 5** considers passenger train capacity. Given the demand growth that is anticipated, it sets out the limitations of tactical measures such as train

lengthening to contain overcrowding, should additional services not be able to operate. It then looks at the potential of the extra route capacity provided by both the Strategic Alternative and HS2 to accommodate future passenger levels over the long term

- **Chapter 6** specifically looks at the freight market and the benefits that each of the Phases of HS2 will provide in accommodating demand for further WCML freight paths

4. Route Capacity – Passenger Operations

- The route (or line) capacity on the WCML is constrained at several points along the corridor. These constraints impact all of the markets that operate on the route – inter-city, regional, commuter/local passenger services as well as freight
- Closer to London, the constraint is essentially the number of trains in each route section, together with the terminus at Euston. Further away, the constraints are more often to do with conflicts at junctions arising from the number of services approaching from different routes that feed into the WCML
- Between Crewe and Scotland, the constraints are largely as a result of mixing slow and fast trains on a two-track railway with the result that fast trains catch up with slow trains
- In some areas, the existing service pattern had to be modified, with some services cut back in order to accommodate the 2008 VHF (Very High Frequency) inter-city timetable
- Going forward, developing new rail markets such as adding direct London services from a wider range of cities in the North West when people most want to travel - in peak periods - is similarly challenging
- Future timetable changes that provide additional capacity for some markets are likely to involve trade-offs that mean cutting capacity or connectivity in others. They may also have adverse punctuality impacts and/or require the extension of existing journey times
- The Strategic Alternative (to HS2) would not provide sufficient capacity to accommodate a material expansion of today's service pattern beyond the level of 16tph across the peak
- Building HS2 provides a step-change in route capacity on the WCML corridor increasing the number of fast paths across HS2 and the current route combined from 15-16tph to 23-25tph

4.1 This chapter looks at the main problems of route capacity on the WCML today, section by section. It illustrates the practical limits of further adapting the existing timetable and infrastructure in order to run more services. For each route section, this chapter sets out:

- The WCML services that run today
- The capacity issues that limit the number of services that can operate
- The pressures that are likely to give rise to a demand to run additional services on that part of the WCML in the future

4.2 The route sections considered are:

- London Euston to Rugby
- Rugby to Birmingham New Street
- Rugby to Stafford
- Stafford to Crewe
- Crewe to Weaver Junction
- Weaver Junction to Preston
- Weaver Junction to Liverpool
- Crewe to Manchester Piccadilly
- Colwich Junction/Norton Bridge to Manchester Piccadilly

4.3 It is also important not to overlook the approach to Euston itself where trains to and from London are fed into one of 18 different platforms through a complex series of junctions.

4.4 These route sections are highlighted in Figure 30 below.

4.5 Each section of the route has different individual capacity constraints. However, because any additional trains that are provided would need to have operating paths across several of these route sections in order to provide a timetable that works, a process that is joined-up between these routes sections is ultimately needed.

4.6 Having outlined the issues, this chapter considers three options to relieve route capacity pressures on the WCML corridor:

- The Strategic Alternative
- ETCS (the European Train Control System)
- HS2

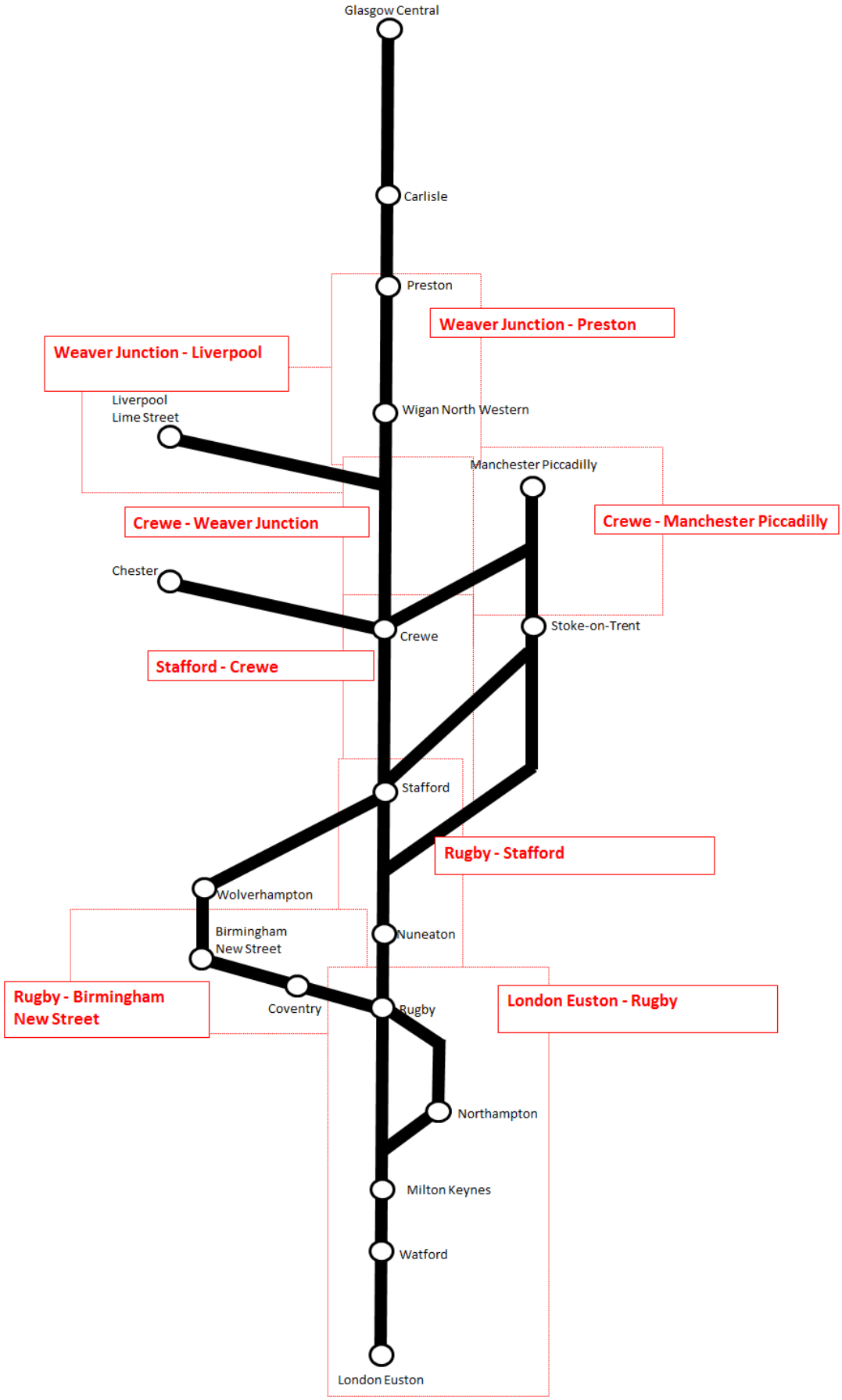


Figure 30 Overview of the West Coast Mainline (WCML)

Principles of route capacity

4.7 Before looking at the route section by section, it is helpful to consider what limits the capacity of a railway network (the number of trains operating on the network each hour) in practical terms. The capacity of a route is determined by the following factors:

- The number of tracks, and the minimum headway (the time permitted between trains) that trains can be operated at
- The mix of traffic operating on a line – there is a greater throughput of traffic when trains operate at a uniform speed (and with similar acceleration/deceleration characteristics) and less capacity available when these characteristics vary
- The stopping patterns of passenger services – there is a greater throughput of trains when services have a uniform stopping pattern (as is the case on commuter services and urban light rail/metro systems such as London Underground). Services with different stopping patterns reduce available capacity
- The configuration of junctions – 'flat', or nongrade-separated, junctions reduce capacity because trains joining or leaving the route have to cross another track on which trains operate in the opposite direction. To an extent this is unavoidable at large terminal stations
- The configuration of stations (such as the number of platforms and platform length) and the approaches to stations
- How the trains are operated (for example, the turn-around times required at terminus stations before the train is ready to make another journey)
- Rules applied by NR in order to operate the railway safely
- Choices about access rights, as ultimately determined by ORR

4.8 The range of factors involved means that assessment of capacity is a complex activity which can only be partially automated through the industry's timetable planning systems.

London to Rugby

Today's service pattern

4.9 The WCML is a four-track railway between London and Rugby; two of the tracks are capable of carrying services at up to 125mph (the Fast Lines) and the other two-tracks have line speeds between 75 and 100mph (the Slow Lines).

4.10 Figure 31 sets out today's service pattern on the WCML south of Rugby based on the December 2014 timetable. In peak periods up to 15tph operate on the Fast Lines, split typically between Virgin West Coast inter-city services at 10-11tph (12tph between 18:00 and 18:59 on Friday evenings) and outer suburban commuter services run by London Midland at 4-5tph. On the Slow Lines, London Midland operates up to 8tph with Southern operating a further 1tph (3tph in one hour between 06:45 and 07:45) from Milton Keynes or Watford Junction to East Croydon.

Time period	Fast Lines (Virgin West Coast)	Fast Lines (London Midland)	Slow Lines (London Midland)	Slow Lines (Southern)
AM peak (Arrivals at London Euston)				
07:00 – 07:59	8	2	5	1
08:00 – 08:59	10	5	8	1
09:00 – 09:59	9	4	4	1
Off peak (standard hour)	9	3	4	1
PM peak (Departures from London Euston)				
16:00 – 16:59	11	3	4	1
17:00 – 17:59	11	4	7	1
18:00 – 18:59	10	4	7	1

Figure 31 Summary of standard weekday passenger services on the WCML December 2014 Timetable[40]

4.11 In the off-peak, 12tph operate on the Fast Lines – 9 inter-city services and 3 outer suburban services. On the Slow Lines, London Midland operates 4tph and Southern operates 1tph. Freight services also run in the off peak on the Slow Lines (up to 4 paths per hour) – with priority given to passenger services in the peak. The time taken to travel between multiple major conurbations makes it difficult to avoid some freight services encroaching into peak periods that end at 10:00 and re-start at 16:00.

Route capacity issues

The mix of traffic on the line

4.12 The Fast Lines carry a mix of 125mph inter-city trains and 110mph outer suburban trains. The minimum headway is three minutes if all the services were operating at 125mph. However, additional headway is required in the timetable to prevent the inter-city services catching up with the commuter services, which typically take 2 to 3 minutes longer between London and Milton Keynes.

4.13 On the Slow Lines, the significant commuter market means that freight services can generally only be operated in the off-peak. A notable constraint here is that there is nowhere for trains to pass each other between Wembley and Northampton.

The stopping patterns of passenger services

4.14 In order to provide northwards connectivity and faster capacity to/from London, three inter-city services per hour stop at Milton Keynes. During the peaks some of these stops are designed only for passengers travelling north of Milton Keynes, and these specific services are not available to London commuters. This is also the case with the one inter-city train per hour that calls at Watford Junction throughout the day; this service consumes one additional fast line path by making this call.

4.15 Outer area London commuter trains serving the section between Leighton Buzzard/Milton Keynes and Northampton use the Slow Lines for the northern part of their route and Fast Lines for the southern. These trains ‘weave’ between the two pairs of parallel tracks at various designated points. The places where ‘weaves’ currently are timetabled are shown in Figure 32.

[40] Data source: December 2014 National Rail timetable, Network Rail

Crossing location	Rugby	Hanslope Junction	Milton Keynes Station	Ledburn Junction	Bourne End Junction
Distance from London	*82 miles*	*56 miles*	*50 miles*	*37 miles*	*25 miles*
AM peak (Arrivals at London Euston)					
07:00 – 07:59				2	
08:00 – 08:59		2		2	1
09:00 – 09:59	1			2	1
Off peak (standard hour)	1			2	
PM peak (Departures from London Euston)					
16:00 – 16:59	1			2	
17:00 – 17:59	1		1	2	
18:00 – 18:59		1	1	2	

Figure 32 Summary of London Midland Outer Suburban Service Crossing Locations[41]

4.16 On the Slow Lines, some capacity is lost in the peak due to the uneven stopping pattern of the London Midland commuter services. For example, between 08:00 and 09:00 only two of the eight London Midland trains in that period make the same stops. The ideal, from purely a capacity perspective, would be for all of the trains to have the same stopping patterns, but some services would have lengthier journey times as a result.

Pressure to run additional services

4.17 There is clear pressure to get more from the London to Rugby section of the WCML. Going forwards, this pressure to run additional services comes from six sources:

- To provide additional West Midlands (WM) franchise peak services/commuter capacity to reduce standing from outer-suburban stations. A number of trains are already at 12-car length and more are planned
- More peak inter-city services, particularly from the West Midlands where loadings are highest (noting that extending the remaining third of the Pendolino fleet that has not yet been extended out to 11-cars would potentially address some of this challenge)
- The new East-West rail link that will reopen an existing route from Bicester to Bletchley in order to support housing development in Buckinghamshire. This would allow direct trains from Oxford to Milton Keynes and also possibly permit an additional cross country train from the south coast to Manchester. At present, finding paths for these trains on the WCML between Bletchley and Milton Keynes is not straightforward
- Serving new markets by giving more towns and cities direct services to London. Network Rail's "Long Distance Market Study" (October 2013) considered options

[41] Data source: "December 2014 to May 2015 National Rail working timetable" (Network Rail)

for services between a number of regional centres across the West Midlands/North of England and London

- To re-instate station calls by inter-city trains at the key intermediate stations of Watford Junction and Milton Keynes which have had to be reduced since 2008
- Accommodating additional freight traffic on the Slow Lines, in particular to address the growth in intermodal traffic from ports in the south east and also potentially Liverpool

4.18 However, given that the WCML is operating at, or very close to, capacity in this route section, satisfying these pressures in one market is only likely to come at the expense of compromising another market. This is illustrated by two examples below.

Convert inter-city paths to commuter paths

4.19 Journey times from London Euston to the key outer suburban stations of Leighton Buzzard, Milton Keynes, Northampton and Rugby are currently typically 33, 45, 60 and 76 minutes respectively - journey times for which commuters expect to have a seat rather than be required to stand. However, as Chapter 5 illustrates, this is likely to prove challenging in the future as crowding pressures grow. To relieve West Midlands franchise overcrowding, a theoretical option is that the number of inter-city trains might be reduced by, say, 2tph and the paths released used for commuter trains instead. As an example, in the current timetable this might be done through:

- Withdrawal of the Birmingham International to London train arriving at 08:50 and the Manchester Piccadilly train to London Euston arriving 08:45, on the basis that these have the lowest Standard Class loadings in the AM peak
- Similarly, in the PM Peak and on the same basis, withdrawal of the 17:33 Liverpool service and 17:57 Lancaster trains

4.20 The effect of this, as demand increases, would clearly be to increase loadings and the numbers of passengers standing on the remaining peak inter-city trains. Given that passengers on these services are typically making journeys of an hour or more, standing for this duration would be considered unacceptable and is not something that could be readily contemplated. Figure 33 shows the impact if such services were removed, on the level of seats provided to and from a number of stations on the WCML corridor in the peak.

Station	Reduction in ICWC service	Reduction in Standard Class seats	% reduction in Standard Class seats
Coventry	3 tph to 2 tph	446	40
Manchester Piccadilly	4 tph to 3 tph	446	30
Stockport	4 tph to 3 tph	446	30
Macclesfield	2 tph to 1 tph	446	60
Stoke-on-Trent	2 tph to 1 tph	446	60
Rugby	2 tph to 1 tph	446	60

Figure 33 Reduction in ICWC service levels/Standard Class seats in the morning peak between 08:00 and 09:00[42]

[42] Data source: December 2014 timetable

Station	Reduction in ICWC service	Reduction in Standard Class seats	% reduction in Standard Class seats
Rugby	2 tph to 1 tph	446	60
Tamworth	1 tph to 0 tph	446	100
Lichfield	1 tph to 0 tph	446	100
Stafford	2 tph to 1 tph	446	60
Crewe	4 tph to 3 tph	446	27
Liverpool	2 tph to 1 tph	446	60
Warrington	2 tph to 1 tph	446	60
Wigan	2 tph to 1 tph	446	60
Preston	2 tph to 1 tph	446	60
Lancaster	2 tph to 1 tph	446	60

Figure 34 Reduction in ICWC service levels/Standard Class seats in the evening peak between 17:30 and 18:30

4.21 As a result of this reduction in ICWC services, Tamworth and Lichfield passengers would lose their one regular peak weekday inter-city service from London that departs after 17:00, with the next fast service departing at 19:40, forcing them to travel on the slower WM service. This would increase journey times by up to 26 minutes - a 42 per cent and 38 per cent increase for Tamworth and Lichfield passengers respectively.

Slowing the WCML Fast Lines to 110mph

4.22 Reducing the maximum speed to match the speed of the slowest rolling stock (110mph) and giving a uniform speed on the WCML Fast Lines would in theory allow all trains to operate at 3 minute headways. Assuming no other changes, the capacity of the Fast Lines might theoretically be raised by 2tph to 17tph. This additional capacity in theory might allow one additional WM train to be run between 08:00 and 09:00, increasing the frequency from 5tph to 6tph. In the evening peak, an extra 2 trains might be accommodated increasing the number of evening peak services from 4 to 6tph between 17:30 and 18:30. The increase in the number of trains would require the procurement of additional Class 350 110mph rolling stock (or equivalent).

4.23 Slowing down the inter-city timetable to 110mph would add approximately six minutes to all inter-city trains over the 82 miles between London Euston and Rugby based on the speed differential between 110mph and 125mph. It is also possible that further journey time increases would be required to accommodate the additional weaves required at Ledburn Junction. The additional journey time would affect around 70,000 passengers per day, which would conflict with wider Government objectives of improving connectivity to the North and the Midlands.

4.24 In any event, Network Rail has advised that no more than 16tph can readily be operated on the Fast Lines into Euston because of the constraints of the approach tracks and platforms with the current mix of services and terminal turn-round times. Encroaching into turn-round times is likely to adversely impact punctuality.

Destination	Journey time – December 2014	Potential journey time
Birmingham	1 hour 24 minutes	1 hour 30 minutes
Manchester	2 hours 8 minutes	2 hours 14 minutes
Liverpool	2 hours 14 minutes	2 hours 20 minutes

Figure 35 Impact of slowing down the inter-city timetable

Serving new long distance markets into London

4.25 Constraints on the WCML mean that it is very challenging to provide additional direct trains to more places. Although some towns and cities (such as Shrewsbury, Blackpool and Wrexham) have a limited direct service to London Euston, other places have not.

4.26 In 2013, Network Rail's "Long Distance Market Study" highlighted the following places from which there may be sufficient demand to provide new/enhanced services. It should be noted that in each case, the business case for new services would need to be established:

With a limited service currently

- Shrewsbury
- Telford
- Blackpool.

Not directly connected at all

- Walsall
- Sutton Coldfield
- Blackburn
- Bolton
- Burnley
- Rochdale
- Barrow-in-Furness

4.27 Recent experience on the East Coast Main Line is that opening up markets by providing new direct services to London has resulted in strong growth in passenger journeys – indeed faster than that from stations that are already served. Examples of this are the new services introduced between London and Hull and London and Sunderland.

Rugby to Birmingham New Street

Today's service pattern

4.28 The WCML route between Rugby and Birmingham New Street is a two-track railway with operating speeds of up to 125mph. It carries nine passenger trains (shared across four TOCs) and 1 freight train per off peak hour:

- Virgin West Coast - 3tph from London to Birmingham New Street (with about a third continuing on to Wolverhampton, Shrewsbury and Scotland)
- London Midland - 2tph stopping services from London to Birmingham New Street, 1tph from Northampton to Birmingham New St and 1tph from Birmingham International to Birmingham New Street stopping at all stations
- Arriva Trains Wales - 1tph from Birmingham International to North Wales, non-stop between Birmingham International and Birmingham New Street
- Arriva Cross Country - 1tph from Bournemouth to Manchester via Birmingham New Street, stopping at Coventry, Birmingham International and Birmingham New Street
- Freight: 1tph between Coventry and Stechford (which is the junction for the cross-Birmingham freight line)

4.29 In the PM peak period between 17:00 and 18:00, an additional London Midland service is operated between Birmingham and Coventry, but this is only made possible by not operating a freight train from Stechford to Coventry in that hour. Although signalling on the route would permit 15tph, the number of junctions and the congested approach to Birmingham New Street significantly constrain the timetable.

Route capacity issues

4.30 The capacity challenges on this section arise from the need to combine fast and slow trains together on just two tracks. The biggest constraints on route capacity are:

- The diverse mix of traffic of different speeds that operates on the route. For example, a stopping train between Coventry and Birmingham International takes six minutes longer than an inter-city train
- The fact that trains are joining from a range of other routes on mostly flat junctions
- Coventry station, which has flat junctions at each end of the station and is also on the main freight route from the port at Southampton to Nuneaton, Crewe and the North West, a key artery for intermodal traffic. Inter-city, local and freight services must be planned with great care through these junctions
- The final approach to Birmingham New Street. Trains approach Birmingham from five different routes (London, Nuneaton, Derby, Lichfield and Leamington) and so need to be 'melded' together to accommodate any out of course running. In addition, it is worth noting that the approach to New Street runs under the Bullring Shopping Centre, the foundations of which prevent widening of the approaches. In part for this reason, the current redevelopment of New Street only provides capacity on the concourse level and for passengers to/from platforms - platform capacity has not been increased by this project
- The problem of knitting together the West Midlands area and Cross Country timetables, both of which are based around 15/30 minute cycles, with that on the WCML, which is based on 20 minute cycles. This means that some gaps need to be left in the service to allow effective "meshing" of the two to take place.

Pressures to run additional services

4.31 The current timetable was put in place at the time of West Coast Route Modernisation with some difficulty. Local services were significantly altered in order to fit in the frequent fast services of the VHF timetable. The result was that stopping trains between Coventry and Birmingham had to be split into two services, one from Coventry to Birmingham New Street (but missing out the smaller stations from Birmingham International) and the other from Birmingham International to Birmingham New Street, forcing passengers making some local journeys to change trains. In addition, none of these trains can continue through to the other side of Birmingham, meaning that passengers must change trains at New Street to reach destinations towards Wolverhampton.

4.32 In addition, the Cross Country service on the route had to be (marginally) slowed down to fit it in. There is pressure to increase Cross Country frequencies from Birmingham International/Coventry and to add a second cross country train via Coventry, providing a 30 minute frequency to Oxford and Reading as well as providing a direct service to the East Midlands/North East.

Rugby to Stafford

Today's service pattern

4.33 The 51 miles between Rugby and Stafford is predominately a four-track railway, but there are significant two and three-track sections, notably the seven mile three-track section between Rugby and Nuneaton and the two-track section just south of Stafford at Shugborough Tunnel. The fast tracks operate at 125mph and the slow tracks at between 60mph and 125mph, with planning headways of three minutes on all lines.

4.34 A mixture of service types and train types operate, again covering long distance and regional passenger markets and freight markets, although capacity pressures have meant that stopping passenger trains to London, mostly provided by London Midland, are rarely more than hourly (even to major locations such as Lichfield and Tamworth). These stations currently only have two fast trains to/from London in the peak, and none in the off peak period.

4.35 Four radial lines from the West Midlands area connect with the WCML Trent Valley stations at Nuneaton, Tamworth, Lichfield Trent Valley and Rugeley Trent Valley, although the development of any integrated timetable pattern for connections has been severely limited by the low number of WCML services that can call at these stations. Thus, access to the WCML from most Midland communities to the north and east of Birmingham is much easier via New Street, even though it is longer than the direct, Trent Valley route.

4.36 The existing off peak passenger service pattern is 7tph, rising to 9tph in the peak:

- London to Liverpool – 1tph off-peak; 2tph in the PM peak
- London to Manchester – 3tph off-peak and peaks
- London to North Wales – 1tph off-peak and peaks
- London to Scotland – 1tph off-peak and peaks
- London to Crewe – 1tph (calling at all local stations)
- London to Preston/Lancaster/Glasgow – 1tph in the PM peak; and
- Freight: Up to 3tph

Route capacity issues

4.37 Constraints are:

- **Brinklow – Attleborough Junction**: this seven mile section has only three tracks southbound there is a Fast and a Slow Line, but northbound there is just one. This introduces a significant constraint because of the speed differential of trains on the route 60-75mph for freight services and 125mph for inter-city passenger services
- **Colwich Junction**: this critical non grade-separated junction, five miles south of Stafford is where the two northbound inter-city trains for Stoke-on-Trent and Manchester each hour leave the route and cross in front of all of the southbound passenger and freight trains from Scotland, Liverpool and Crewe
- **The two-track section between Colwich Junction and the approach to Stafford about four miles away (including the 700m Shugborough Tunnel)**: here inter-city and freight services share the same tracks in both directions, again with a significant speed differential
- **Whitehouse Junction, immediately North of Shugborough tunnel**: this is a flat junction where southbound freight services to London must cross northbound passenger services, meaning lengthy track/crossing occupation times
- **Stafford station**: there are flat crossings north and south of the station where the line from Manchester to Wolverhampton and Birmingham crosses the WCML. This means that trains from Manchester and Stoke-on-Trent going to Birmingham have to cross over in front of fast inter-city trains from London, although this is being substantially relieved by the Norton Bridge project (see 4.43 below)

Pressures to run additional services

4.38 There are three main pressures:

- Better services along the Trent Valley providing regular services to London from Stafford, Rugeley, Lichfield, Tamworth and Nuneaton, with ‘inter-city’ timings
- Increased inter-city services from the North West to London
- Good quality day-time freight paths that allow freight trains to enter the route section at Rugby or Nuneaton and run to their exit from the WCML without having to stop (since there are no places where freight trains can be held off-line in a loop to permit faster passenger services to ‘overtake’)

Stafford to Crewe

Today’s service pattern

4.39 Stafford to Crewe is a highly utilised section of the WCML which links together lines from London and Birmingham and carries services for the routes to North Wales, Manchester, Liverpool and Scotland. The junction at Stafford is one of Britain’s network wide focal points: Northbound passenger trains from origins as diverse as London, Southampton, Bristol, Plymouth and the West Midlands converge here and then go on to serve Manchester, Liverpool, Holyhead, Glasgow and Edinburgh. The freight service pattern is also complex.

4.40 In terms of passenger services, in the off peak 10tph operate from Stafford to the North of England and Scotland, increasing up to 12tph in peak periods. In addition, 47 freight paths are available each day in either direction:

- London to Liverpool – 1tph off-peak; 2tph in the PM peak
- London to Manchester – 1tph in the off-peak and peaks
- London to North Wales – 1tph in the off-peak and peaks
- London to Scotland – 1tph off-peak and peaks
- London to Crewe (calling at all local stations)
- London to Preston/Lancaster – 1tph in the PM peak
- 1tph Birmingham to Scotland operated by Virgin West Coast
- 2tph Birmingham to Manchester operated by Arriva Cross Country (operates between Stafford and Norton Bridge, the junction for Stoke-on-Trent)
- 2 semi fast trains per hour Birmingham to Liverpool operated by London Midland

Route capacity issues

4.41 This section is mainly a four-track railway with, as previously described, a pair of Fast Lines on the east and Slow Lines on the west of the alignment. The Fast Line has a maximum of 125mph with the Slow Lines operating up to 100mph following the soon to be completed line speed upgrade between Norton Bridge and Crewe. Even with four tracks and the rebuilt Norton Junction, the service mix and remaining flat junctions along the route will still restrict route capacity. The key issues are:

- The need for weaves and crossing moves means that the number of trains is restricted to 13tph on both the Fast Lines and the Slow Lines
- Crewe Station – Crewe is a major passenger and freight hub. Lines from Manchester, Scotland, Stoke-on-Trent, Chester, and Shrewsbury converge at Crewe and there are flat junctions north and south of the station. The crossing movements at these junctions and the limited number of platforms available for through trains at Crewe restrict capacity for passenger and freight services. The station itself and associated track layout was partially upgraded in the 1960s and 1980s but is now in need of modernisation

4.42 Network Rail is currently completing the Stafford area improvement project as part of Control Period 5 (CP5). The work is being delivered in phases and includes:

- Phase 1: Line speed improvements between Crewe and Norton Bridge (already completed) which have increased the maximum speed on the Slow Lines used by freight and local passenger trains from 75 to 100mph. Further line speed increases between Stafford and Great Bridgeford (just south of Norton Bridge) are also part of the project, and are scheduled to take place after the resignalling work around Stafford is completed
- Phase 2 (already completed) which has created a new 775 metre freight loop in the station area and replaced life expired signalling, telecoms and power supplies
- Phase 3 involves the construction of a grade-separated junction at Norton Bridge, removing much of the conflict between services on the WCML and those to/from Stoke-on-Trent via Stone. Completion is expected in the winter of 2016

4.43 By reducing the junction conflict, the Stafford area improvement project will deliver local capacity gains and improvements in network punctuality.

Pressures to run additional services

- Faster inter-city trains between Birmingham and Manchester the current services make many station calls and take 1 hour 26 minutes to cover this 85 mile journey
- A better local stopping service as a supplement to the Cross Country service between Birmingham, Stafford and Stoke-on-Trent, allowing more frequent stops at small stations (at present these are hourly at best)

Crewe to Weaver Junction

Today's service pattern

4.44 This section is largely a two-track railway that is highly utilised by a mixture of long distance services from Liverpool and Scotland to London, stopping passenger services to Liverpool and a significant volume of freight, some for Liverpool and the rest for Scotland. The speed differential of the different services presents the main operational challenge.

4.45 The service pattern on this section of the WCML in the off-peak is 5tph passenger and up to 3tph freight. In the PM peak the number of passenger services rises to 7tph.

- 1tph London to Liverpool operated by Virgin West Coast
- 1tph London to Scotland operated by Virgin West Coast
- 1tph Birmingham to Scotland by Virgin West Coast
- 2tph to Birmingham to Liverpool operated by London Midland. One service operates non-stop between Crewe and Runcorn, the other makes stops at some or all of the three local stations
- Additional PM peak services from London operated by Virgin West Coast: 1tph to Liverpool and 1tph to Preston/Lancaster/Glasgow
- Freight: 1-3tph (up to 37 freight movements per day in each direction between Crewe and Preston)

Route capacity issues

4.46 Route capacity is mainly constrained by the two-track section between Winsford and Weaver Junction, where a mix of service and train types share the same track. Trains that stop at the local stations are six minutes slower through this route section than the Virgin West Coast inter-city train, while freight services are up to five minutes slower than inter-city services. Therefore each stopping service or freight train consumes more train paths than inter-city services, reducing overall capacity.

4.47 The interaction between fast passenger and freight trains is particularly important here as all freight both to Liverpool and Scotland is routed through this section. Therefore, as freight flows grow, there will be challenges for timetabling and potentially the need to seek to radically alter today's freight routing strategy in the North West.

4.48 At the north end of Crewe station, the line splits into three and there are flat crossings for passenger services. Some freight is routed via dedicated tracks that pass under the junctions and connect the freight yards south of the station to the line to Manchester and towards Weaver Junction. These tracks have no platforms, so cannot be used for passenger services that stop at Crewe.

Pressures to run additional services

- Since local stations are served only by the Liverpool – Birmingham trains, direct connections from Winsford, Hartford and Acton Bridge to Warrington and places further north are precluded
- Other longer distance inter-regional or inter-city services
- Increased freight services

Weaver Junction to Preston

Today's service pattern

4.49 This section once again carries a complex mix of services, including inter-city, commuter services to Liverpool and Manchester, regional services to the Lake District and Blackpool and freight services. It has a mixture of two and four-track sections with a number of flat junctions.

4.50 Below is a summary of the services levels between Weaver Junction and Preston.

Inter-city services:

- 1tph London to Scotland; off peak and peak - operated by Virgin West Coast
- 1tph Birmingham to Scotland off peak and peak - operated by Virgin West Coast
- Additional PM peak services: 1tph to Preston/Lancaster/Glasgow - operated by Virgin West Coast

Regional services:

- Transpennine Express services from Manchester Airport via Manchester Piccadilly to:
  - Scotland - 1tph (these have recently been converted to electric operation)
  - Blackpool North - 1tph
  - Barrow-in-Furness - 9 trains per day
  - Windermere - 2 trains per day
  - Preston - 1 train per day
  - Lancaster - 1 train per day
- Northern Rail services:
  - Manchester Victoria to Blackpool North - 1tph
  - Liverpool to Blackpool North - 1tph (currently operating to/from Preston as an Electric Multiple Unit (EMU))
  - Hazel Grove to Preston - 1tph (currently operating to/from Blackpool North)
  - Wigan to Liverpool - 2tph, 4tph in peak hours
  - Warrington Bank Quay to Liverpool Lime Street - 1tph
  - Ormskirk to Preston - 1tph
  - Colne to Blackpool South - 1tph
  - York to Blackpool North - 1tph
  - Ellesmere Port to Warrington Bank Quay - 2 trains per day

- Arriva Trains Wales
  - Manchester Piccadilly to Llandudno/Holyhead/Chester - 1tph
- Freight: up to 37 paths per day

Route capacity issues

4.51 The biggest constraints on route capacity on this section are:

- The diverse mix of fast inter-city services, stopping passenger services and freight of variable speeds creates a significant challenge to fit the inter-city timetable with that of various local and regional services
- Conflicts with a number of regional services that cross the WCML or run along it for short distances. All of these services which come on and off the WCML at un-modernised, speed-constrained flat junctions (Acton Grange, Winwick, Golborne, Springs Branch, Balshaw Lane, Euxton and Farrington Curve)

Pressures to run additional services

4.52 There are pressures to add to services in this section, including:

- Additional inter-city services from the North West to London as well as between Manchester, Preston and Scotland (recently electrified via Newton-le-Willows)
- Additional freight paths to and from Scotland, particularly intermodal

Weaver Junction to Liverpool

Today's service pattern

4.53 This route branches off the core WCML to serve Runcorn and Liverpool Lime Street and, in the final three miles from Edge Hill into Lime Street, it is joined by the intensive service from Manchester to Liverpool. Currently, Runcorn has three trains per hour: two of them are London Midland services to/from Birmingham and one is a Virgin West Coast service to/from London. The branch is also a key freight corridor serving the terminals at Ditton, the Halewood Car plant, Garston Freightliner terminal and Liverpool Port and has up to 25 freight paths per day in each direction.

Route capacity issues

4.54 Key constraints are the:

- Two-track section from Weaver Junction through to Runcorn and over the River Mersey
- Flat junction at Allerton where Liverpool-Manchester and WCML services merge

Pressures to run additional services

4.55 There are pressures to add to services in this section, including:

- Liverpool inter-city services to be every 30 minutes
- The expansion of freight traffic to/from Liverpool Port

Crewe to Manchester Piccadilly

Today's service pattern

4.56 The line between Crewe and Manchester Piccadilly links Crewe with Manchester via Wilmslow and Stockport. As with Birmingham New Street, the final approach from

Stockport is a complex mix of train services from across the country that has to be melded together on the four-track approach to Piccadilly.

4.57 The passenger service pattern between Crewe and Cheadle Hulme is outlined below:

- 1tph from London to Manchester operated by Virgin West Coast
- 1tph from Cardiff to Manchester operated by Arriva Trains Wales
- Local stopping services operated by Northern Rail:
  - 1tph from Crewe to Manchester
  - 1tph from Alderley Edge to Manchester
  - 1tph from Crewe to Manchester via Manchester Airport
  - Two Cross Country trains per day from Birmingham/South Coast to Manchester via Crewe
  - A further set of services that join the route at Cheadle Hume and Stockport
- Freight:
  - Manchester Piccadilly to Slade Lane Junction – 29 paths per day
  - Slade Lane Junction to Cheadle Hulme – 9 paths per day in one direction

Route capacity issues

4.58 Route capacity constraints on this section include:

- The 18-mile two-track section between Sandbach and Cheadle Hulme – here fast long distance services from London and South Wales mix with slower stopping local trains and freight trains
- Cheadle Hulme Junction – this flat junction is the point where trains from London via Stoke-on-Trent join back with those from London via Crewe, as well as Cross Country and local services
- Short section of two-track railway between Cheadle Hulme and Adswood Road Junction which is shared by trains from both the Crewe and Stoke-on-Trent directions heading towards Stockport and Manchester
- The approach to Piccadilly station where the complex track layout and range of destinations curtails operational flexibility

4.59 A number of improvements are planned as part of the Northern Hub programme to increase platform capacity at Manchester Piccadilly and on its immediate approaches. This will bring valuable service enhancements and take some of the pressure off the approach to Manchester Piccadilly. It will also allow better connections to both Manchester Victoria and Manchester International Airport.

Pressures to run improved and additional services

4.60 There are pressures to add to services in this section, including:

- Faster services between Sheffield and Manchester, which join the route just south of Stockport
- One out of every two Chelford - Northwich - Manchester peak commuter trains was removed in 2008, forcing passengers to change at Stockport
- Additional services to Manchester Airport, particularly from the South

Colwich Junction/Norton Bridge to Manchester Piccadilly

Today's service pattern

4.61 This branch of the WCML to Manchester carries a wide mix of service types with inter-city, regional, and local services all using the same section of railway. However, very little freight traffic is routed this way; most goes via Crewe instead. In the busiest section of the route between Stoke-on-Trent and Kidsgrove Junction, 7tph operate:

- 2tph from London to Manchester operated by Virgin West Coast
- 2tph from South West England to Manchester operated by Arriva Cross Country
- 1tph from Stoke-on-Trent to Manchester operated by Northern Rail
- 1tph from London to Crewe operated by London Midland
- 1tph from Derby to Crewe operated by East Midlands Trains
- Freight: Norton Bridge to Stone Junction – 1 path per day in each direction, Colwich Junction to Cheadle Hulme – 3 paths per day in each direction

Route capacity issues

4.62 Key route capacity constraints are:

- The mix of service types and operating speeds between Stoke-on-Trent and Cheadle Hulme restrict route capacity. For example a stopping Northern service (from Stoke-on-Trent to Manchester) is typically 14 minutes slower than an inter-city service
- As previously mentioned, at Cheadle Hulme the lines from Crewe and Stoke-on-Trent converge into a busy two-track section until just south of Stockport
- The Stockport station area, where the lines from Sheffield, Hazel Grove and Buxton merge together for the final five mile approach to Manchester Piccadilly. Although there are separate fast and slow routes from Stockport to Piccadilly, elaborate crossing movements are needed to get the trains onto the right route for the approach

4.63 As previously noted, some improvements in the Manchester area are coming as part of the Northern Hub programme.

Pressures to run additional services

4.64 There are pressures to add to services in this section, including:

- A Buxton - Blackpool service which was split into three new service groups: Buxton - Manchester Piccadilly, Hazel Grove - Preston and Manchester Victoria - Blackpool to accommodate the VHF timetable
- Local services connecting Rose Hill, in Marple to the east of Manchester, to Piccadilly and Bolton via Oxford Road were also curtailed. The Rose Hill trains now terminate at Manchester Piccadilly because of the shortage of paths across all the tracks at Piccadilly

Options for addressing the constraints

The Strategic Alternative

4.65 Chapter 3 provided a brief overview of the Strategic Alternatives to HS2 In essence, the Alternative proposed the following:

- A new grade-separated junction near Milton Keynes to allow commuter trains to leave the Fast Lines without slowing down to access Northampton. This would increase the capacity of the Fast Line to 16tph throughout the peak
- Four-tracking the route from Rugby to Birmingham (the 'Coventry Corridor')
- Lengthening both West Midlands and ICWC trains: the former to 12-cars and the latter to 11-cars
- Power supply reinforcement, particularly on the northern part of the route
- Grade-separation just north of Stafford, to allow trains from Birmingham to Stoke-on-Trent and Manchester to operate more reliably
- Doubled inter-city frequencies to Liverpool and Glasgow, through the use of splitting and joining. This would mean some existing trains operating in two portions, and then splitting/joining at Warrington Bank Quay. As a result, alternate trains to Glasgow would have to be slowed down by perhaps 7-10 minutes to allow time for this and a new fleet of shorter trains would be required, since the existing Pendolino trains are too long to be operated in this way

4.66 Figure 36 summarises the service pattern assumed in the Strategic Case.

4.67 In fact, significant elements of the Strategic Alternatives work are already committed. Specifically, the train lengthening proposed is already underway and has been allowed for in the train capacity analysis in Chapter 5 of this document. In addition, London Midland now operates more trains on the Fast Lines as a result of the LM110 project of the kind envisaged in the Strategic Alternative but without the need for grade separation. Some of the infrastructure interventions are in hand, particularly the grade-separated junction being built at Norton Bridge discussed previously.

4.68 Provision of a grade-separated junction south of Milton Keynes would allow the route to go up to 16tph throughout the peak compared with the current situation where 15tph are generally operated throughout the peak (aside from between 08:02-09:01 on weekdays, and 18:00-18:59 on Fridays, when 16tph are operated).

4.69 When originally developed a few years ago, the Strategic Alternative envisaged that additional paths would be created to increase both Birmingham and Manchester services from three trains per hour to four. However, in the interim, one of the additional Fast Line train paths has been taken up by a 110mph London Midland commuter service, so in practice, only one additional inter-city path is likely to be available following the £2.5 billion programme of works.

4.70 The Strategic Alternative would in effect be a further "patch and mend" solution to the capacity problems on the WCML. The considerable expenditure and disruption involved would provide some crowding relief via a limited extension of today's services. However, there would be much less opportunity to reinstate services curtailed to accommodate the VHF timetable, or to improve connectivity to places that are currently poorly served. In addition, the potential opportunity to release capacity on the WCML to accommodate the growth in demand for freight paths that is forecast by Network Rail would be missed.

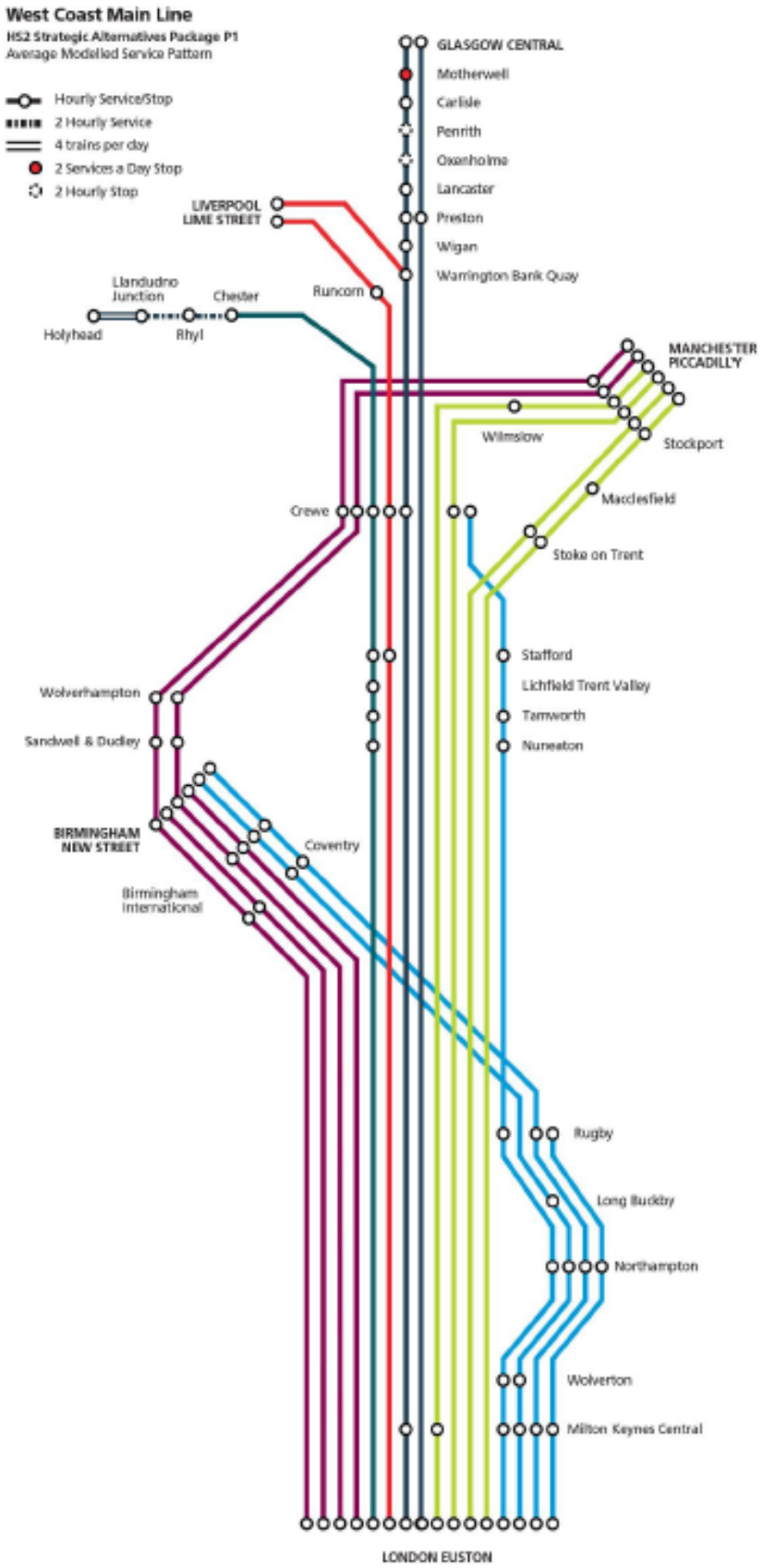


Figure 36 Strategic Alternative Package P2 service specification[43]

[43] Source: "HS2 Strategic Alternatives, Final Report" (DfT, 28 October 2013)

European Train Control System (ETCS)

4.71 While not an explicit part of the Strategic Alternative, the European Train Control System (ETCS) is a signalling, control and train protection system which is seen as offering the potential to increase capacity by optimising the operating distances between train services in real time. Its application on the WCML is not yet programmed or committed. ETCS could reasonably be expected to bring some benefits, especially in terms of punctuality, helping to address the question of secondary delays in particular. But the basic infrastructure issues on the WCML that constrain the number of services that can be run, notably complex, non grade-separated junctions, the mixing of trains running at different average speeds and the lack of capacity at stations, would remain.

HS2 capacity benefits

4.72 In reading the following section it is important to note that Network Rail is currently leading a strategic rail study ("Capacity Plus") with the objective of identifying strategic options for rail services to operate after the implementation of HS Phase One. This will include options for train services made possible through released capacity on the WCML. Options being assessed include new long distance services (to enhance inter-regional connectivity and potentially through services to London from new origins), additional capacity for freight growth and options to accommodate further commuting growth into London.

4.73 At this stage, no decisions have been taken on the introduction of these new services. Well established statutory, regulatory, and administrative processes will be used to build an open and shared evidence base, consult passengers, communities and freight users, establish options and take decisions ahead of the introduction of a new timetable.

4.74 As described in Chapter 3, HS2 would increase the capacity for fast trains on HS2 and the West Coast Fast Lines combined to/from London Euston from 15-16tph to 23tph. It could also increase capacity on the Slow Lines from 8 to 10tph. Figure 37 summarises the HS2 Phase One service pattern that has been presented to the hybrid Bill Committee. It should be noted that a range of service options exist and that final choices do not need to be taken until closer to route opening when they could be better shaped by the market pressures prevailing at that time.

4.75 The second phase of HS2 adds high-speed capacity with an increase in train lengths to Manchester – and potentially for Scottish services too. While Phase One allows a transformation in local and regional services operating over today's congested Coventry corridor, Phase Two opens up the prospect of a similar transformation through Greater Manchester's 'Stockport corridor' with new services, greater capacity and new connections, as well as better and more services through Staffordshire and Cheshire.

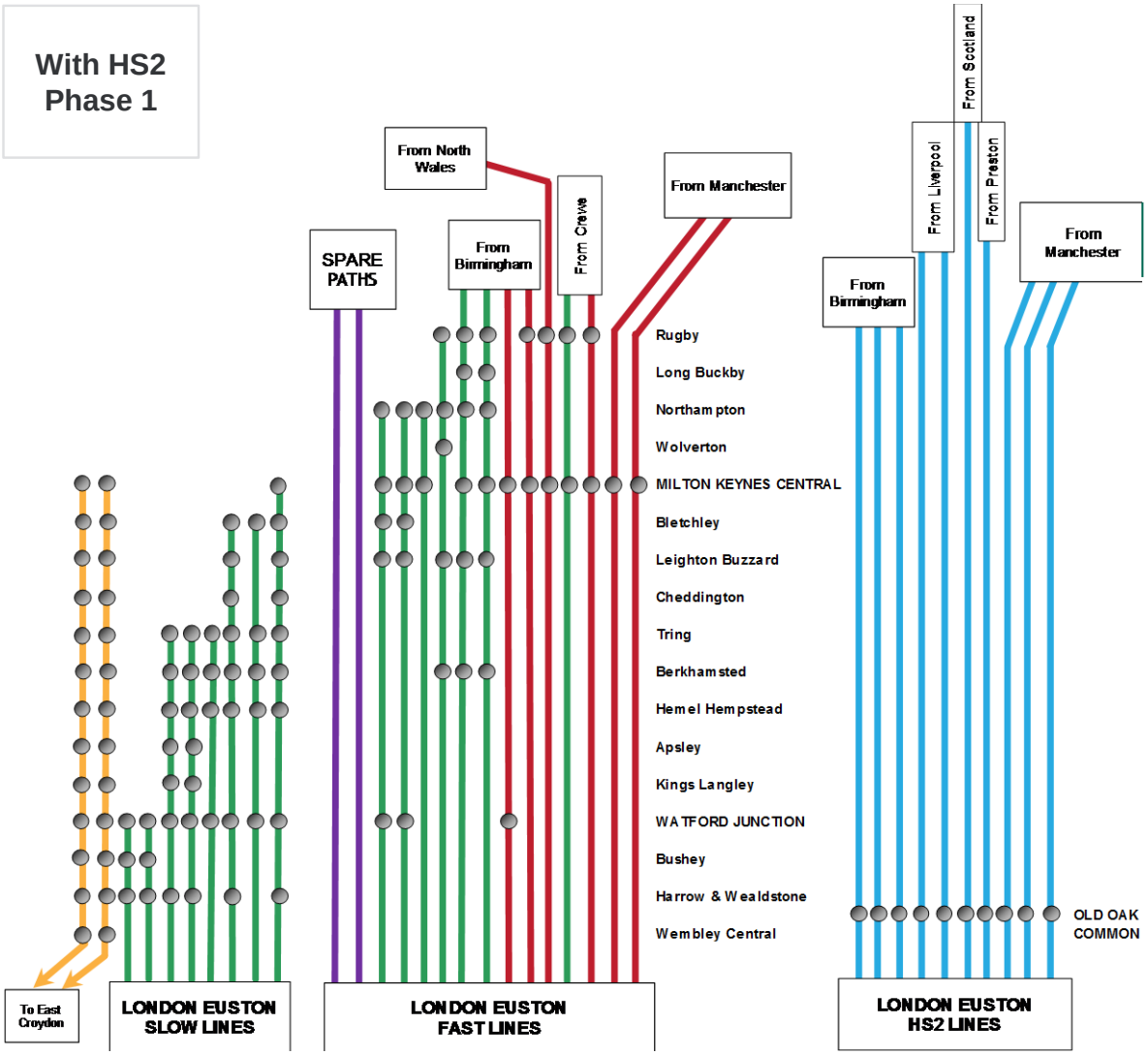


Figure 37 Indicative plan of services of the WCML and HS2 following Phase One[44]

4.76 The following sections look at what HS2 offers, by route section. This extra capacity means that a balanced approach can be taken to address inter-city, commuter and freight growth along the WCML.

London to Rugby

4.77 HS2 Phase One provides a long-term response to the route capacity issues highlighted above by providing two extra tracks between Rugby and London and the expansion of London Euston station. After the completion of HS2 Phase One, combining HS2 and WCML together, there will be capacity for 31 passenger trains directly into London Euston per peak hour from the western half of the country. Following the completion of HS2 Phase Two, including the addition of trains from the eastern leg of the network, the total number of trains could be up to 41 passenger trains directly into London Euston per peak hour.

[44] Source: HS2 Ltd. Version presented by HS2 to Hybrid Bill Committee, 2015

Commuter services

4.78 With HS2 Phase One, capacity released from running fewer ICWC services on the WCML allows WM services across the three AM peak hours to increase from 28 today to 41, under the Autumn 2013 Business Case assumptions used to support the Phase One hybrid Bill.

4.79 HS2 would potentially allow most trains from Leighton Buzzard and further north to use the Fast Lines. This, in turn, would allow a more even stopping pattern on the Slow Lines which at present is a hybrid between semi-fast and all-stations services. This could create two further paths per hour on the Slow Lines where the current service is a mix of semi-fast passenger, slow passenger and freight. This change would also permit more frequent local connections for Milton Keynes from its surrounding stations, including in future from the planned East-West rail link, helping establish it as a regional hub.

4.80 As noted above, no decisions have been taken on the introduction of new or amended services as a result of HS2.

Inter-city services

4.81 Peak inter-city services across both HS2 and the WCML added together under Phase One could increase by around 50 per cent, i.e. from today's 11/12tph to 17tph (plus 2 potential spare paths on WCML for future use). Of the 17, 12 are planned to serve the North and Scotland (7 via HS2 and 5 via the WCML), whilst five could connect London with the West Midlands (3 of these via HS2 and 2 via the existing route). These latter two services could make more calls off peak than at present, opening up the possibility of a distinct "inter-regional" express service fully linking the principal stations between London, Rugby and Birmingham in order to support growth in the Northamptonshire and Milton Keynes area.

4.82 As noted above, no decisions have been taken on the introduction of new or amended services as a result of HS2.

New markets

4.83 Without the need to accommodate longer distance demand to Britain's major cities on the WCML, HS2 potentially gives scope to provide connections to some of the next tier of smaller centres which cannot be provided with through services today because of the capacity limitations. This could potentially include:

- More inter-city services, to stations not currently served by direct trains or stations that currently have relatively poor direct services
- More stops (which require capacity) on some of the inter-city services at intermediate stations such as Watford Junction and Milton Keynes, particularly those to the North and Scotland, which lost most of their calls in 2008

4.84 As noted above, no decisions have been taken on the introduction of new or amended services as a result of HS2.

Rugby to Birmingham New Street

4.85 HS2 essentially provides a high speed bypass of this section, allowing inter-city trains to run straight into Birmingham without conflicts with either interurban, stopping or freight services.

4.86 This means that the timetable between Rugby and Birmingham can potentially be recast to give higher priority to cross country, stopping and freight trains than is

possible today. This could result in an increase in service levels along the Coventry corridor.

4.87 Centro[45],in its recent paper "HS2 Unlocking the Benefits", outlined the potential opportunities of improved service levels and local/regional connectivity that can be delivered post HS2 Phase Two in combination with other planned infrastructure works such as the doubling of the track between Leamington and Coventry.

4.88 Centro's network plan (detailed in Figure 38) sets out a standard pattern of 12tph between Birmingham International and Birmingham New Street, with 8tph operating between Coventry and Birmingham New Street. This is an increase of 3tph on the current standard pattern off peak between Birmingham International and Birmingham New Street and an increase of 1tph between Coventry and Birmingham New Street.

4.89 The uplift in capacity may provide the opportunity to provide better connectivity both across the West Midlands and to destinations beyond the West Midlands, for example via:

- Cross Birmingham links - from Leamington to Walsall and from Birmingham International to Wolverhampton/Shrewsbury
- A London to Liverpool via Birmingham New Street and Walsall service - providing direct services for Walsall to London and Liverpool
- More frequent inter-city services from Wolverhampton/Shrewsbury to London
- Re-routing of the South Coast to Newcastle service via Coventry and Birmingham International, providing direct services between Coventry and Birmingham International to the East Midlands, Yorkshire and north-east England

4.90 As noted above, no decisions have been taken on the introduction of new or amended services as a result of HS2.

Rugby to Crewe

4.91 Transferring the current Manchester, Liverpool and Scotland to London inter-city services to operate over HS2, releases five paths per hour on the existing WCML between Rugby and Crewe.

4.92 This could give the opportunity to:

- Provide better service levels to Trent Valley stations, with more regular fast services to London, particularly from Lichfield and Tamworth, and improved connectivity to Manchester and Liverpool
- Serve new inter-city markets

Provide new regional services such as Oxford (via East-West rail) to Manchester or Milton Keynes to Liverpool

- Potentially accommodate up to two more freight paths per hour

As noted above, no decisions have been taken on the introduction of new or amended services as a result of HS2.

It should be noted that while HS2 Phase One will bypass the constraints of the 3-track section between Brinklow and Attleborough, service levels between Rugby and Crewe will still be subject to the constraints of flat junctions at Colwich Junction and Whitehouse Junction and the two-track section through Shugborough tunnel, through which all services on HS2 and the existing WCML would have to pass. This section

[45] The body responsible for the delivery of public transport in the West Midlands, representing the seven metropolitan borough councils.

would, however, be relieved by the Phase 2a extension from Lichfield to Crewe, extending the capacity benefits of the Phase One scheme northwards.

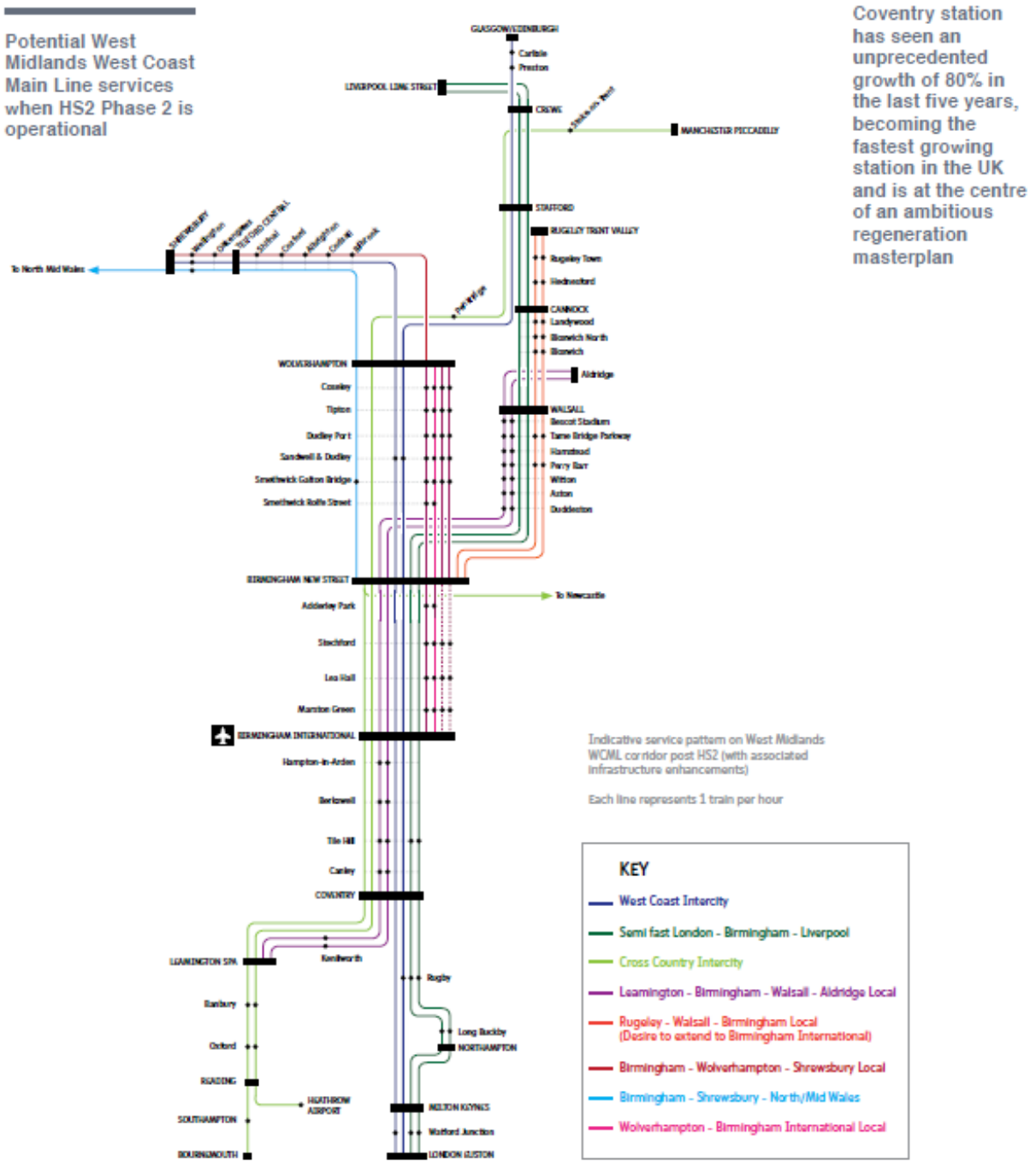


Figure 38: Service Plan from Centro for post HS2 Phase Two (Source "HS2 Unlocking the Benefits" by Centro)

Crewe to Weaver Junction

4.93 Under Phase Two, HS2 services to Liverpool and Lancaster/Blackpool would need to use the existing WCML between Crewe and Weaver Junction with the expectation that at least two HS2 trains each hour will operate between London and Liverpool and one train per hour between Lancaster/Blackpool and London. HS2 would allow the two trains per hour to Scotland (one from London, one from Birmingham) currently operating on the WCML to be replaced with HS2 services, releasing two inter-city peak paths per hour on the existing WCML. These paths could be used by

high speed conventional (non HS2) services such as the proposed second hourly service between Liverpool and London and a service between Carlisle and London, retaining and enhancing the availability of direct London services.

4.94 Further capacity could be released (depending on the stopping pattern mix and future operating speeds of freight and passenger services) since HS2 could provide more timetable flexibility as a result of HS2 services by passing existing WCML constraints and interacting with fewer services south of Crewe.

4.95 The greater flexibility provided by HS2 could give the potential for:

- A better defined network of local and interurban services, connecting Liverpool, Preston, Manchester and Crewe
- More freight services to be accommodated

4.96 As noted above, no decisions have been taken on the introduction of new or amended services as a result of HS2.

Weaver Junction to Preston

4.97 HS2 Phase Two will join the existing WCML at Golborne Junction between Warrington Bank Quay and Wigan North Western stations. Similar to the Crewe to Weaver Junction section, the two London/Birmingham to Scotland services that will run on HS2 will release paths between Weaver Junction and Golborne Junction. However, north of Golborne Junction, Scotland trains will operate on the existing WCML in a way similar to the current services.

Weaver Junction to Liverpool

4.98 This section is likely to benefit from any released capacity on the Crewe to Weaver Junction section of the WCML.

Crewe/Colwich Junction/Norton Bridge to Manchester Piccadilly

4.99 Following construction of Phase Two, there would in effect be another two tracks on the approach to Manchester from the south, a 50 per cent increase on today. It is planned that the current inter-city services on the WCML will be moved to HS2, releasing capacity on both the Crewe and Stoke corridor to Manchester.

4.100 The released capacity in the Crewe/Stoke corridor could allow reshaping of services, such as:

- More stopping trains, particularly from Stoke-on-Trent, Macclesfield and Bramhall
- Extension of the Derby to Crewe service to Manchester Airport
- Improved frequency between South Wales and Manchester
- Service frequency from the mid-Cheshire line could be increased, and more connections via the Northern Hub scheme would become possible

4.101 As noted above, no decisions have been taken on the introduction of new or amended services as a result of HS2.

5. Train Capacity Analysis

Introduction

5.1 Chapters 3 and 4 considered issues of route capacity on the West Coast Main Line (WCML). Taken together they highlighted that:

- Growth in demand, both in the passenger and in the freight markets, are, and will continue to lead to pressures to run additional services on the WCML corridor
- At its busiest points, in the peak, the WCML is operating at, or close to, its full route capacity, making it challenging to accommodate additional services on the route
- HS2 will provide a step change in route capacity and therefore gives a wider range of options to accommodate new services in the WCML corridor than the Strategic Alternative

5.2 This chapter considers the question of train capacity. In other words, how effectively the level of seats and standing capacity provided on trains can accommodate passenger demand on the WCML corridor. In particular, it considers:

- The level of train crowding that will arise on the West Midlands (WM) franchise (currently operated by London Midland) and the Inter City West Coast (ICWC) franchise (currently operated by Virgin West Coast) services should further investment in route capacity not occur
- The ability of tactical measures such as the lengthening and reconfiguration of trains to accommodate this crowding
- The extent to which the investment in route capacity provided by the Strategic Alternative and HS2 allows sufficient additional train capacity to provide a long term solution to any future overcrowding problems

Future growth scenarios

5.3 In order to assess future passenger crowding, two Growth Scenarios have been modelled: a ‘Reference Case’ and a ‘Higher Growth Case’.

5.4 The ‘Reference Case’ uses a peak period growth rate derived from the DfT’s Planet Framework Model (PFM) – the same source used for the Economic Case HS2, in November 2015. The growth rates used in the ‘Reference Case’, averaged out over the period from 2014/15 to 2033/34, are:

- 1.8 per cent for WM services
- 2.0 per cent for ICWC services

5.5 The ‘Higher Growth Case’ uses the ‘high sensitivity’ growth rates from the DfT’s Network Modelling Framework (NMF). The growth rates used in the ‘Higher Growth Case’, averaged out over the period to 2033/34, are as follows:

- 3.0 per cent for WM services
- 3.7 per cent for ICWC services

5.6 The base year for the analysis is 2014/15 and it uses train loading figures taken from the passenger counts undertaken by the Train Operating Companies (TOCs) and supplied to DfT. For ICWC, Virgin West Coast passenger counts from Autumn 2014 have been used. For WM, later London Midland counts, undertaken in Spring 2015, have been used to provide the base loadings. This is because these counts take into account the impact of London Midland's December 2014 timetable change in which two additional London Euston arrivals were added in the peak hour. Within the analysis, train capacities for both WM and ICWC are consistent with the timetables and train configurations operated by the train companies in December 2014.

West Midlands (WM) services

- Today, the current operator London Midland experiences notable levels of overcrowding into and out of London – 6.5 per cent in Autumn 2014
- Without intervention, crowding could lead to major issues on WM; PiXC is estimated to increase between 18 per cent and 30 per cent by 2033/34
- PiXC is estimated to be in the range of 11-19 per cent in 2033/34, even if all AM and PM peak services are lengthened to 12-cars
- HS2 can mitigate this by allowing step change in peak capacity on WM that cannot be achieved with the Strategic Alternative

5.7 Before examining how crowding levels are forecast to change on WM services, it is important to look at the growth rates used in this exercise in a historic context. The left-hand side of Figure 39 sets out the growth rate observed across the London and South East (LSE) sector as a whole during the 18 year period since privatisation to 2014/15 as well as that observed on London Midland since the first full year of operations in 2008/9. The growth rates are 4.3 per cent per annum and 4.0 per cent per annum respectively.

5.8 Figure 39 compares these rates with the growth in the 'Reference Case' and the 'Higher Growth Case.' The forecasts presented on the right-hand side of the graph represent the projected impact of a number of exogenous demand drivers such as growth in the economy, growth in the population and changes in modal competition (for example changes in rail usage given changes in the cost of car ownership). The forecasts also include the impact of endogenous demand drivers such as changes in rail fares and the impact of the timetable/capacity changes that occurred in December 2014. The forecasts do not include the impact of any train operator-led initiatives, for example new products, improvements in service quality or marketing.

5.9 Figure 39 illustrates that the rate of demand growth used for this exercise is around 45 per cent of historic London Midland growth rate in the 'Reference Case' and 75 per cent of this growth rate in the 'Higher Growth Case.'

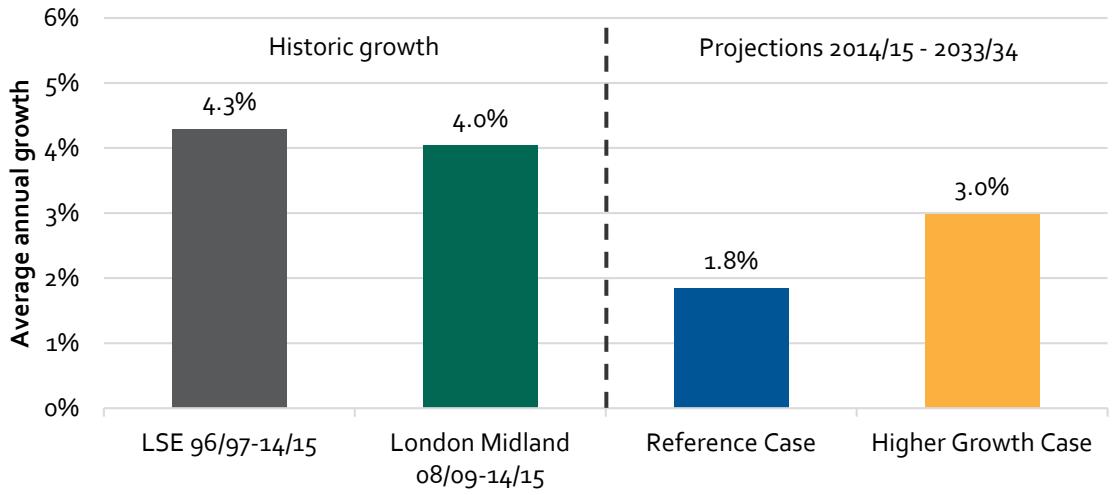


Figure 39 West Midlands franchise (currently operated by London Midland) historic and projected growth[46]

5.10 Passengers in Excess of Capacity (PiXC) is DfT's published measure of the level of overcrowding on trains. It is defined as the number of passengers standing above the agreed capacity limits of a train, divided by the total number of passengers on the train.

5.11 For current London Midland services, 'agreed capacity' per train is measured as the number of seats on the train plus 2.2 passengers per square metre of standing space. For a sub-set of London Midland outer suburban services that do not stop within 20 minutes of London, capacity is defined as seating capacity only (i.e. any passenger standing is included in the PiXC measure).

5.12 Figure 40 compares morning (AM) and evening (PM) peak PiXC on the TOCs that DfT groups within the LSE sector. The most crowded TOC is Greater Western. Crowding on these services is being addressed through investment in the following: remodelling of Reading station and the surrounding track layout to improve the performance and capacity of the network, electrification of the Greater Western Main Line route; new trains as part of the Inter-city Express Programme; and new electric commuter trains. Behind Greater Western, London Midland has the second highest PiXC figures.

[46] Data source: ORR data portal; Planet Modelling Framework version 4.3; Network Modelling Framework.

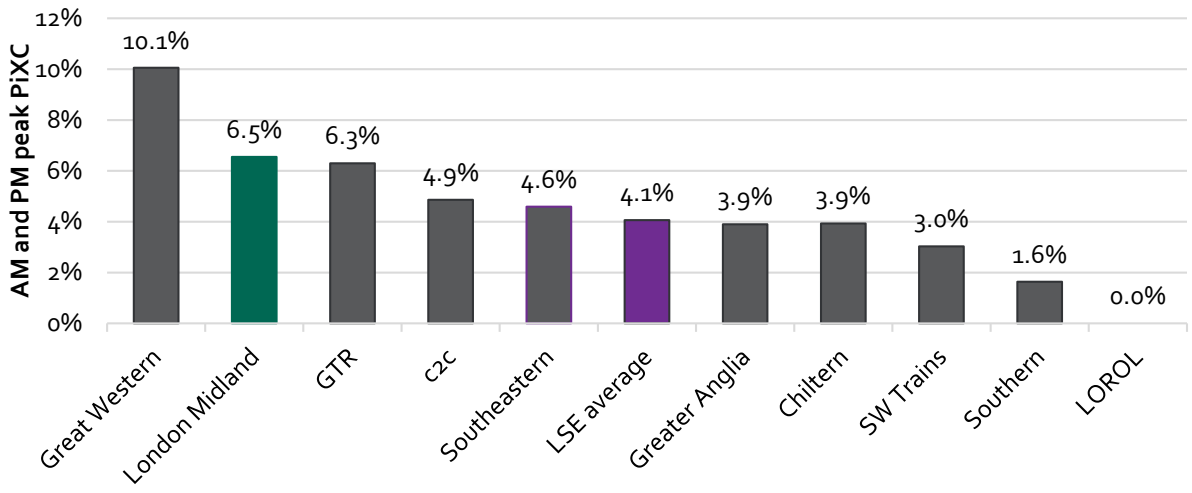


Figure 40 AM and PM peak Passengers in Excess of Capacity, Autumn 2014[47]

5.13 This problem is not a one-off. Figure 41 compares the PiXC levels on London Midland to the LSE average going back to 2008. In each of the last seven years, PiXC on London Midland has exceeded the LSE average. In five of the last seven years, London Midland has been measured as having the second highest PiXC levels behind First Great Western.

Figure 41 London Midland historic PiXC - AM and PM peak combined[48]

[47] Data source: DfT Passengers in Excess of Capacity statistics. Note that the South West Trains PiXC figure is calculated on a different basis to other operators, and would be higher if measured in the same way.
[48] Data source: DfT Passengers in Excess of Capacity statistics.

5.14 In response to its notably high levels of crowding, London Midland's December 2014 timetable added two additional services into London Euston in the AM peak hour. Using the Spring 2015 counts - which were undertaken after the new timetable was introduced - Figure 42 sets out how PiXC on London Midland services could be expected to increase in 2033/34 in two operational scenarios:

- **Today's capacity:** This assumes that the December 2014 timetable continues to be operated with the same size train fleet
- **All 12-car:** Assumes that all AM and PM peak services are operated at 12-car length (the current maximum length of operation)

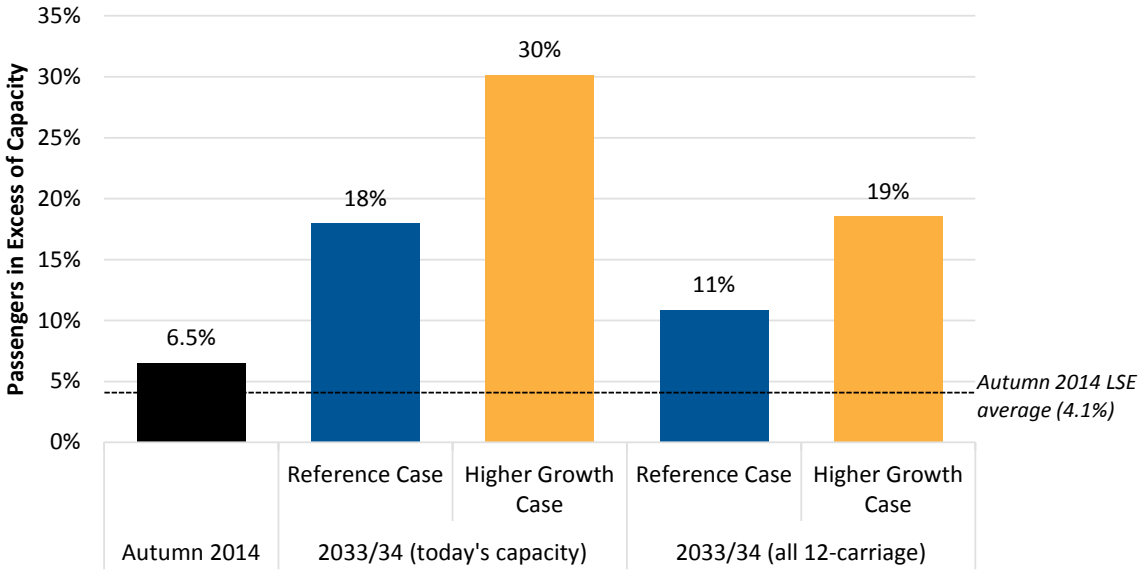


Figure 42 West Midlands franchise current and projected PIXC (AM and PM peak combined)[49]

5.15 Figure 42 demonstrates that continuing to operate the current train service in 2033/34 could result in overcrowding levels of 18 per cent in the 'Reference Case' and 30 per cent in the 'Higher Growth Case' - three to five times greater than overcrowding levels today. This is likely to present severe operational difficulties, such as extended dwell times as large numbers of passengers attempt to board and alight from trains. This could have a knock-on impact on punctuality.

5.16 This overcrowding could be mitigated in part by operating all trains at 12-car length[50]. However, even then, PiXC is forecast to range from 11-19 per cent - greater than it is on Great Western today, where major investment to mitigate crowding is in progress.

5.17 Overcrowding could become a serious issue on WM much sooner than 2033/34 if passenger demand continues to grow at the rate that has been seen on London commuter flows in the period since privatisation. If growth was to continue to average 4.3 per cent per annum, then by 2026/27, the year HS2 Phase One is scheduled to open, PiXC could be as high as 16.3 per cent, even if all trains had been lengthened to 12-cars. Higher capacity rolling stock and swapping station stops could potentially

[49] Data sources: DfT Passengers in Excess of Capacity Autumn 2014 and Spring 2015 train counts
[50] Lengthening all trains to 12 carriages on the West Midlands franchise is not a committed scheme.

help to ameliorate this situation. However, but it would result in more standing for passengers and potentially longer journey times from some stations.

Impact of different investment interventions

5.18 To determine how this passenger crowding might be mitigated, the impact of the Strategic Alternative and HS2 are considered. Figure 43 illustrates that the Strategic Alternative builds on the all 12-car option by allowing two further fast services between 07:00–08:00 (increasing the current 28 AM peak trains to 30.) With HS2 Phase One, route capacity released from running fewer inter-city services on the WCML allows the number of WM AM peak arrivals to increase from 28 to 41.

Scenario	Number of services	Standard Class seats	Standard Class capacity
December 2014	28	15,132	20,234
All 12-carriage	28	19,344	25,884
Strategic Alternative	30	20,580	27,120
With HS2	41	30,330	41,103

Figure 43 WM AM Peak (07:00–09:59 arrivals into Euston) capacity scenarios[51]

5.19 Figure 44 examines the capacity impact of each of these scenarios by forecasting average load factors on WM across the AM peak in 2033/34. This covers all Euston arrivals between 07:00 and 09:59 with the load factor defined as demand divided by agreed capacity (seating plus standing allowance). For each option, the yellow bars represent forecast load factors under the 'Higher Growth Case' and the blue bars under the 'Reference Case' growth rates. The analysis demonstrates that:

- Operating the existing train service in 2033/34 would result in average load factors in the AM peak of 117 per cent in the 'Reference Case' and 142 per cent in the 'Higher Growth Case'. This would translate into PiXC levels across the AM and PM peaks of 18 per cent and 30 per cent respectively compared to 6.5 per cent in Autumn 2014
- Operating every service with 12 carriages would reduce load factors to 91 per cent and 111 per cent respectively. This translates into PiXC levels of 11 per cent and 19 per cent
- The infrastructure investment contained within the Strategic Alternative only provides a marginal increase in WM capacity over and above running today's services with 12-cars. Average load factors in 2033/34 are estimated to be 106 per cent across the AM peak in the 'Higher Growth Case.' In the 'Reference Case', loadings would exceed today's levels (91 per cent to 84 per cent)
- Due to the release of WCML route capacity for commuter services, the "with HS2" option allows future growth on WM to be accommodated in both the 'Reference Case' and the 'Higher Growth Case' scenarios

5.20 With the additional capacity released by HS2, average loadings across the AM Peak would not return to today's levels until 2063 in the 'Reference Case' and 2041 in the 'Higher Growth Case'.

[51] Data source: Analysis of the December 2014 timetable; "The Strategic Case for HS2" (DfT 2013)

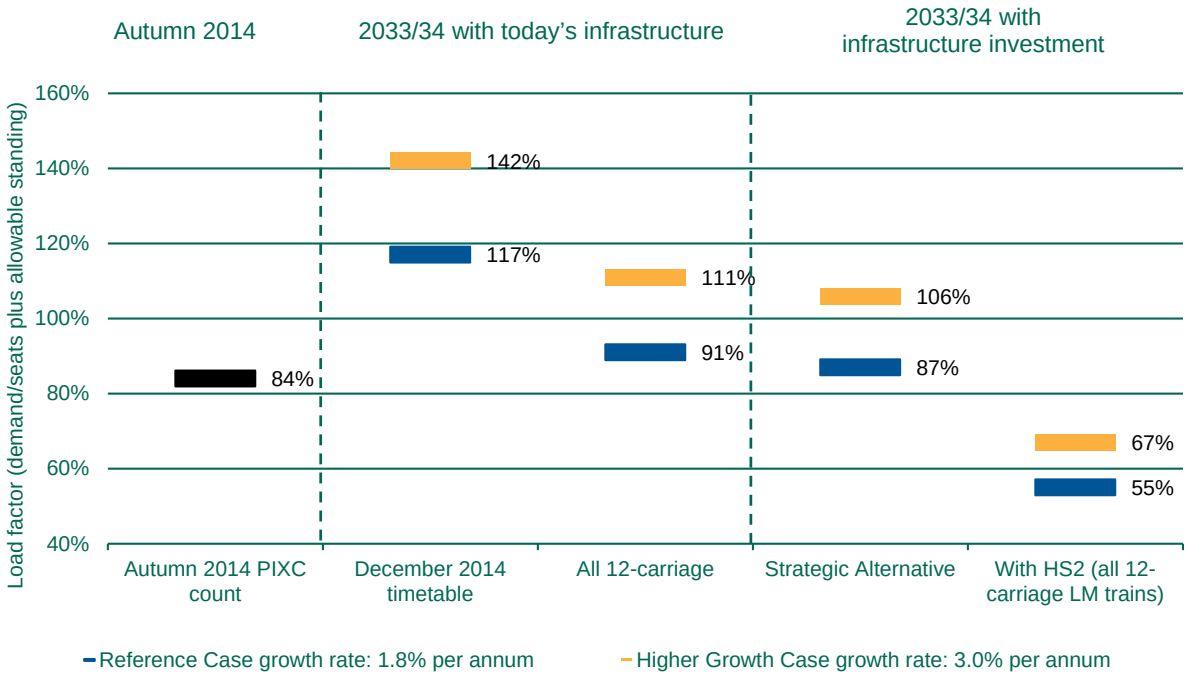


Figure 44 Forecast WM 2033/34 AM Peak load factors on arrival at Euston (demand/seats and allowable standing)[52]

Inter City West Coast services

- Certain ICWC services are overcrowded today and around two thirds of the additional peak inter-city seating capacity provided by the WCML upgrade is already being filled
- By 2033/34, standing on ICWC services to and from London will become a material issue even if all trains are extended to 11 cars and reconfigured to increase Standard Class capacity
- Changing fares restrictions is unlikely to solve crowding issues over the long term
- HS2 provides the flexibility to add over 100 per cent additional inter-city capacity to ICWC destinations and provides resilience for all future ICWC growth scenarios

Strong growth is forecast on ICWC, continuing historic trends

5.21 As for WM, Figure 45 compares historic growth both on Virgin West Coast and across the wider long distance rail sector with the growth rates used in the 'Reference Case' and 'Higher Growth Case.' Since 1996/97, the average growth achieved by Virgin West Coast has been 5.5 per cent per annum. This compares to 4.7 per cent per annum across the wider long distance rail sector. The 'Reference Case' and 'Higher Growth Case' assume annual growth rates of 2.0 per cent and 3.7 per cent respectively.

[52] Data sources: "Analysis of DfT Passengers in Excess of Capacity Statistics" (Autumn 2014) combined with PFM and NMF growth rates; "The Strategic Case for HS2" (DfT 2013)

5.22 Consistent with the WM growth rates, the forecasts include exogenous and endogenous demand drivers but exclude the impact of train company-led initiatives. Broadly speaking, the 'Reference Case' assumes that growth is at just over 40 per cent of the rate seen in the long distance rail market since privatisation. This rises to around 80 per cent in the 'Higher Growth Case'.

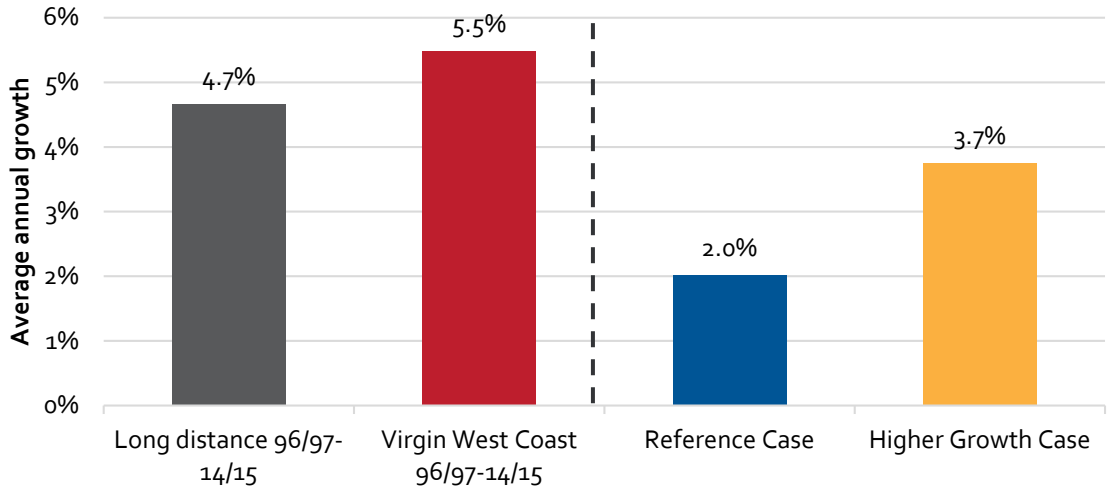


Figure 45 ICWC historic growth and projections (average annual growth)[53]

5.23 Within this analysis of crowding on ICWC services, the load factor is defined as the number of passengers on the train divided by the number of seats. On long distance services there is no allowable standing capacity – all passengers are expected to have a seat for their journey (this definition is relaxed on trains that call at stations that are less than 20 minutes from London Euston, although the allowable capacity is only available on that 20 minute leg of the train's journey). The analysis below focuses on Standard Class demand and capacity. First Class demand and capacity is excluded.

5.24 Figure 46 sets out load factors on ICWC services in the AM and PM peak periods based on the autumn 2014 counts. Within the analysis, the PM peak on ICWC has been extended to include the period from 19:00 to 19:59. Between 16:00 and 18:59 peak period restrictions apply to the types of tickets that can be used to travel on ICWC services. These restrictions finish at 19:00 when lower priced tickets become valid on ICWC services again. This makes the hour from 19:00 to 19:59 a particularly popular hour for travel and therefore highly relevant to any analysis of future crowding on ICWC.

5.25 Our analysis shows the following:

- Average loads on Virgin West Coast are currently 68 per cent in the AM peak and 67 per cent in the PM peak, rising to 79 per cent in the PM peak on Fridays
- Today, average loadings are as high as 100 per cent on Friday evenings between 19:00 and 19:59 – i.e. there are as many passengers as there are seats on Euston departures across this particular hour

[53] Data source: ORR data portal; Planet Modelling Framework (PFM) version 5.2b; National Modelling Framework (NMF)

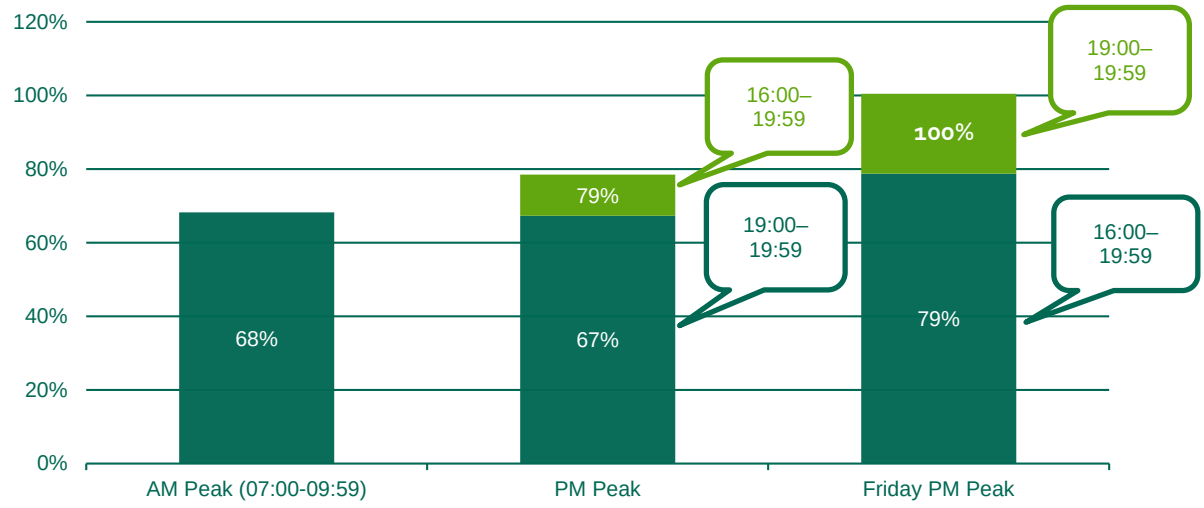


Figure 46 Virgin West Coast Standard Class load factors in autumn 2014[54]

Standing on ICWC will become a material issue by 2033/34

5.26 In looking at future crowding on ICWC, two options were considered for increasing train capacity within the constraints of the existing infrastructure[55]:

- **Extending all Pendolino (electric) trains to 11 cars and all Voyager (diesel) trains to 10 cars.** Of the 27 AM peak (07:00-09:59) ICWC services in the December 2014 timetable; seven are currently 9-carriage Pendolinos, 17 are 11-carriage Pendolinos and three are 10-car Voyagers. Of the 41 PM peak (16:00-19:59) ICWC services in the December 2014 timetable; 12 are currently 9-car Pendolinos, 21 are 11-car Pendolinos, three are 5-car Voyagers and five are 10-car Voyagers
- **All 11-car train reconfigured**: As per the previous option but with all 11-car Pendolinos re-configured from seven Standard Class and four First Class cars to eight Standard Class and three First Class cars

5.27 Both of these measures are part of the Strategic Alternative for ICWC services.

5.28 Figure 47 sets out the additional capacity that would be provided under these two options – up to a further 27 per cent in the AM peak and 33 per cent in the PM peak.

Scenario	AM Peak (07:00-09:59)	PM Peak (16:00-19:59)
Autumn 2014	11,040	15,869
All trains 11 car	12,074 (+9.4%)	18,350 (+16%)
All trains 11 car (reconfigured)	13,974 (+27%)	21,162 (+33%)

Figure 47 ICWC Standard Class seat capacity scenarios – existing infrastructure[56]

5.29 Taking the train-by-train loadings from the Autumn 2014 counts as a base, Figure 48 forecasts the proportion of peak ICWC passengers estimated to be on trains with a

[54] Data source: DfT Passengers in Excess of Capacity Statistics
[55] Extending all Pendolino trains to 11 cars and reconfiguring Standard Class carriages are not committed schemes
[56] Data source: DfT analysis

Standard Class load factor of >100% and therefore standing. This is assuming that all Pendolino trains are 11-car and have been reconfigured to have eight Standard Class cars as per the 'All trains 11-car reconfigured' scenario described above.

5.30 At present, count data suggests that 0.7 per cent of Virgin West Coast passengers across the AM and PM peaks are standing as trains arrive at/depart Euston. This rises to 2.4 per cent during the PM peak on a Friday.

5.31 In the 'Reference Case', by 2033/34, this is forecast to grow to an average of 2 per cent of peak passengers standing when arriving at/departing from Euston during weekday AM and PM peaks with 9 per cent of passengers standing on departure from Euston in the Friday PM peak. The 'Higher Growth Case' forecasts suggest that on average, 14 per cent of passengers will be standing arriving at/departing from Euston during AM and PM peaks. This rises to 23 per cent of passengers standing in the Friday PM peak on trains leaving Euston.

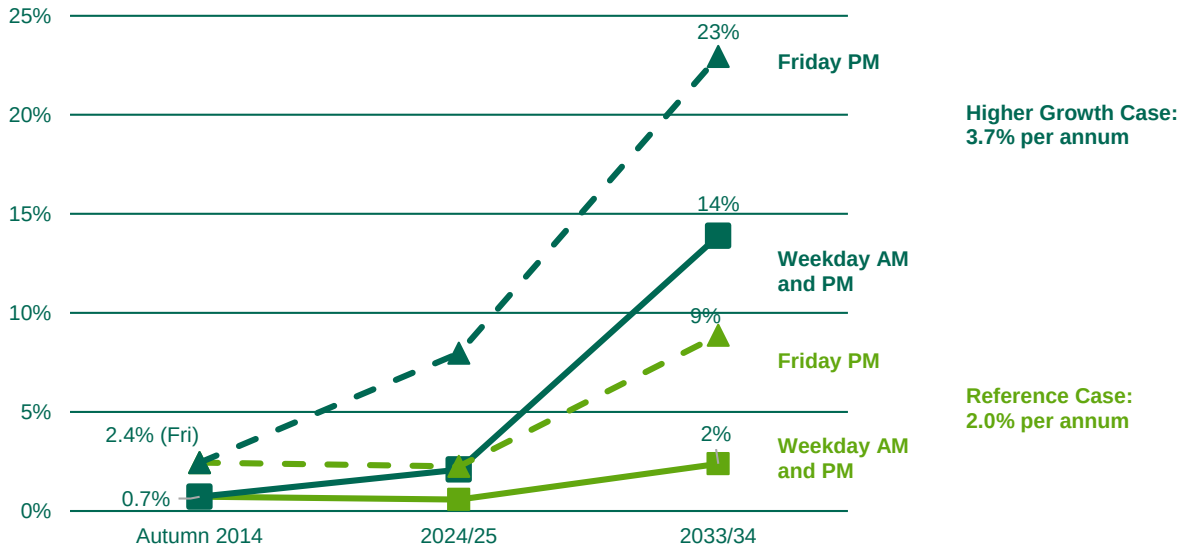


Figure 48 Projected % of Standard Class passengers standing (all 11-car, reconfigured trains)[57]

5.32 In practice, standing is likely to be more prevalent than simply the number of passengers in excess of the number of seats - unless of course the ICWC operator moves to a "reservations-only" system. This is because inter-city trains are typically over 250 metres in length with around 20 access doors. Passengers are not always able to spread evenly along trains to find available seats, especially when boarding at intermediate stops. In addition, loadings are not evenly distributed between services throughout the peak. For these reasons, once load factors are above 80 per cent, passengers are likely to be standing.

5.33 The long distance nature of the ICWC services means that many of the standing passengers identified in the analysis above will be standing for an hour or more. For each of the ICWC trains on which it is forecast that there will be standing passengers, the first stop on that service has been identified. This first stop is effectively the minimum period for which a passenger will stand – either because they leave the train at this station or because seats have become available due to other passengers alighting.

[57] Data sources: DfT Passengers in Excess of Capacity; DfT analysis

5.34 Figure 49, illustrates the position in 2033/34 on a typical weekday in the 'Higher Growth Case' scenario. Here, it is estimated that 3,200 passengers will stand on ICWC trains departing London in the PM peak. Of these, 1,350 (40 per cent) will be on trains with a first stop 59 minutes or more outside of London.

5.35 On a typical Friday, it is estimated that 5,900 passengers will be standing on departure from Euston in the PM Peak. Of these, 3,500 (60 per cent) will be on trains with a first stop 59 minutes or more outside London, of which around 1,300 (22 per cent) will stand for 90 minutes or more.

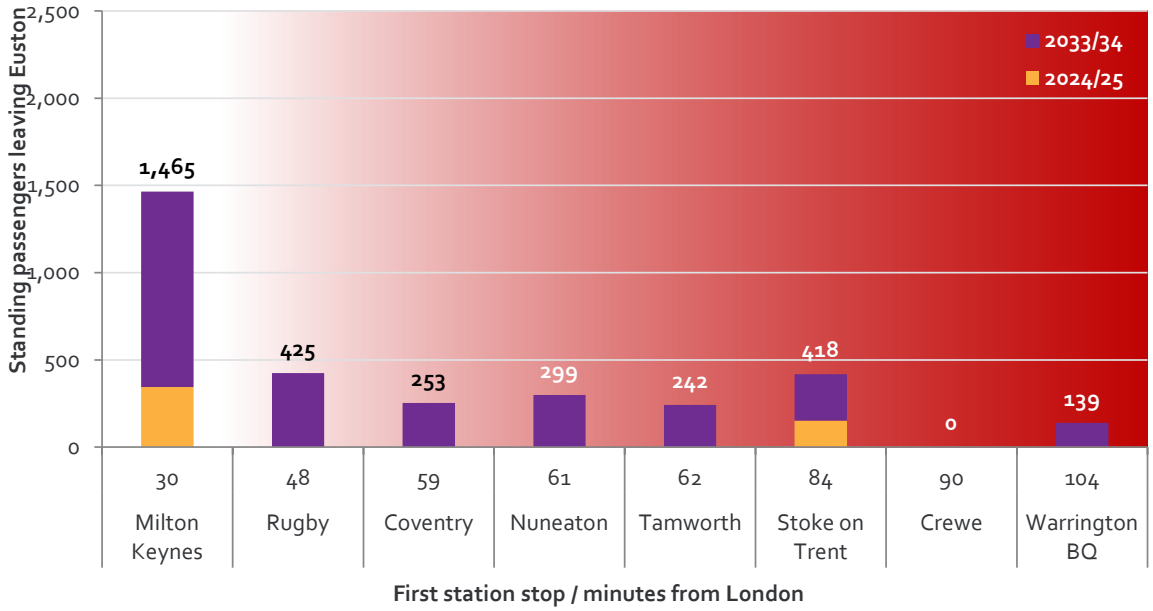


Figure 49 Midweek PM Peak analysis of likely duration of standing – Higher Growth Case (11-car reconfigured trains) [58]

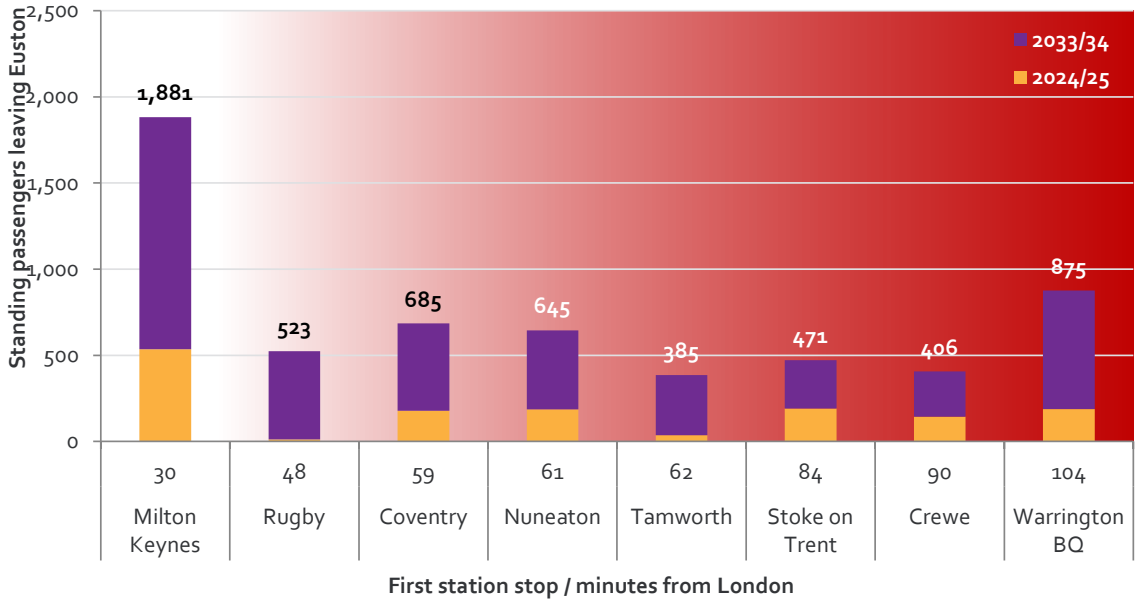


Figure 50 Friday PM analysis of likely duration of standing – Higher Growth Case (11-car reconfigured trains) [59]

[58] Data sources: Autumn 2014 counts: NMF growth rates
[59] Data sources: Autumn 2014 counts, NMF growth rates

5.36 A high proportion of the standing that is forecast in the PM peak would arise in the 19:00-19:59 hour, when peak fare restrictions do not apply. Today, Virgin West Coast manages peak demand by offering a quota of cheaper Advance Purchase fares as well as offering Peak Walk-up fares. Yield management is used by the operator to maximise revenue (returned as premium payments to DfT). The 'price ceiling' for Off Peak Walk-up fares is limited by regulation.

5.37 Figure 51 analyses weekday load factors and fare levels on ICWC services between London and Birmingham and London and Manchester. For London - Manchester the 'Anytime' peak fare is currently 300 per cent higher than the Off Peak fare (£329 vs £81.60 for a return trip). For London–Birmingham journeys, the 'Anytime' peak fare is 225 per cent higher (£168 vs £51.70). The chart demonstrates how higher peak fares ('Anytime' and 'Advance') help to control peak period demand, generally maintaining load factors at 60 per cent - 70 per cent. This load factor rises by about 10 per cent between 19:00 and 19:59 as the Walk-up fare and Advance fares fall in price at the end of the peak period restrictions.

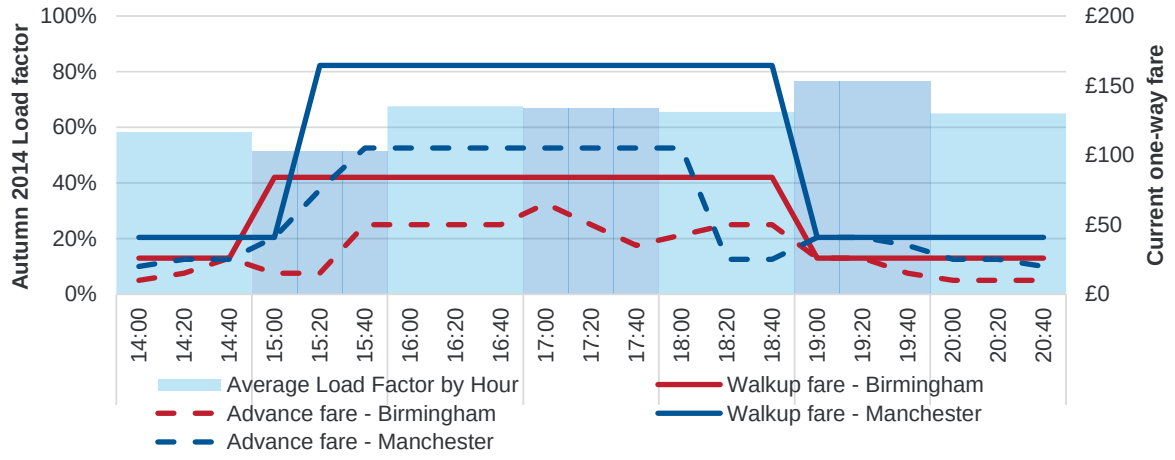


Figure 51 Weekday load factors and fare profiles - London-Birmingham and London-Manchester[60]

5.38 Potentially, therefore, future crowding could be managed through targeted changes to fares restrictions. However, analysis undertaken at a service group level (presented in Figure 52) shows that this would have limited effectiveness in materially reducing standing levels by 2033/34. For each service group, the average load factor across the PM peak period (16:00 – 19:59) is presented in 2033/34 under the 'Higher Growth Case' scenario. Key points of the analysis are:

- Average load factors are estimated to be 111 per cent to Birmingham and 109 per cent to North Wales across the PM peak four hours. As there are more passengers than seats, standing cannot be eliminated by relaxing fares restrictions to spread loadings more evenly
- There is also very little scope for manoeuvre on the other service groups, all of which are estimated to have average load factors of between 94 per cent-99 per cent. At these load factors, it would be difficult to limit/manage standing whilst still permitting "Walk Up" fares. This might mean making inter-city WCML services

[60] Data sources: Analysis of DfT Passengers in Excess of Capacity Statistics, Autumn 2014 combined with fares obtained from Virgin Trains website

"reservation only" which would change the nature of the railway and significantly impact upon the flexibility of business and leisure passengers alike

Average load factors across the entire Friday PM peak are forecast to be 116 per cent by 2033/34 under the 'Higher Growth Case' with all trains extended and reconfigured. Given that in aggregate, there would be 16 per cent more passengers than seats, it would be impossible to eliminate standing even by moving to a "reservations only" system. Even if such a type of system was adopted, demand is estimated to be such in the 'Higher Growth Case' that many people would not be able to find space to travel on what are some of Britain's key rail flows

Service group	No. PM peak trains (weekday/Friday)	Average weekday PM	Average Friday PM
Birmingham	11	111%	124%
Manchester	12/13	94%	105%
Liverpool	7	99%	123%
North Wales	4	109%	112%
Glasgow/Preston	7/8	98%	119%
Total	**41**	**102%**	**116%**

Figure 52 Weekday and Friday 2033/34 load factors by service group – Higher Growth Case (all 11-car, reconfigured trains)[61]

HS2 provides resilience for all future ICWC growth scenarios

5.39 Having illustrated the limitations of containing crowding on the ICWC services by increasing train capacity, Figure 53 extends the analysis to consider those options that involve investing in infrastructure. The yellow bars represent forecast load factors under the 'Higher Growth Case' and the blue bars load factors under the 'Reference Case'. The chart shows the following:

- Operating every service with 11 cars and reconfiguring the trains to eight Standard Class and three First Class cars leaves average load factors over 100 per cent in the 'Higher Growth Case' scenario. The load factor of 102 per cent translates into 14 per cent of peak passengers standing given the distribution of demand across the peak. In the 'Reference Case' weekday average load factors are 74 per cent, approaching the loading conditions currently experienced on a Friday
- The Strategic Alternative gives some increase in ICWC capacity by providing an additional five trains in the AM Peak and four trains in the PM peak. However, average load factors are forecast to be 91 per cent by 2033/34 in the 'Higher Growth Case'. Load factors would rise to 102 per cent by 2036/37 the same rate at which 14 per cent of peak weekday passengers are estimated to be standing in the analysis presented in Figure 48. Put simply, the Strategic Alternative would provide for approximately three years of additional growth in the 'Higher Growth Case'
- The step change in route capacity provided by HS2 allows crowding issues on inter-city services on the WCML corridor to be solved for the long term. This

[61] Data sources: December 2014 timetable, Autumn 2014 counts, NMF growth forecasts

includes accommodating the increase in total WCML inter-city demand which PFM forecasts will be generated by HS2 itself, primarily due to the step change in journey times

- Phase Two – which delivers the same quantum of services as Phase One to WCML destinations but would allow longer trains to run north of Birmingham – gives the potential to accommodate further growth in demand beyond 2033/34

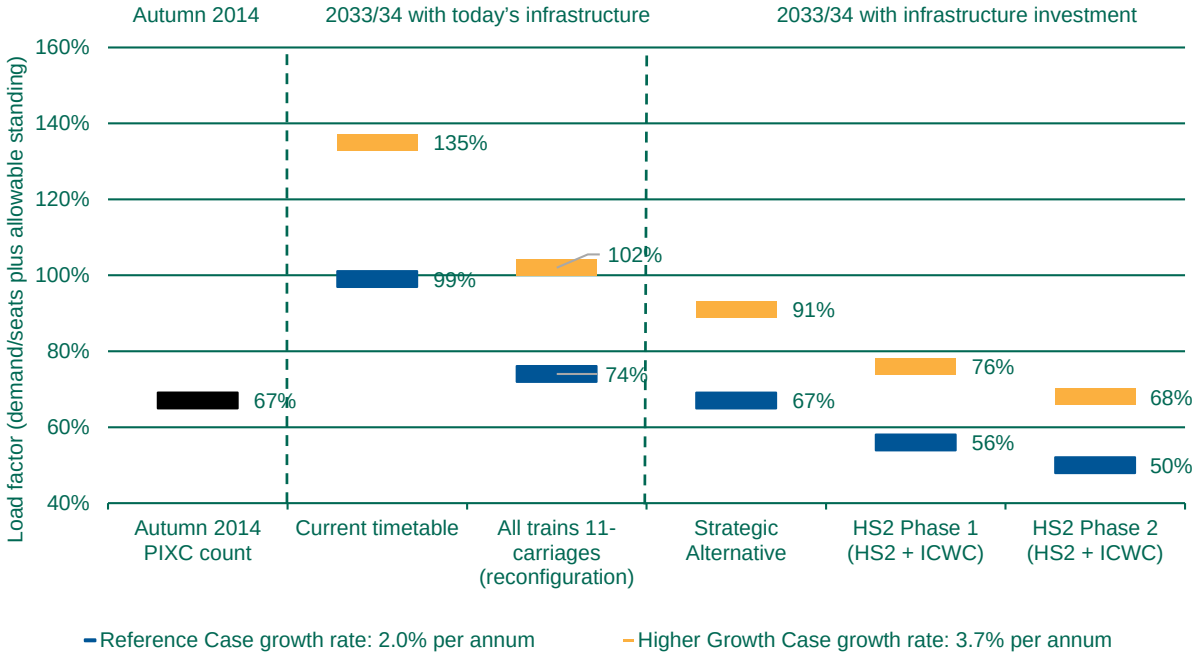


Figure 53 Forecast ICWC and HS2 2033/34 weekday PM Peak (16:00–19:59) load factors[62]

5.40 As stated above, as well as providing a step-change in route, and therefore train, capacity, HS2 will also generate significant new demand for rail travel to destinations on the WCML corridor. The primary driver of this new demand is the journey time improvements that HS2 Phases 1 and 2 will deliver. Figure 54 summarises the journey time improvements that HS2 will deliver to WCML destinations along with the increases in capacity.

[62] Data sources: Analysis of DfT Passengers in Excess of Capacity Statistics, Autumn 2014, combined with PFM and NMF growth rates; "The Strategic Case for HS2" (DfT 2013)

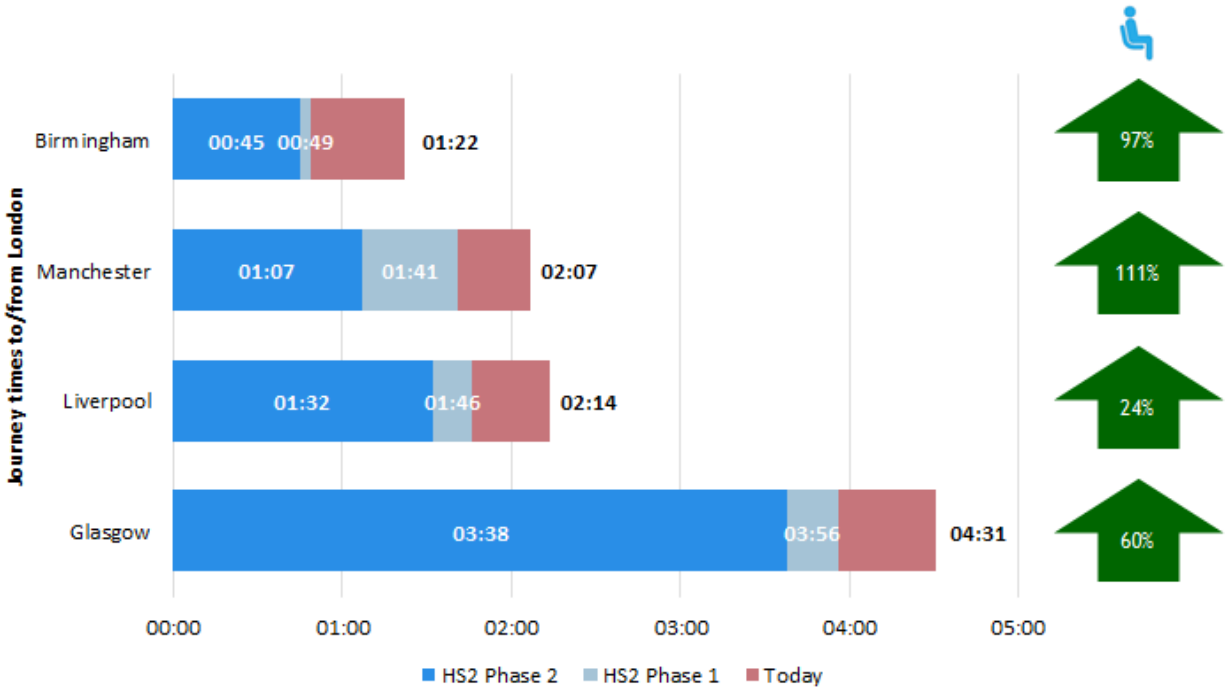


Figure 54 Western leg fastest journey times with and without HS2 and peak capacity increases (HS2 services only)[63]

5.41 Figure 55 illustrates the forecast impact of the faster HS2 journey times on demand between London and key WCML destinations. As can be seen from the chart, demand between London and Birmingham/Coventry and between London and Manchester/Stockport/Manchester Airport is forecast to grow by over 80 per cent and the market between London and Glasgow is forecast to more than double in size.

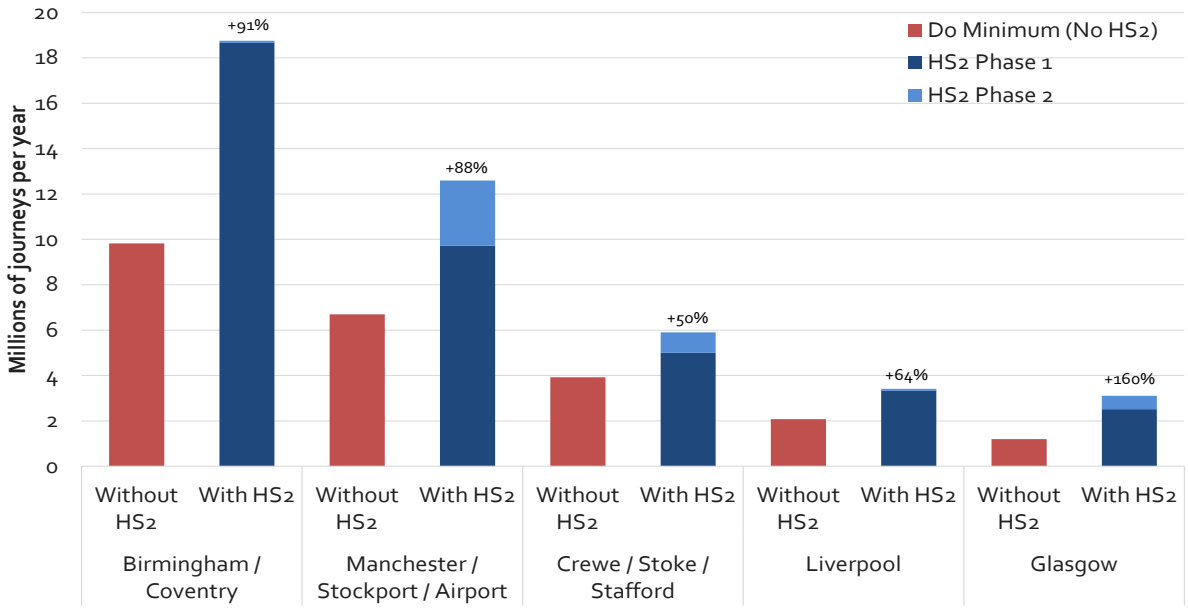


Figure 55 2036/37 demand to/from London by location under Do Minimum and HS2 operating scenarios[64]

[63] Data source: High Speed Two: East and West The next steps to Crewe and beyond (DfT, November 2015)
[64] Data source: PFM v4.2. Note: 'Birmingham/Coventry' includes Birmingham New Street, Moor Street, International, HS2 Curzon Street, HS2 Interchange, Coventry.

Crowding on peak services into/out of Birmingham

5.42 Figure 56 summarises AM and PM peak crowding on all peak services to/from Birmingham (not just WCML services). Whilst PixC is around 1.6 per cent in the AM peak and 0.8 per cent in the PM peak, across the peaks 10 per cent of passengers stand. In the high peak hour (08:00 to 08:59 in the AM and 17:00 to 17:59 in the PM) passengers stand on circa 60 per cent of services and 13 per cent of these services breach PiXC.

	Service provision				PiXC		Passengers standing		Services with PiXC		Services with passengers standing	
	Services	Seats	Capacity	Critical load	#	%	#	%	#	%	#	%
AM Peak												
1 hr	67	19,461	27,065	19,929	395	2.0%	3,111	16%	12	18%	42	63%
3 hr	179	48,919	67,121	40,349	627	1.6%	4,610	11%	17	9%	65	36%
PM peak												
1 hr	68	17,779	24,546	17,489	221	1.3%	1,889	11%	5	7%	36	53%
3 hr	186	48,970	66,840	40,960	330	0.8%	3,196	8%	10	5%	66	35%

Figure 56 Birmingham, Standard Class loads and crowding on a typical weekday: Autumn 2014[65]

West Midlands franchise services on the WCML Birmingham – Coventry corridor

5.43 London Midland currently operates four trains per hour in each direction along the Coventry corridor. These are predominantly run as 4-car trains[66]. At present, allowing for standing capacity, load factors are around 65 per cent across the AM peak and PM peak, rising to 89 per cent in the AM peak hour. This level of crowding translates to PiXC of 1.1 per cent in the Coventry corridor across the AM and PM peak combined.

5.44 Figure 56 shows future projections of AM and PM Peak PiXC on these services in 2024/25 and 2033/34. Without any intervention, under 'Reference Case' growth, it is estimated that PiXC on these services will rise to 4.4 per cent in 2024/25 and 12.4 per cent in 2033/34. In the 'Higher Growth Case', this rises to 13.7 per cent and 27.5 per cent.

5.45 In order to address these future crowding issues, capacity on commuter trains could potentially be increased, subject to suitable platforming being available at New Street station, by lengthening all peak Birmingham services to 8-cars. This would provide an overall increase in peak capacity of 77 per cent.

5.46 With this train lengthening, under 'Reference Case' growth average load factors in 2033/34 would be 50 per cent across the AM Peak and PM Peak, and PiXC would be 3.4 per cent. Under the 'Higher Growth Case' average load factors in 2033/34 would be 74 per cent across the AM Peak and PM Peak, and PiXC would be 8.0 per cent - comparable to today's level at the London end of the route.

[65] Data source: DfT Rail Statistics, Table RAI0212
[66] Two AM Peak services and one PM Peak service operate with 8-cars

5.47 Whilst train lengthening could potentially be effective mitigation for future crowding issues on WM services operating on the Coventry corridor, it would not address route capacity issues or improve wider network connectivity. Therefore the region might not benefit from the types of opportunities identified by Centro in its recent paper "HS2 – Unlocking the Benefits" (see Chapter 4, Figure 38) for improved service levels.

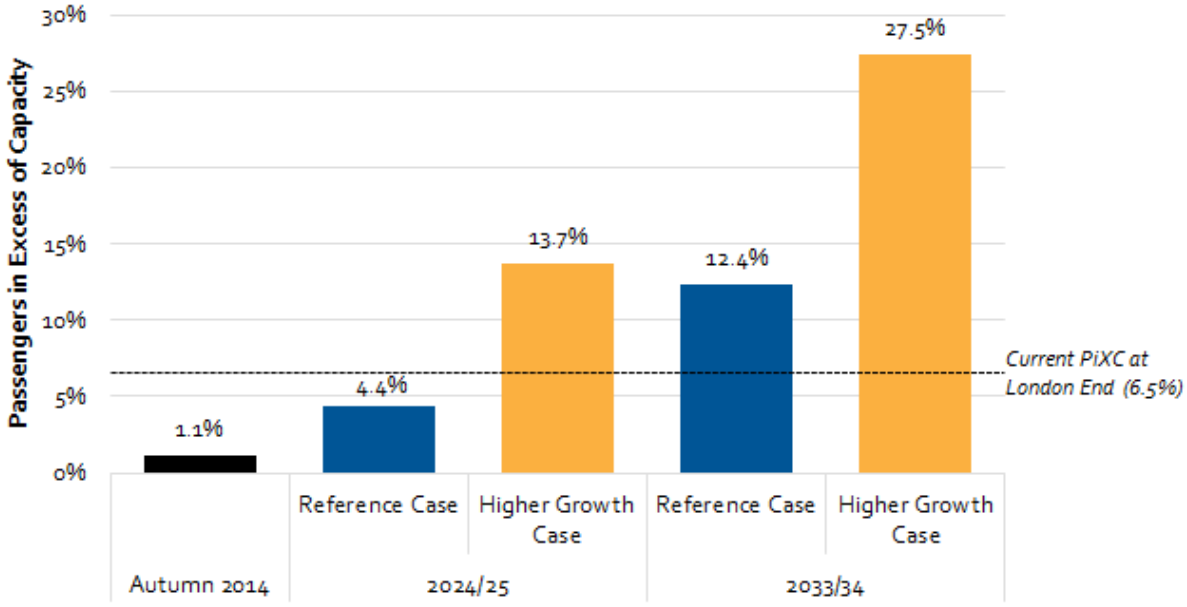


Figure 57 West Midlands franchise – current and projected PiXC at Birmingham New Street (AM and PM peak combined) with no intervention[67]

Inter City West Coast services on the Birmingham – Coventry corridor

5.48 ICWC also operates services along the Birmingham - Coventry corridor. Figure 58 summarises the load factors on these services based on Autumn 2014 counts. These average around 70 per cent across the AM and PM peak.

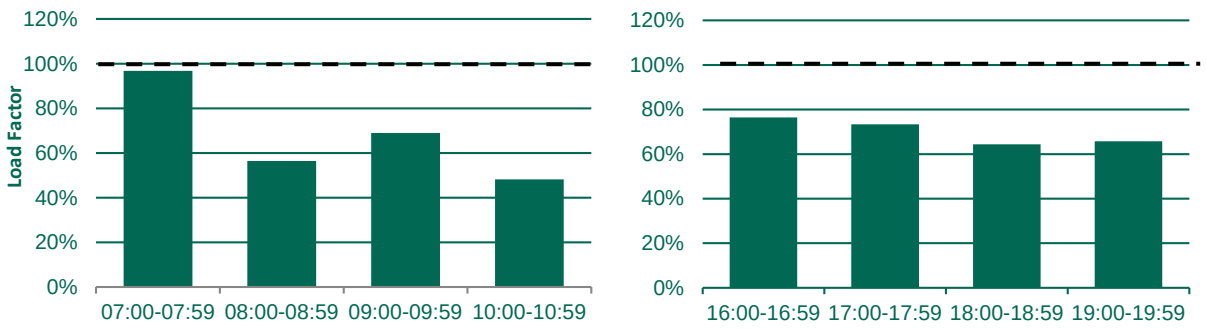


Figure 58 Virgin West Coast weekday peak Standard Class load factors along the Coventry corridor[68]

[67] Data source: DfT Passengers in Excess of Capacity Autumn 2014; PFM and NMF growth rates
[68] Data source: DfT Autumn 2014 count data

5.49 Some individual ICWC services have standing passengers, with 1.9 per cent of passengers standing on arrival at/departure from Birmingham New Street across the AM and PM peak. Many of these passengers are likely to be travelling relatively short distances, for example between Coventry, Birmingham International and Birmingham New Street – with journey times of less than 20 minutes. Others travelling longer distances in the PM peak are likely to be able to obtain a seat once shorter distance passengers have left the train.

5.50 Depending on future growth, crowding could potentially become an issue on ICWC services operating along this corridor. The following chart forecasts the proportion of peak ICWC passengers who would be on trains with a Standard Class load factor of over 100 per cent and therefore be standing on arrival at/departure from Birmingham New Street in 2033/34. This is assuming that all Pendolino trains are 11-car and have been reconfigured to have eight Standard Class carriages as per the 'All 11 car reconfigured trains' scenario described above.

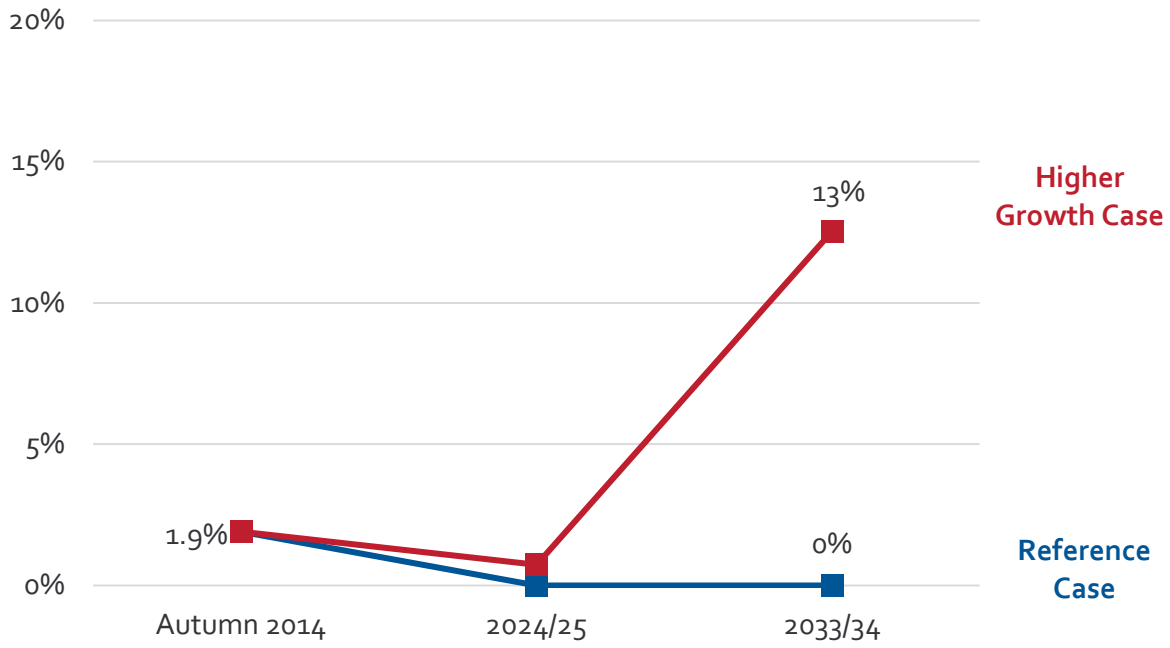


Figure 59 Projected % of Standard Class passengers standing (all 11-car, reconfigured trains)[69]

5.51 This shows that under the 'Reference Case' growth, standing on ICWC peak services to/from Birmingham would be eliminated for the foreseeable future if all ICWC trains are reconfigured in this way. However under the 'Higher Growth Case' 13 per cent of peak ICWC passengers would be standing on arrival/departure from Birmingham New Street by 2033/34.

Alternative infrastructure interventions

5.52 The Strategic Alternative 'P1' specification developed for the 2013 Strategic Case envisaged one additional peak train per hour to each of Birmingham and Manchester – that is two additional peak train paths. However one of the paths required to achieve this has been consumed by the London Midland service improvements south of Rugby that were introduced in the December 2014 timetable.

[69] Data source: DfT Passengers in Excess of Capacity; PFM,NMF growth rates

5.53 If the remaining additional train per hour available in the Strategic Alternative were operated to/from Birmingham rather than Manchester, it would increase ICWC frequency from 3tph to 4tph. Whilst this would provide a substantial boost to capacity - 33 per cent in most peak hours compared with the 'All 11 car reconfigured train' scenario, it would not provide a future-proof solution. Under the 'Higher Growth Case', combined AM and PM Peak load factors would be 77 per cent in 2033/34 – significantly higher than the 69 per cent seen today in autumn 2014.

5.54 In contrast, under the current Business Case assumption, HS2 Phase One would provide three High Speed services per hour operated with much longer (400 metre) trains and still have two ICWC services operating on the classic network.

Crowding on peak services into/out of Manchester

5.55 Figure 60 summarises AM and PM peak crowding on all peak services to/from Manchester (not just WCML services). PixC is 4.3 per cent in the AM peak and 2.3 per cent in the PM peak, and across the peaks, 12 per cent of passengers stand. In the high peak hours (08:00 to 08:59/17:00 to 17:59) passengers stand on 57 per cent of services and 20 per cent of these services breach PiXC.

	Service provision				PiXC		Passengers standing		Services with PiXC		Services with passengers standing	
	Services	Seats	Capacity	Crit. load	#	%	#	%	#	%	#	%
AM Peak												
1 hr	70	15,491	21,183	17,244	991	5.7%	3,496	20%	18	26%	43	61%
3 hr	186	38,942	53,927	33,643	1,452	4.3%	5,279	16%	29	16%	71	38%
PM peak												
1 hr	68	15,541	21,470	15,262	269	1.8%	1,944	13%	10	15%	35	51%
3 hr	193	40,793	55,908	35,879	832	2.3%	4,207	12%	22	11%	78	40%

Figure 60 Manchester Standard Class loads and crowding on a typical weekday: Autumn 2014[70]

5.56 The analysis of crowding on services into Manchester within this report focuses on WCML services running into Manchester from the Crewe and Stoke-on-Trent lines via the Stockport corridor. The analysis is segmented to cover an aggregation of local and regional services (comprising services operated by the Northern, Cross Country and Wales and Borders franchises), alongside an analysis of ICWC services operating through this corridor into Manchester Piccadilly.

Local and regional services on the WCML Stockport-Manchester corridor

5.57 Currently, there are between 6-8 peak trains per hour operated by local and regional operators on the WCML Stockport-Manchester corridor. In Autumn 2014, allowing for standing capacity, load factors are around 65 per cent across the AM peak and PM Peak, rising to around 90 per cent in the AM peak hour. This level of crowding translates to PiXC of 1.4 per cent on this corridor across the AM and PM peak combined.

[70] Data source: DfT Rail Statistics, Table RAI0212

5.58 Figure 61 shows future projections of AM Peak and PM Peak PiXC on these services in 2024/25 and 2033/34. Without any intervention, under 'Reference Case' growth, it is estimated that PiXC on these services will rise to 4.3 per cent in 2024/25 and 9.3 per cent in 2033/34. In the 'Higher Growth Case', this rises to 10.4 per cent and 24.9 per cent.

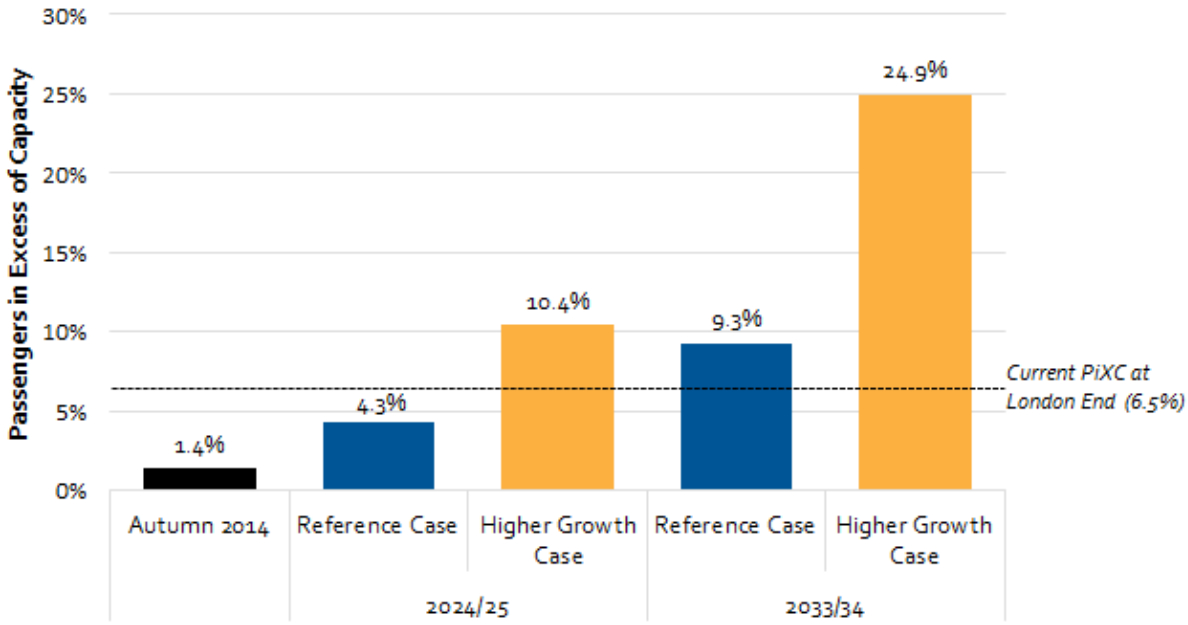


Figure 61 Current and projected PiXC by train on Stockport-Manchester corridor (AM and PM peak combined)[71]

5.59 This future crowding issue could potentially be addressed by lengthening trains. It should be noted that this solution is likely to require platform lengthening at individual stations, and could also be subject to finding a solution to the limitations of terminating platform capacity at Manchester Piccadilly. The full 'Northern Hub' scheme could help to address this as it provides for a doubling in the number of through platforms.

5.60 An indicative train lengthening scenario could see:

- All Northern trains (currently operated using 3-car Class 323s) lengthened to 6-car
- Wales and Borders trains (currently a mix of 2-car and 3-car Class 170s) operated with 3-car units
- Cross Country trains (currently operated using a mix of 4-car and 5-car Voyager Class 220/1s) operated using 10-car trains

5.61 This scenario would broadly double peak capacity into Manchester Piccadilly. This would contain 2033/34 PIXC in the 'Higher Growth Case' to 2.7 per cent, compared to 24.9 per cent with no intervention.

5.62 Whilst train lengthening can potentially mitigate future on-train crowding issues on local and regional services operating on this corridor, it would not improve wider connectivity into and around Manchester.

[71] Data source: DfT Autumn 2014 count data; PFM, and NMF growth rates

5.63 In contrast, the potential released capacity from HS2 Phase Two in the Crewe-Stoke-Manchester corridor could allow the reshaping of services as identified in Chapter 4.

Inter City West Coast services on the Stockport-Manchester corridor

5.64 ICWC also operates three services per hour along the Stockport-Manchester corridor. Figure 62 summarises the load factors on these services based on Autumn 2014 counts. Given the journey time from London of over 2 hours, AM peak services do not start to arrive until after 8am, with average load factors of around 50 per cent. In the PM peak, these services typically carry a mix of local and regional commuters to Stockport, Macclesfield, Crewe, Stafford and Stoke-on-Trent as well as longer distance business travellers to London and the south east. As a consequence, load factors of above 70 per cent are commonplace on services leaving Manchester Piccadilly. While some of these passengers will be travelling short distances (e.g. from Manchester to Stockport), there are also significant commuter flows from Manchester to Crewe and Stoke-on-Trent, with journey times of around 40 minutes.

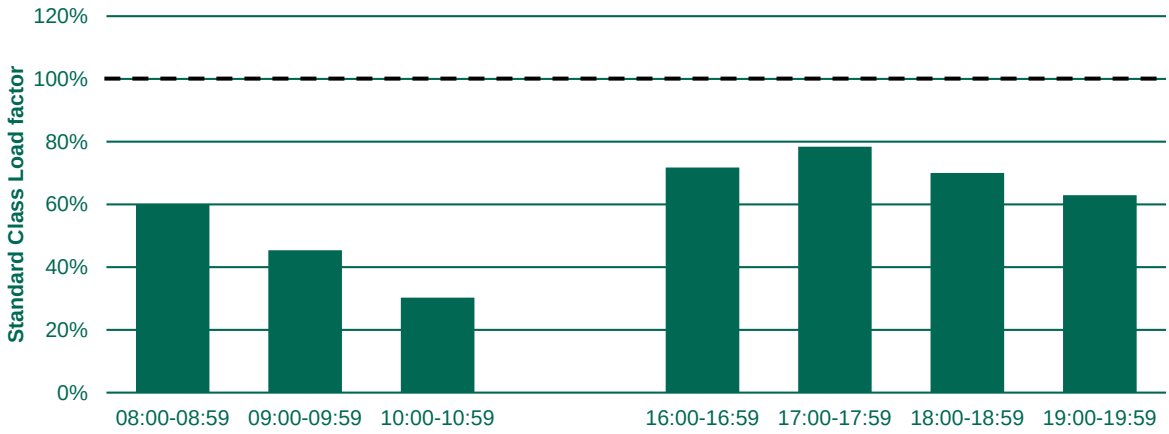


Figure 62 Virgin West Coast weekday peak Standard Class load factors along the Stockport-Manchester corridor[72]

5.65 With future growth, crowding could potentially become a significant issue on ICWC services operating along this corridor. The following chart forecasts the proportion of peak ICWC passengers who would be on trains with a Standard Class load factor of >100 per cent and therefore be standing on arrival at/departure from Manchester Piccadilly. This is assuming that all Pendolino trains are 11-car and have been reconfigured to have eight Standard Class carriages as per the 'All 11-car reconfigured trains' scenario described above.

5.66 Under the 'Reference Case' growth, 2 per cent of peak passengers are estimated to be standing on arrival/departure from Manchester Piccadilly by 2033/34. However under the 'Higher Growth Case' this increases to 16 per cent of peak passengers for a large part of their journey.

[72] Data source: DfT Autumn 2014 count data

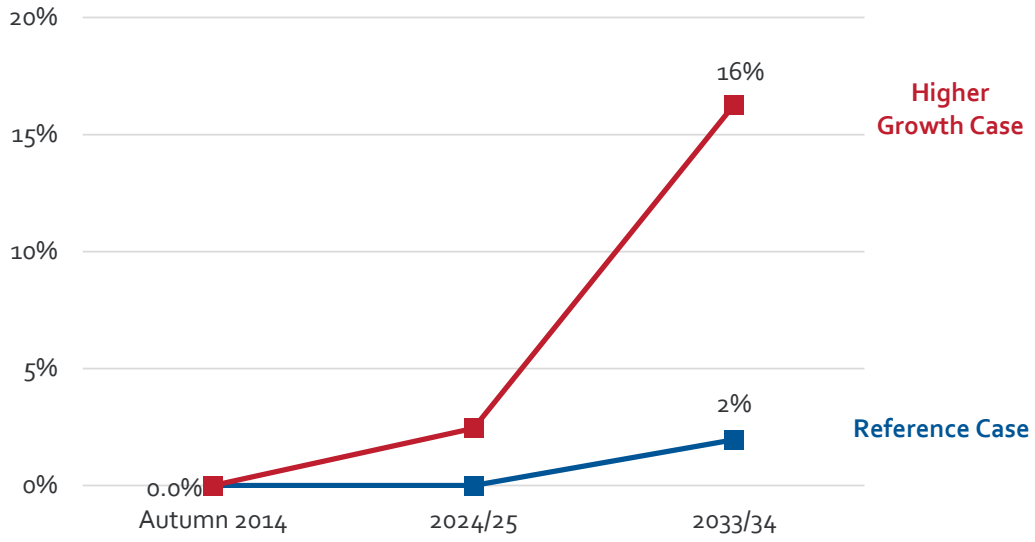


Figure 63 Projected per cent of Standard Class passengers standing (all 11-car, reconfigured trains)[73]

Alternative infrastructure interventions

5.67 As set out above, the Strategic Alternative P1 specification could potentially deliver an additional ICWC train per hour to Manchester Piccadilly. This would deliver 33 per cent additional capacity in most peak hours compared with the 'All 11-car reconfigured trains' scenario. However, this is not a future-proof solution – under the 'Higher Growth Case', PM Peak load actors are estimated be 91 per cent in 2033/34 – significantly higher than the 74 per cent seen in the Autumn 2014 passenger counts.

5.68 By contrast, under the current Business Case assumptions HS2 Phase One would provide three High Speed services per hour operated with 200 metre trains plus two inter-city services operating on the conventional network. Phase Two would further boost capacity by allowing longer HS2 trains to operate to/from Manchester.

[73] Data source: DfT Passengers in Excess of Capacity; PFM, NMF growth rates

6. Freight

- It is estimated that around 40 per cent of all Britain's rail freight services use the West Coast Main Line (WCML) at some point in their journey. Network Rail forecast that total freight volumes will grow at 3 per cent per annum for the next 30 years; with the intermodal market expected to grow at 7 per cent per annum
- Around 40 additional freight paths per day need to be found on the WCML by 2033/34 in order to accommodate this growth
- HS2 Phase One could unlock 20-40 additional freight paths per day between London and the South East and the West Midlands
- Phase Two and Phase 2a will release further capacity between the West Midlands and North West England on the WCML – as well as potentially on the Midland Main Line and East Coast Main Line (ECML) corridors
- The precise level of capacity released depends on the balance that is ultimately struck between passenger and freight use of the capacity released by HS2. This will be resolved by the industry's access planning process. Decisions on this will not be made until near the time that HS2 opens
- In addition, some investment in other routes (for example between the North West and Scotland) is needed in order to allow all of the capacity released by HS2 to be utilised fully by freight operators. This because the HS2 corridor is only part of the wider national freight network.

6.1 This chapter sets out:

- The role of the WCML in transporting rail freight today
- The level of growth in rail freight volumes that is forecast and how this will impact on demand for freight paths on the WCML
- How the different phases of HS2 will release capacity on the WCML which, in combination with investment in feeder routes, could help accommodate growth in freight demand. Freight benefits on the Midland Main Line and East Coast Main Line are not considered in this document

6.2 In reading this section it is important to note that Network Rail is currently leading a strategic rail study ("Capacity Plus") with the objective of identifying strategic options for rail services to operate after the implementation of HS Phase One. This will include options for train services made possible through the released capacity on the WCML. Options being assessed include new long distance services (to enhance inter

regional connectivity and potentially through services to London from new origins), additional capacity for freight growth and accommodating further commuting growth into London.

6.3 At this stage, no decisions have been taken on the introduction of these new services. Well established statutory, regulatory, and administrative processes will be used to build an open and shared evidence base, consult passengers, communities and freight users, establish options and take decisions ahead of the introduction of a new timetable.

Freight on the WCML Today

6.4 It is estimated that around 40 per cent of all freight journeys currently use the WCML at some point. The WCML corridor is the back bone of Britain's rail network, carrying large volumes of both passenger and freight traffic. At some points, the WCML is highly congested. This is despite the capacity increases that followed the West Coast Route Modernisation, some of which (such as the widening of the line from Nuneaton to north of Lichfield) were undertaken in order to more fully segregate freight and fast passenger services and provide more capacity for freight.

6.5 Figure 64 divides the core WCML network into three sections and highlights the key factors that affect freight in each, as well as the typical number of freight trains operated in each direction per day. This is drawn from 2011 operational data; the actual number of trains operated varies on a daily basis according to the needs of the market.

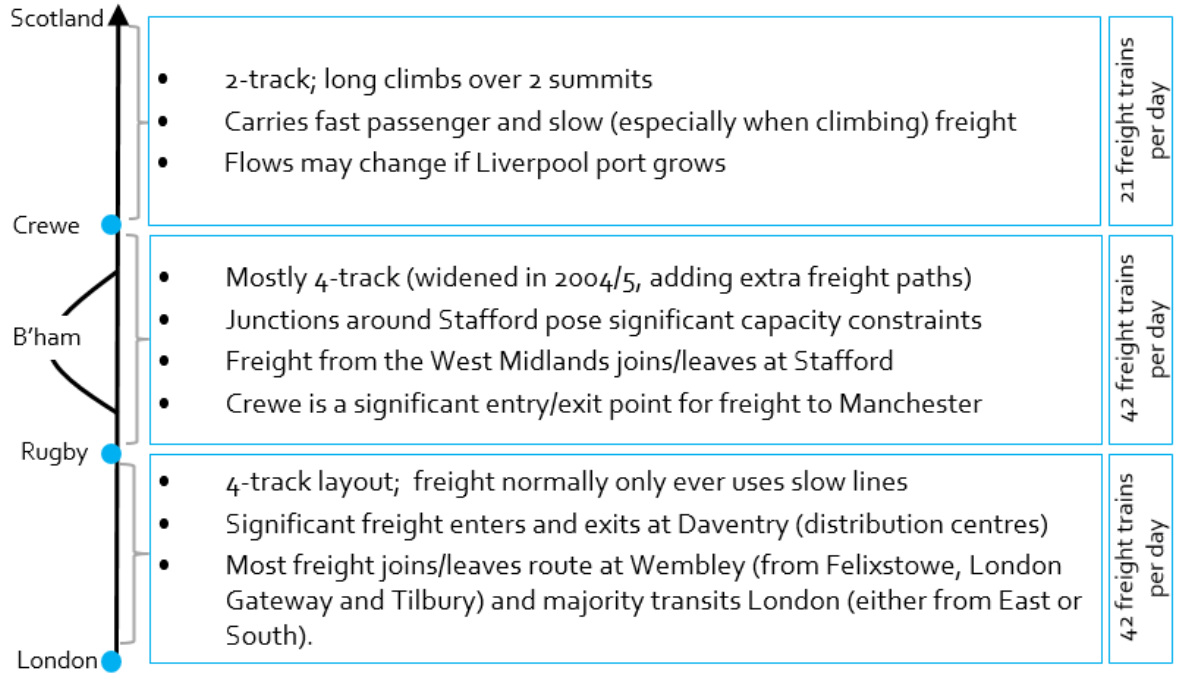


Figure 64 Helicopter view of freight on the WCML (Source: Network Rail, 2013)

6.6 Freight in the WCML corridor takes three forms:

- Intermodal – both international (to/from ports), which is the largest sector, and domestic (to/from major distribution centres). These flows join/leave the WCML at a number of points but typically have a lengthy segment along the WCML itself

- Other major flows along significant sections of the route – aggregates and coal traffic, for example. These trains have a diverse flow pattern using a large number of entry/exit points to the WCML
- Other traffic that only uses short sections of the WCML, but which interacts with the general north-south flows and so also has a bearing on capacity assessments

6.7 Freight traffic on the WCML is subject to a different set of uncertainties to passenger demand. It is a fully commercial sector and the volume of traffic is affected by many factors outside the control of the freight companies such as trends in the road haulage sector, the commercial policies of individual ports and shipping companies and the wider commercial strategies adopted by key customers. The sharp fall-off in coal movements in 2014-15 was not widely foreseen, for example – although a gradual, long-term decline in this sector was expected.

6.8 Freight trains, which are generally less time sensitive than passenger, can sometimes be routed in different ways across the country as circumstances change. For example, freight trains from Southampton had to be re-routed earlier this year, including on to the WCML, because of a landslip near Banbury which closed that particular freight route for almost a month. To provide this flexibility, it is important that track capacity on key routes such as WCML is not completely committed at all times.

6.9 Freight demand varies through the year (there is a seasonal peak related to consumer goods, for example, affecting the Autumn period) and freight trains only run when there is demand, which is often less than on a daily basis. Freight paths are therefore allocated to accommodate the best estimates of demand available, but this cannot be as precise as is the case when planning for passenger demand.

6.10 Taken together, this means that there are a broader range of options and choices open on freight routing and capacity than there are for passenger services.

6.11 In addition to this, current policy is that when new infrastructure is put in place it should be designed to support 775 metre train lengths. This is considerably longer than the historic UK norms which apply to the existing WCML freight loops. This limits the ability of full length freight trains to be overtaken by faster passenger trains on the WCML, which historically was a key operating principle.

6.12 The main constraints that face freight traffic on the WCML today are:

- At the southern end of the WCML, freight is very largely restricted from operation between 7-10am and between 4-7pm – the commuter peak periods. Because no further freight trains can practically be operated to/from London during the peaks, freight must use off peak times, potentially meaning that goods arrive or depart at inconvenient times for customers
- Limited capacity at the junctions at Stafford and the two-track section near Colwich makes further expansion of services challenging
- Finding further paths to serve terminals in Manchester is a challenge because the network from Crewe northwards is highly constrained
- Paths from Crewe to Scotland are also constrained by the need to fit in around fast passenger trains to Glasgow and Edinburgh
- Whilst the WCML is electrified, by no means all freight services use electric traction, in part because not all connections to terminals are electrified. On the northern hillier sections of route in particular, this erodes capacity by extending the sectional running time differentials between freight and passenger services

6.13 More generally, freight demand on the WCML, and the capacity available to accommodate it, cannot be considered in isolation from the capacity on the feeder routes which freight services must use in order to connect with the WCML. Especially in the major urban areas, capacity on these routes can be the binding constraint.

6.14 The key feeder routes that connect to the WCML are illustrated in Figure 65. At the southern end of the route these are:

- The North London Line (NLL) which feeds in traffic from Felixstowe, London Gateway and other Thameside ports
- The West London Line (WLL) which feeds in traffic from the Channel Tunnel

6.15 Further north, significant entry/exit points for freight on the WCML are at Crewe, Stafford and Daventry.

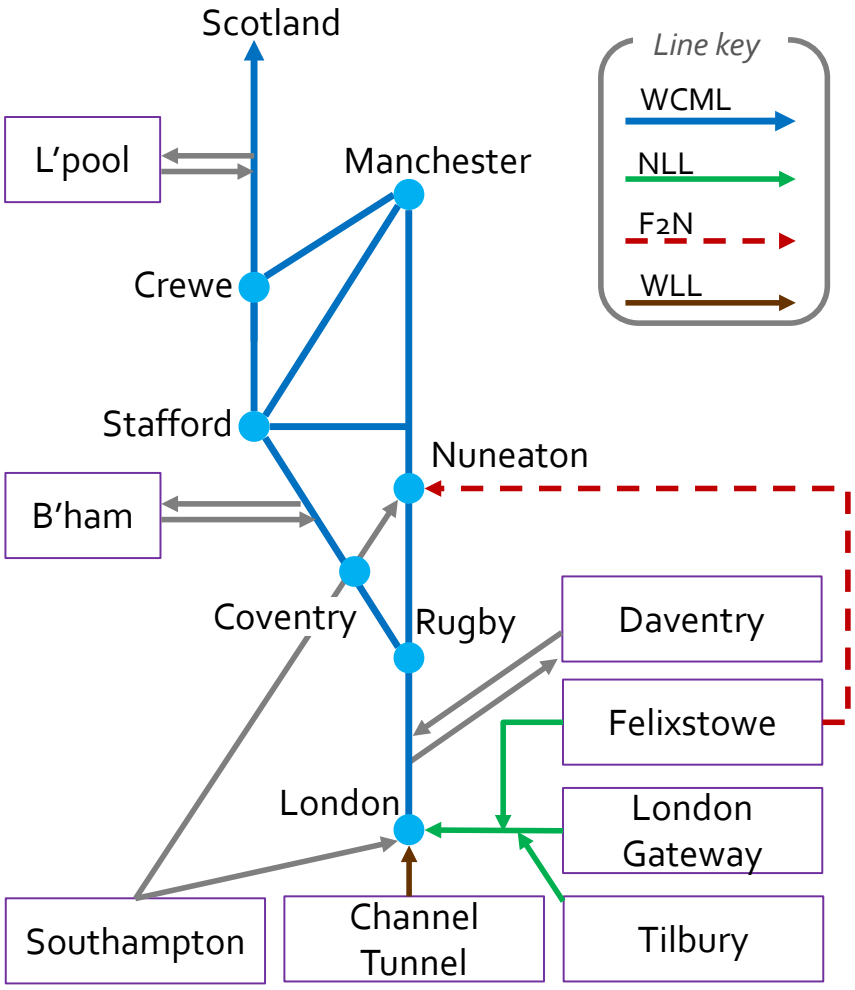


Figure 65 WCML and major freight feeder routes

6.16 To address problems with capacity on the feeder routes (and at the southern end of WCML), the Felixstowe to Nuneaton (F2N) project has been developed and is due to be completed in CP6. This could provide an additional 24 paths per day by 2023, allowing the growing traffic from Felixstowe to join the WCML at Nuneaton without placing additional demand on the southern end of the route.

6.17 Going forwards, proposals to develop port facilities in the North may increase the freight traffic fed into the WCML from the "top end" of the route. Most notable are the

proposed Liverpool 2 and SuperPort schemes in Liverpool that could see a 'reverse flow' of intermodal freight, with it being moved from north to south rather than the other way around which is more usual at present.

Forecast growth in rail freight volumes

6.18 Network Rail published its 'Long Term Planning Process: Freight Market Study' in October 2013, which forecasts freight volumes for the next 30 years and remains the most up-to-date assessment. The report was developed in consultation with the rail freight industry including the FOCs and relevant bodies such as ATOC, DfT and the Rail Freight Group.

6.19 The forecasts set out in the Freight Market Study were prepared by MDS Transmodal, a specialist rail freight consultancy, and provide an unconstrained view of demand – i.e. the work assumed that freight growth is not constrained by available train paths on Britain's rail network. Forecasts illustrated in Figure 66 show that total rail freight volumes are expected to grow at 3 per cent per annum over the next 30 years. This is largely driven by a forecast annual growth of 7 per cent per annum in intermodal traffic.

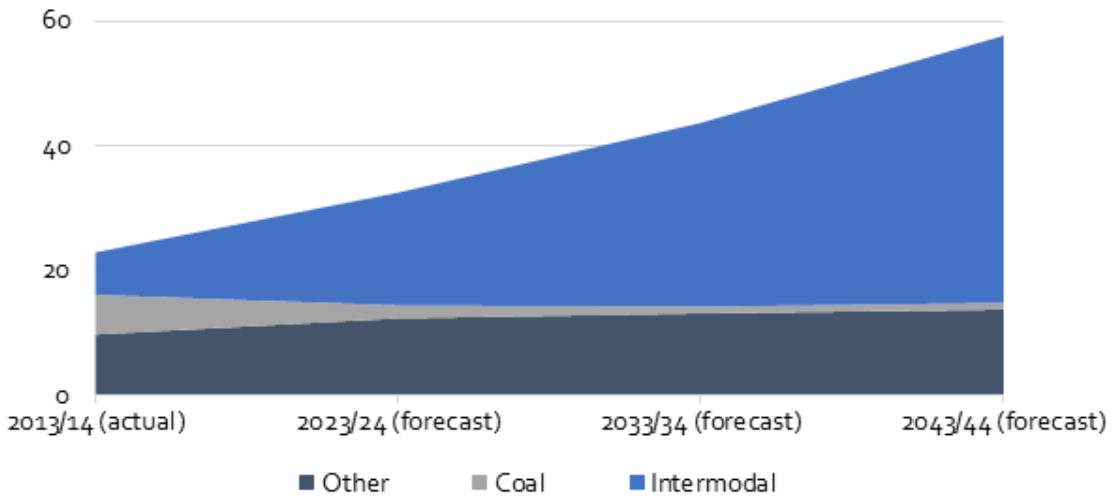


Figure 66 Rail freight forecast by sector[74]

6.20 Intermodal traffic can be defined as "the movement of goods in one and the same loading unit or road vehicle, using successively two or more modes of transport without handling the goods themselves in changing modes"[75]. Not all intermodal traffic travels by rail; freight moved by ship and road is also regarded as intermodal as well if it is in a container that can easily be transferred from mode to mode. Typically, intermodal traffic is freight moved in rigid metal containers, which come in a number of internationally-agreed standard sizes.

6.21 Domestic intermodal is the movement of freight between UK distribution centres. This market is currently dominated by road (98 per cent market share) but rail's competitive position is better over longer distances, which is one reason why the WCML is so important to the intermodal rail freight market.

6.22 International intermodal traffic comes from sea ports and the Channel Tunnel. In essence, intermodal trains from the Channel Tunnel and the ports in the South East

[74] Data source: "Freight Market Study" (Network Rail, 2013)
[75] Rail Freight Portal (ECMT/UN definition)

travel via London, to use the WCML to reach the West Midlands and the North West. In addition, trains from the port at Southampton join the WCML at Coventry either to access Birmingham or the North West via Crewe. The market for moving containers between UK ports and inland distribution centres is expected to grow considerably as long term trade growth is anticipated to outperform UK economic growth.

6.23 Network Rail's overall forecasts, when applied to current West Coast demand, suggest that the requirement for WCML paths could nearly double by 2033 from 42 to 80 freight paths per day on the southern section of the WCML. This rises still further to over 100 paths in 2044.

6.24 Within this, demand for paths for intermodal freight traffic is expected to grow from 32 to 58 paths a day in 2033/34, by which point it will comprise approximately three quarters of total freight trains.

HS2 Phase One could unlock 20-40 additional freight paths per day

6.25 Figure 67 illustrates schematically the route of HS2 Phase One and shows, in strategic terms, how it could help release capacity for freight. Following the completion of HS2 Phase One and prior to the completion of Phases 2a or 2b, high speed services will join the existing four-track railway at Handsacre Junction to the north of Lichfield, and travel on to Colwich Junction about 20 kilometres north, where the routes to Crewe and Stoke-on-Trent diverge.

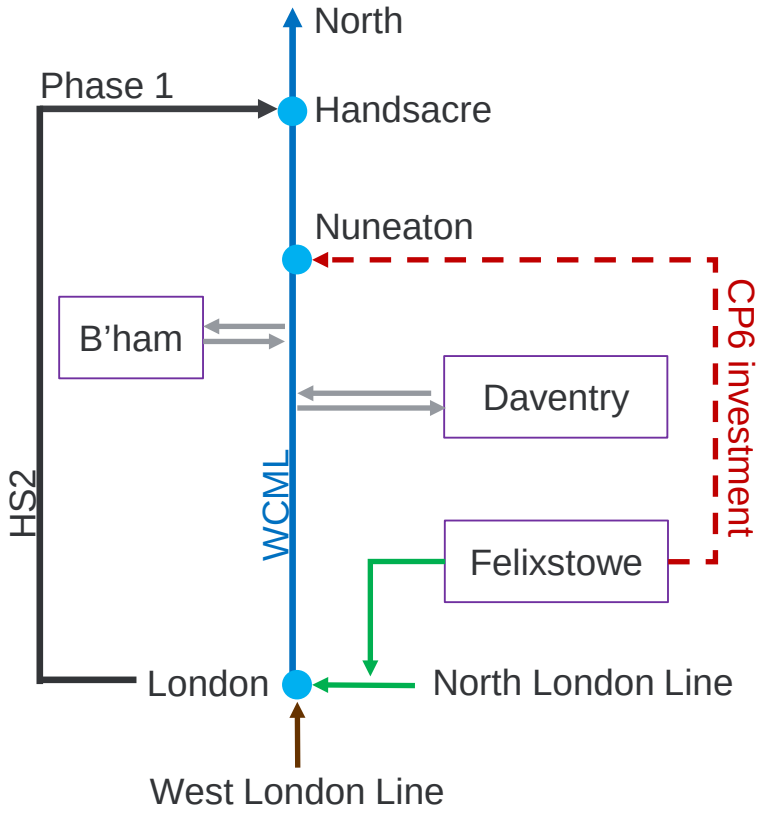


Figure 67 Schematic of WCML and HS2 Phase One

6.26 In essence, the available information frHS2 Limited and the Train Service Specification (TSS) presented to the hybrid Bill committee in January 2015 suggests

that at least one extra freight train each hour – in each direction - could potentially operate post Phase One and that a second might be possible as well. This is due to the greater space that will be available on the Slow Lines from Euston once all “fast commuter” services to Milton Keynes and beyond switch to the Fast Lines to take the space currently used by inter-city trains.

6.27 Because freight north of Rugby can use either the WCML or other routes in the West Midlands area, it is possible that the section between Rugby and Crewe will not be as significant a constraint as at present once HS2 opens. However, the number of trains on the two-track section from Colwich to Stafford means that timetables would need to be orientated around this section to avoid performance risks.

6.28 Once freight trains reach Crewe, there are also a number of further capacity constraints in the north of England that restrict the ability to provide additional paths to freight terminals.

Phase Two and 2a will release further capacity

6.29 The track north of Crewe remains a problem for freight as it is only two-tracks, with freight loops that are too short to accommodate today’s freight demand, with slow exit and entry speeds and, in some cases, poor locations, at the foot of lengthy (and therefore slow) inclines.

6.30 Figure 68 considers the impact, in very schematic terms, of the Western leg of Phase Two that would rejoin the WCML at Golborne Junction, near Wigan, as well as the proposed potential Phase 2a scheme where HS2 would join the WCML at Crewe.

6.31 The key benefit of Phase 2a for freight is that it would allow fast passenger trains to bypass three bottlenecks (the junction at Colwich, the two-track section south of Stafford and the junction at Stafford itself) thus opening up more capacity for freight (and slower passenger) trains in these areas. The freight centre at Basford Hall, just south of Crewe, is a key location for re-forming trains and changing train crew. The approaches to it from Stafford are operationally complex, with non grade-separated junctions. The Phase 2a junction would bypass these crossovers, helping provide capacity for freight traffic between Basford Hall and London/the West Midlands.

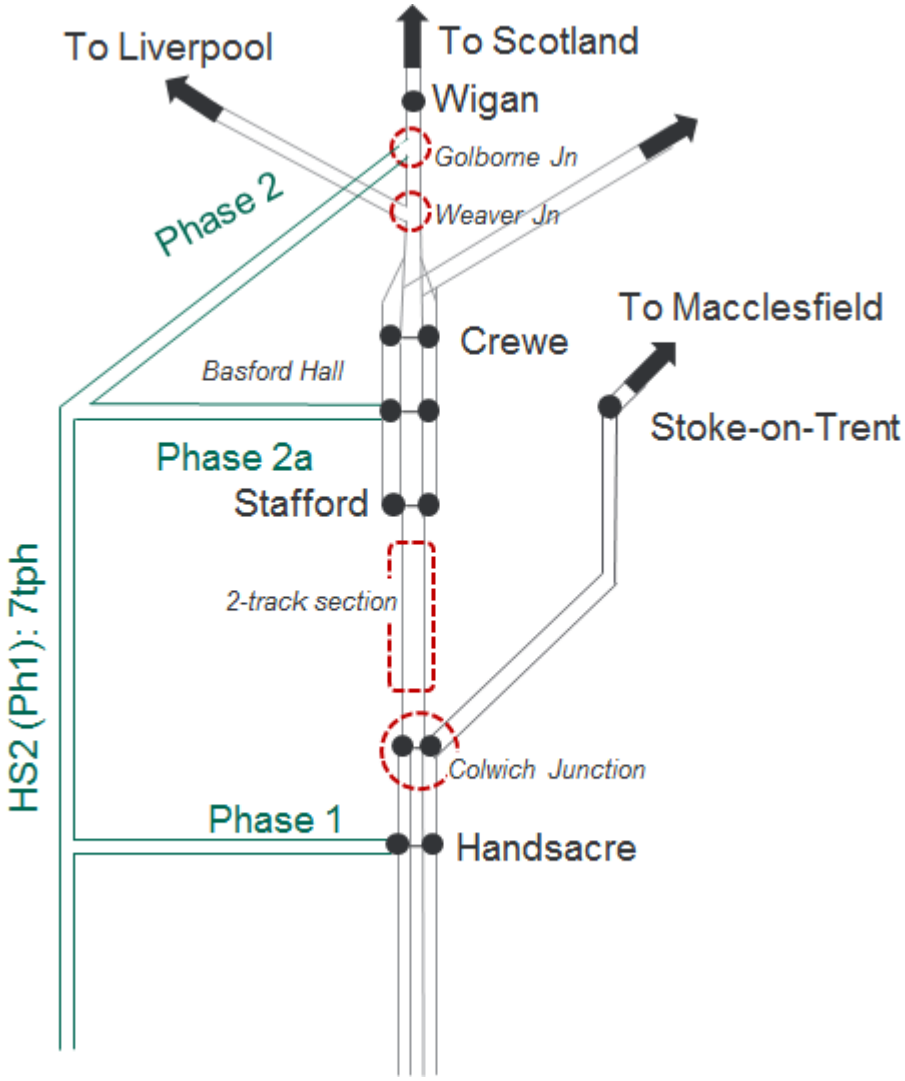


Figure 68 Schematic of WCML and HS2 Phases 1, 2a and 2

6.32 Full Phase Two will include a further extension of the high speed line from Crewe to Golborne Junction, just south of Wigan, as well as to Manchester. The link to Golborne will provide some further potential freight capacity between Crewe and Weaver Junction, where the route to Liverpool leaves the WCML since Phase Two effectively bypasses today's line, and between Crewe and Warrington. At present, the Crewe - Weaver - Warrington section is heavily constrained, with up to 10tph in each direction comprising a diverse mix of fast passenger, stopping passenger and freight trains of various speeds that is a challenge to timetable. There are three small passenger stations on this section which have an hourly service that is particularly capacity-heavy. With Phase Two, up to two London-Preston/Glasgow inter-city trains per hour would divert from the WCML and potentially also the hourly Birmingham - Glasgow trains. The capacity released by this could be used by freight. This could potentially be useful for services to the West Midlands, Daventry and London from expanded port facilities at Liverpool, once complete.

6.33 In essence, the further north HS2 joins the WCML, the greater the benefit for freight. This is for three reasons:

- The greater the length of classic network that HS2 releases capacity from, the greater the benefits

- The classic network is less crowded (due to lower population and thus passenger demand) the further north you travel
- The Phase One junction (Handsacre) is just south of a particularly busy two-track section around Colwich Junction

WCML Feeder Routes

6.34 To take full advantage of the capacity released on the WCML by HS2, it is important to look at investment options to accommodate freight growth on WCML feeder routes – in particular at the southern end of the route. Work suggests that there could well be sufficient existing or planned capacity, depending on the resources available to Network Rail and the extent of use of the North London routes by TfL. In particular:

- There appears to be sufficient capacity for the identified future growth in demand between Felixstowe and London via the Great Eastern Main Line, subject to sufficient capability being available to stage trains between the Great Eastern Main Line and North London Lines
- On the North London Line the Anglia Route Study suggests that infrastructure planned for Control Period 5 (CP5) will be sufficient to deliver freight capacity in CP6, with a signalling scheme to reduce headways required to accommodate long term growth and maintain performance. This will allow an additional hourly freight path to operate
- There is significant growth anticipated on the Gospel Oak - Barking route. A number of infrastructure enhancements are committed for CP5 to help deliver this additional capacity. These include electrification which will speed up passenger services. These enhancements are anticipated to give two or three additional freight paths each hour

Rail Central
Northamptonshire

The Rail Central Rail Freight Interchange

Northampton Gateway Examination

Written Representation of Ashfield Land Management Limited and Gazeley GLP Northampton s.a.r.l.

Appendix 13 - Chronology of Discussions between the Rail Central Applicant and Northampton Gateway

Northampton Gateway PINS Reference Number
TR050006

6 November 2018

Chronology of Discussions between Rail Central and Northampton Gateway

The table below sets out a chronology of the attempts made on behalf of Rail Central to discuss the interrelationship between the two schemes in order to seek to identify and resolve issues ahead of submission.

Date	Event	Outcome
3 May 2017	Rail Central writes to Northampton Gateway to request sharing of information for the purposes of cumulative assessment.	No immediate response received.
24 November 2017	Rail Central submits responses to Northampton Gateway Phase 2 Statutory Consultation.	
19 December 2017	Northampton Gateway responds to Rail Central's Phase 2 Statutory Consultation response.	Contains a response to May 2017 letter.
12 January 2018	Northampton Gateway writes to Rail Central requesting environmental information to complete cumulative assessment.	
2 February 2018	Rail Central submits response to further focussed consultation. Letter includes confirmation from Rail Central that environmental information will be available through the formal Phase 2 Statutory consultation that would commence on 15th March 2018.	
9 February and 5 March 2018	Northampton Gateway writes to Rail Central and provides information relating to LVIA ZTV.	
23 April 2018	Northampton Gateway submits response to Rail Central's Phase 2 Statutory Consultation. Response focusses upon environmental information and critique to Rail Central's proposals.	
21 May 2018	Submission of Northampton Gateway application to PINS.	
22 June 2018	Rail Central writes to Northampton Gateway stating that following a meeting between Rail Central and PINS on 25 May 2018 that a key part of their advice relates to overlapping	

	Order Limits and possible Works Packages and the need for certain provisions within both the Rail Central and Northampton Gateway DCOs, and that there is a requirement for Rail Central to demonstrate to the ExA how both schemes and our associated mitigation will work together if both developments are granted a DCO.	
26 June 2018	Northampton Gateway sends response letter to Rail Central stating that in order that Northampton Gateway can give Rail Central's letter proper consideration that they are provided with a copy of the advice from PINS.	
6 July 2018	Rail Central responds explaining they are waiting for PINS to ratify the minutes of the 25 May 2018 meeting. Rail Central requests a meeting with Northampton Gateway.	
12 July 2018	Northampton Gateway indicates that they require a copy of the PINS meeting note and following receipt will be in a position to respond to Rail Central's meeting request.	No meeting arranged.
6 August 2018	Northampton Gateway chase for a copy of the PINS meeting note.	Meeting note not yet issued by PINS.
7 August 2018	Rail Central respond to indicate that they are waiting for PINS to upload the agreed minute to their website and Rail Central will contact PINS that day.	
16 August 2018	Northampton Gateway contacts Rail Central following reviewing a note available on the Planning Inspectorate website for a meeting between PINS and Rail Central held on 25 May 2018. Northampton Gateway indicate that they have received no advice from PINS and cannot identify a requirement for such in the Meeting Note.	
6 September 2018	Rail Central contacts Northampton Gateway stating the Rail Central DCO application will be submitted shortly to PINS, requesting a meeting to discuss the Statement of Common Ground and Protective Provisions for the Northampton Gateway DCO.	

17 September 2018	Confirmation received by Rail Central that Northampton Gateway were willing to meet.	Availability sought and meeting set for 2 October 2018.
2 October 2018	Meeting between Rail Central and Northampton Gateway.	Discussion to run through Rule 6 response letter and Secretary of States letter submitted by Rail Central to Northampton Gateway. Subsequent meeting arranged for 8 November 2018.
31 October 2018	Meeting set for 8 November 2018 between Rail Central and Northampton Gateway postponed by Northampton Gateway.	Rail Central requested availability for second meeting prior to Deadline 3.

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The Rail Central Rail Freight Interchange

Northampton Gateway Examination

Written Representation of Ashfield Land Management Limited and Gazeley GLP Northampton s.a.r.l.

Appendix 14 - Investing in the Network, Network Rail, February 2018

Northampton Gateway PINS Reference Number
TR050006

6 November 2018

Investing in the Network

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1. Introduction

This guide gives you an overview of Network Rail's investment process and associated contractual framework. It covers a suite of enhancement template agreements for engaging with current and prospective promoters and stakeholders sponsoring infrastructure enhancement projects. It is intended to be consistent with the Office of Rail and Road (ORR)'s Policy Framework for Investments.

The guide's appendices cover:

- enhancing the network
- the Governance for Railway Investment Projects (GRIP)
- the investment process
- criteria used for assessing promoters' reasonable requirements
- services provided by Network Rail
- approval in principle
- risk management
- regulated change processes
- Network Rail's template agreement structure

2. Network Rail's Role

Network Rail is a key point of contact for anyone who wants to invest in the rail network – also known as 'enhancing the network'. Our aim is to facilitate appropriate investment in the network regardless of the role we are asked to play in delivering that investment.

The earlier you involve us with a project's development, the more we can help you to define its scope and deliver your proposal. This will help us both to align our respective objectives or commitments, to realise opportunities from integrating these commitments and to manage interface risks effectively. Details of how we engage with promoters can be found at Network Rail open for business. See also Appendix A.

Our role is to help developers, funders, stakeholders and other 'promoters' who wish to invest in the rail network to develop and then deliver their proposals in co-ordination with all relevant stakeholders.

We will coordinate and involve the train operators, the Department for Transport (DfT), Transport Scotland, the Welsh Government and other stakeholders as appropriate where a proposal:

- could have a separate impact on train service franchises; or
- could have a material linkage with wider public policy objectives (such as airport access or freight access to major ports).

Network Rail governance arrangements

Before committing to a contract for services, products and works with a promoter or committing internal resources to a project, we need to approve internally every investment project. This provides for adequate monitoring of the project's impact on the network. It also lets us control and prioritise our investment plans where we're funding or delivering the project.

We authorise investment funding in discrete stages during a project's various phases. This:

- brings business case certainty;
- reduces the risks in committing investment expenditure on projects; and
- verifies that each project phase is adequately defined.

The Governance for Railway Investment Projects (GRIP) explains the stages of the project lifecycle where funding approval is required. Further details can be found in Appendix B.

Network Rail's stakeholders

On generic industry-wide issues, passenger and freight operators are often represented by the Rail Delivery Group (RDG).

The main funder of network outputs is the Department for Transport (DfT). Following the enactment of the Railways Act 2005, Scottish Ministers are in a similar position to the DfT, in Scotland through Transport Scotland (TS).

Other funders include the Welsh Government, Transport for London (TfL), Combined Authorities (formerly Passenger Transport Executives), Local Enterprise Partnerships (LEPs), local and county councils, the European Union (EU), rolling stock manufacturers and developers.

We consider our stakeholders to be all of the above, including any other party which relies on us to invest in the rail network infrastructure and anyone who may be affected by the proposed project.

3. The Investment Process

The investment process has a number of possible stages. These depend on the type of project, the level of our involvement and the promoter who approaches us.

Once a promoter has approached us, we'll work with them to determine the appropriate scope and contractual framework for the project's lifecycle.

When we deliver services to the promoter, and also when developing and implementing projects ourselves we follow the Governance for Railway Investment Projects (GRIP) process.

Where the promoter undertakes the development and the implementation of the works, we will facilitate its project by providing non-contestable services, which we outline below.

We describe below the various investment process stages which we will follow from inception through to completion. Appendix C provides flowcharts to illustrate this process. We also explain the contracting arrangements which apply for different kinds of project.

GRIP Stage 1: Output Definition

Information requirements

When considering an investment in the rail infrastructure, you should consider:

- the objective, scope, timing, and specification of the enhancement;
- the funding for the project and any project risks;
- the procurement methodology: what you think we should undertake in development and implementation works or provision of non-contestable services (defined below);
- the likely interface with existing railway operations and other relevant projects and route strategies; and
- other stakeholder involvement.

Receipt of request

When we receive an investment request, we will appoint an appropriate representative. The nature of the investment will determine who within Network Rail will take responsibility for the investment process, and the nature of the proposed investment and its complexity will largely determine how we allocate it.

Our representative will:

- respond to your initial request on a timely basis;
- act as your point of contact with us and keep you informed regarding the progress of your project;

- meet you to undertake an initial assessment of the project; and
- check you have given us the necessary information for our representative to seek endorsement of your request from the 'Route Strategy Planning Group (RSPG)', which is described in more detail in the following section.

Review of project proposals by the RSPG

Each route has a RSPG, which is an internal (Network Rail) multifunctional review group which:

- provides clarity on the route's required outputs via an appropriate specification;
- verifies that the route investment programme will deliver these outputs efficiently and cost-effectively; and
- verifies that investment proposals are sufficiently well managed and supported.

All enhancement schemes, regardless of funding, are discussed at the relevant RSPG meeting. We will also seek feedback on the proposal from stakeholders and industry partners at industry meetings like the Route Investment Review Group.

As part of the review process, the RSPG will assess the scheme against the decision criteria we use to assess promoters' requirements. You can read a summary of our decision criteria in Appendix D.

Failure to meet decision criteria

If our assessment of your scheme is that it does not meet the decision criteria for promoters' requirements, the RSPG may reject the proposal.

Rejection of scheme by RSPG

If the RSPG reject the proposal, our representative will work with you to identify possible options for your proposed scheme, which may include revising and resubmitting your proposal.

Appealing against a decision

If you want to appeal against a decision made by our RSPG, you should appeal in writing to our representative. This appeal should clearly set out why you believe that the decision was incorrect, and give further information as necessary.

The RSPG will review your appeal, and may invite you to a meeting to discuss your proposed scheme. The RSPG will then reassess the scheme against the decision criteria for assessing promoters' requirements.

GRIP Stage 2: Project Feasibility

Following successful review and prioritisation of the investment proposal, Network Rail will make contact with the promoter to move the project forward.

Network Rail will decide at the RSPG meeting which part of the organisation will sponsor the project. Where a scheme changes the capability of the railway, i.e. changes to the timetable or operation of the network, or integrates with existing major programmes of work then Network Rail's System Operator team will sponsor the scheme. Other schemes will be sponsored by Route Enhancement teams (such as investments in stations).

At this stage, we will also define our involvement in the scheme. We have to be included in elements of the project that impact on the railway, which we call 'non-contestable services'. This reflects the requirements on us to preserve the railway's integrity and protect our assets. However, you may choose to engage third parties for other elements of the project. This is explained further below.

Non-contestable services

If you intend to design and implement the project yourself, we will provide asset protection services. Only Network Rail can provide these 'non-contestable' services.

They include protecting the integrity and safety of the rail network and its operations, the provision of asset and operational information, safety management (including approvals), consents and protected access to the railway. If the works are straightforward, then a Basic Asset Protection Agreement (BAPA) may be appropriate at this stage. If the project is more complex, then an Asset Protection Agreement (APA) is likely to be more suitable. Further information can be found on our website at: Third Party Template Agreements

Contestable services

As well as non-contestable services we may also be able to undertake a full range of 'contestable' project development and implementation services.

The specific type of service we provide will depend on the stage in the project lifecycle and we will discuss and agree the services and any charges with you before taking any action or incurring any charges.

In the early stages of a project, we recognise that you might need help to develop and refine your business case.

As part of the business case development, we need to establish:

- a sustainable funding route for the project, including risk management;
- what, if any, adverse impact the scheme will have on network capacity, and options to mitigate this; and
- what are the interface risks with our Operations, Maintenance and Renewal (OM&R) activities, including:
  - all safety risks;
  - the needs of other users of the network;
  - avoiding conflict with the existing rights of other users; and
  - the need to verify that we are not placed at undue risk of breaching our stewardship obligations as set out in our own network licence.

If you ask us to develop the scheme and we agree that we should do so, we will use either a Basic Services Agreement (BSA) or Development Services Agreement (DSA) to capture the services and fees required to progress the project. Both of these agreements are described in section 4 below and can be found on our website at Third Party Template Agreements

Appendix E has an indicative list of services (both contestable and non-contestable) that we can provide.

Business efficiency objectives

In some cases, it might be more efficient to align your proposal for investing in the rail network with our own renewal or other activity – for example, if you were to propose a minor enhancement where we are undertaking a major renewal. In these cases, we might agree to undertake the works as part of our own renewal activity.

Where appropriate, we will give you more information on our renewal plans to help you find such opportunities. When the proposed enhancement may pose a significant risk to the efficient operation, maintenance or renewal of the network but is nonetheless deemed to be a priority, then we will offer to develop the project in line with our template agreements.

GRIP Stage 3: Option Selection

At the end of this phase, the following workstreams should have been completed by either us or your development services provider:

- the various options available to complete the project will have been identified;
- each of these available options will have been appraised; and
- a single option and outline design should be recommended.

Based on this recommendation, you should receive indicative time and cost information from either us or your development services provider. You can use this to inform your business case.

The business case should confirm whether or not the project is affordable, including consideration of whole-life cost issues, whether it can be delivered in a reasonable timescale, whether it will provide value for money, and on this basis whether to proceed to detailed design and implementation.

GRIP Stages 4 to 8: Option Development, Design, Construction, Handback and Close Out

If the procurement route you choose is through Network Rail, we will enter into an Implementation Agreement (IA) with you. We will seek a sufficient level of design certainty and equivalent terms from our supply chain after completing design at GRIP Stage 4 or 5 as appropriate.

Where we implement the project, we'll agree the appropriate contracting strategy with you. This will usually be on an emerging cost methodology based on cost estimates and tenders with appropriate contingencies and allocation of risk between the parties.

There are four possible implementation agreements, depending on the value and complexity of the scheme.

- a Basic Implementation Agreement (Emerging Cost or Fixed Price); and
- an Implementation Agreement (Emerging Cost or Fixed Price).

These agreements are described in section 4 below and can be found on our website at Third Party Template Agreements

During the implementation stage, we might provide the following services (and any other services that are required):

- project management;
- detailed design (if not already completed);
- constructing the new assets;
- approval, acceptance, commissioning; and
- project close out.

Before project close out and after implementation, you should review the business benefits of the project with us, reviewing and recording any lessons which could benefit future schemes. This is in line with project management best practice.

In cases where you are undertaking the implementation activity yourself, we will facilitate the project's interface with our business according to an Asset Protection Agreement or Basic Asset Protection Agreement, as appropriate. (For further details see our website at http://www.networkrail.co.uk/aspx/1606.aspx)

4. Contracting Templates

Introduction

We have a set of template agreements with model terms and conditions for use by promoters. These were first introduced in 2005 after extensive consultation with our stakeholders and approval by the ORR. They have been updated over the years to improve them, deal with stakeholder issues and keep them up-to-date.

By establishing clear frameworks setting out for the roles and responsibilities of Network Rail and the promoter, these agreements seek to:

- encourage investment in rail enhancements;
- identify practical solutions which reduce barriers to investing in the railway;
- reduce the need for time-consuming negotiations; and
- reduce the need to develop specific contracting arrangements for each and every scheme.

The principles of the template enhancement agreements are consistent with the ORR Investment Framework and our regulatory obligations. In particular, they are consistent with the obligation to "secure the improvement, enhancement and development of the network', and to meet stakeholders' reasonable requirements.

Template agreements

These agreements are designed for projects generally with a total cost of circa £50 million or less. To make things clearer, you can read our explanatory notes on the different agreement types at: Third Party Template Agreements

The agreements are summarised below:

Basic Services Agreement (BSA)

A simple agreement, aimed at quickly putting in place a contractual relationship after you've approached us initially. It covers pre-feasibility works to scope the scheme and develop the business case.

The tasks it covers can include:

- providing you with asset information;
- attending meetings and workshops; and
- where appropriate for minor schemes, reviewing the 'Approval in Principle' design you've procured (see Appendix F for more information on Approval in Principle).

The agreement also permits you or your representative to undertake visual inspection of the network, within certain constraints.

It will generally be used during GRIP stages 1 and 2, but could also be used up to the end of GRIP Stage 3 for simple schemes.

Development Services Agreement (DSA)

This agreement covers development and design work we undertake on your behalf. This includes:

- project and development management;
- contract management of consultants;
- management of the necessary consents and approvals; and
- governance and control.

The DSA covers GRIP Stages 2 to 4 inclusive, with the potential to reach GRIP Stage 5 if agreed.

Basic Implementation Agreement (Emerging Cost) (BIA EC)

This is a simple agreement for straightforward low-risk works up to a typical value of £2m, which are on or near to the controlled railway infrastructure. You pay for the works on an emerging cost basis, and the agreement covers GRIP Stages 5 to 8 inclusive.

Basic Implementation Agreement (Fixed Price) (BIA FP)

This is a simple agreement for straightforward low-risk works up to a typical value of £2m. It envisages that the works contractor will have given us a fixed price based on the specification that you have agreed with us. You pay for the works on a fixed price basis, and the agreement covers GRIP Stages 5 to 8 inclusive.

Implementation Agreement (Emerging Cost) (IA EC)

With Network Rail acting as a construction manager, this is an emerging cost agreement which establishes a clear commercial framework for enhancement work on or near to the controlled railway infrastructure. It allows for detailed design and implementation of your scheme, with the contracting strategy agreed between you and us.

Implementation Agreement (Fixed Price) (IA FP)

This is generally intended to cover implementation of schemes up to £10m from the end of GRIP Stage 5. It envisages that the works contractor will have given us a tendered price based on similar fixed price terms against a specification which you have agreed with us.

Basic Asset Protection Agreement (BAPA)

This is a simple agreement for straightforward, low-risk promoter-led works on the controlled railway infrastructure, where we facilitate your project through asset protection. The works may take place on secondary routes and will present low risks to our network and require few or no possessions.

You will pay the costs of our services, which generally include:

- engineering safety management approvals;
- provision of asset information;
- booking of possessions and necessary consents; and
- attending meetings as required.

Whilst the agreement can cover GRIP Stages 2 to 8 inclusive, you will need to establish the implications of any single option on the agreement form before implementation. It can also be used at GRIP Stage 1 for surveys.

Asset Protection Agreement (APA)

This is an agreement for promoter-led works on the controlled railway infrastructure, where we facilitate your enhancement scheme interface with our Operations, Maintenance and Renewals activities. You pay the costs of our services, including:

- engineering safety management approvals;
- provision of asset information;
- booking of possessions and necessary consents; and
- attending meetings as required.

Whilst the agreement can cover GRIP Stages 2 to 8 inclusive, you need to establish the implications of any single option on the agreement form before implementation. Although this agreement can be used from the end of GRIP Stage 2, it is generally used at GRIP Stages 3 to 4 onwards.

Risk Management

Promoters' projects place additional responsibilities upon Network Rail to deliver development and design

services, asset protection services and works for which it is not funded by the DfT. The template agreements frame the balance of risk and responsibility as between Network Rail and the promoter and introduce two risk funds to deal with Network Rail's contractual risks (the Network Rail Fee) and those risks systemic to the rail industry (the Industry Risk Fee).

The nature of these risks and percentage fees charged to promoters as part of the template agreements is detailed in Appendix G.

5. Public Liability Insurance

The ORR requires the rail industry to have a minimum of £155m of public liability cover, and this level of cover may apply to promoters carrying out works on or close to our railway infrastructure.

Promoters should consult with their insurance advisors in order to arrange the required cover, but promoters may be interested to know that a top-up insurance facility that can provide cover over a promoter's or contractors' £25m or £50m public liability cover, up to the £155m requirement, is available through JLT Specialty Ltd and AON UK Ltd. The following personnel can provide details if required:

Kevin Mannifield, Client Director Aon Risk Solutions, Global The Aon Centre, The Leadenhall Building, 122 Leadenhall Street, London, EC3V 4AN +44 (0) 207 086 0490 kevin.mannifield@aon.co.uk	Ian Thompson, Senior Partner JLT Specialty Ltd Direct Dial : +44 (0)20 7558 3497 Mobile : +44 (0)7771 710 923 Email : ian_thompson@jltgroup.com
Gill Bretherton, Client Director Aon Risk Solutions, Global The Aon Centre, The Leadenhall Building, 122 Leadenhall Street, London, EC3V 4AN +44 (0) 207 086 1891 gill.bretherton@aon.co.uk	Andrew Birt, Senior Partner JLT Specialty Ltd Direct Dial : +44 (0)20 7528 4927 Mobile : +44 (0)7956 023 333 Email : andrew_birt@jltgroup.com

Other insurance facilities may also be available and promoters should seek independent advice to ensure their liabilities are adequately covered to suit their needs.

Where promoters ask Network Rail to deliver projects and an Implementation Agreement is used, either Network Rail or our contractors will provide the relevant insurance.

Further Information

If you need further information or have queries regarding the content of this document please follow the various links in the document to Network Rail's website pages, talk to your Network Rail contact or email SubmissionstoCorporateCommercial@networkrail.co.uk

Appendix A: Enhancing the Network

We maintain details of all the proposed investment schemes with an enhancement element, and their current status, within the route plans we publish as an annex to our annual business plan. We publish these details at least once a year.

There are eight routes and the details for each one can be found by following the links below:

Anglia

London North Eastern and Midlands

London North Western

Scotland

South East

Wales

Wessex

Western

In addition Rail Freight is treated on a national basis.

We encourage input into our network planning process through channels which include:

- Route Utilisation Strategies and other route stakeholder groups;
- routine liaison with train operators; and
- direct contact with the relevant route enhancement manager or principal network planner.

We use Route Investment Review Groups as the formal basis for providing further dialogue with train operators about our investment plans.

We also engage separately with other stakeholders to discuss our plans and we have arrangements with freight operators for a national dialogue.

Appendix B: The GRIP Process

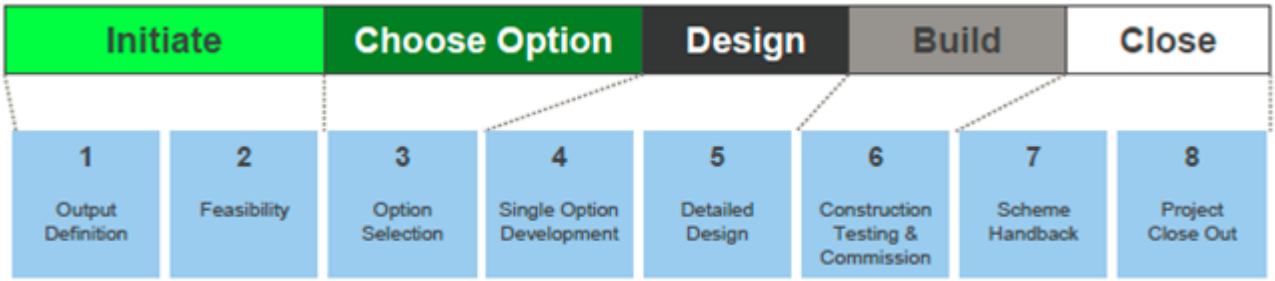
Network Rail's management and control process for enhancements

In comparison with other industries, working on or alongside an operating rail network adds significant complexity. Work may need to be carried out at certain restricted times, like evenings or weekends, which can mean that even minor interruptions or delays in the work programme can have a significant impact on timescale and costs.

There is also a much greater risk that investment projects will lead to operational disruption. As well as the standard construction risks that affect all sectors of the economy, rail industry enhancement projects are likely to face significant additional risks that can lead to cost overruns in completing the works.

To minimise and mitigate the risks associated with delivering projects on an operational railway, we have developed an approach to managing investment schemes which we set out in GRIP. We base the approach on our own best practice, as well as that of other industries that undertake major infrastructure projects, and major professional bodies including the Association of Project Management. It covers the investment lifecycle from inception through to the post-implementation realisation of benefits:

Key stages of the investment lifecycle (GRIP Stages)



The lifecycle shows how a project is broken down into eight stages. The overall approach is driven by product rather than process, and each stage needs to deliver an agreed set of products to specific quality criteria.

At each stage of the investment lifecycle, GRIP defines all of the 'products' which could be produced within that stage. Within each GRIP document, the products are summarised in a matrix which lists what could be produced, and at which stage in the investment lifecycle. We hold formal stage gate reviews throughout the investment lifecycle. These reviews examine a project at critical stages in its lifecycle to give assurance that it can continue successfully. The review looks at the completeness of products and assesses the risk associated with any variance or derogation.

All projects are subject to at least four mandatory stage gate reviews during the project lifecycle. At least two reviews take place during the project's development phase, leading to a single option and agreed scope, prior to the award of the detailed design and construction contract. Two other reviews look at scheme handback and project close out. Additional stage gate reviews are undertaken where we carry financial or output risk.

Where a third party carries any of the financial and/or output risk associated with an investment project, then a stage gate review may be held at the end of any stage at the request of the third party to support their investment authorisation processes. In this case, the stage gate review's format and approach stays the same, but may involve the third party's representatives.

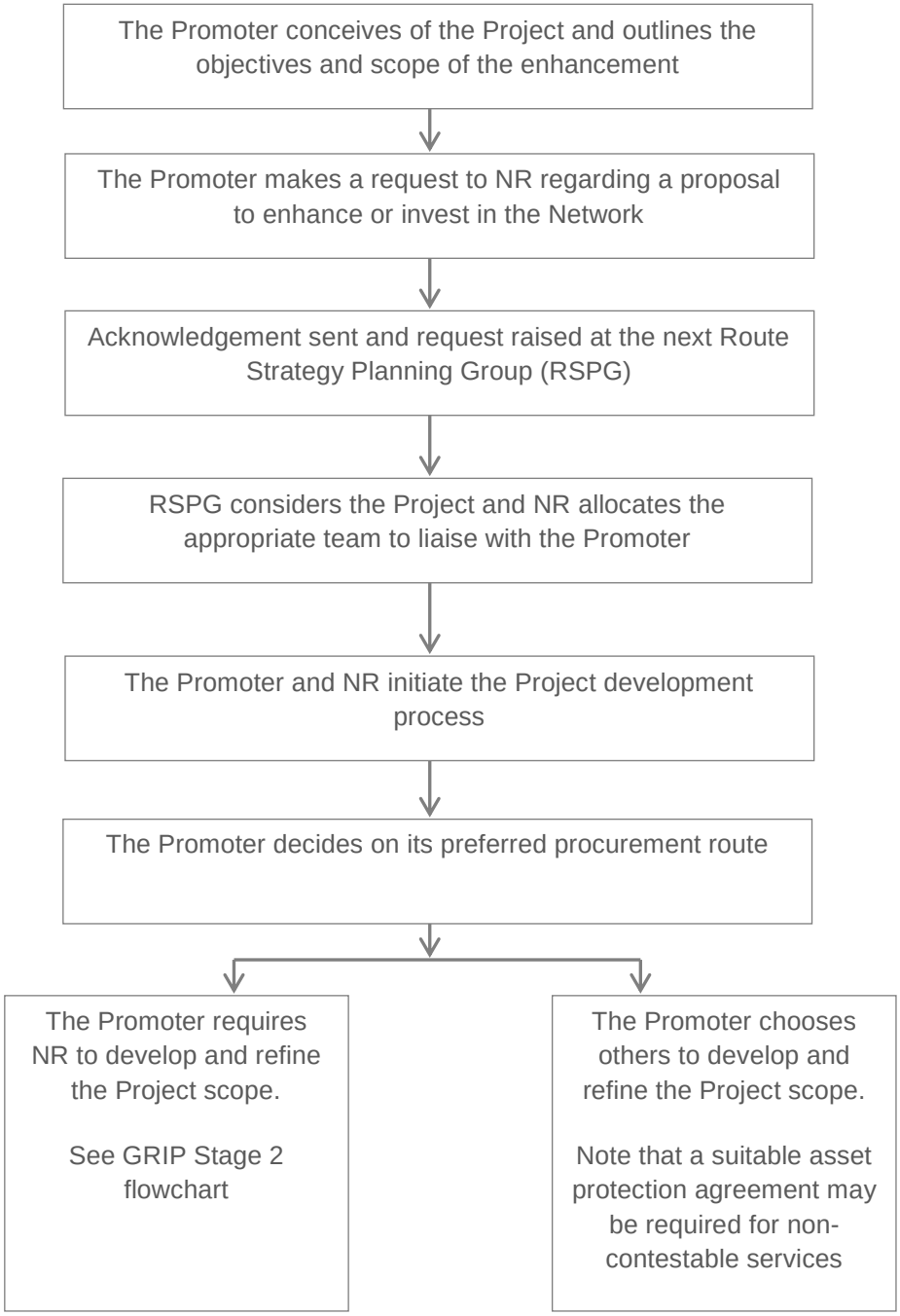
GRIP consists of several Network Rail standards and manuals, including a description of the products that must be produced on an investment project for us to discharge our role as infrastructure controller, operator and maintainer, as well as our asset protection role if a third party delivers the asset change in full or in part.

Appendix C: Investment Process Flowcharts

The following four charts show an example of the typical steps in the investment process. For brevity they do not show all aspects, variants or alternative methodologies available as the Project moves through the eight GRIP stages.

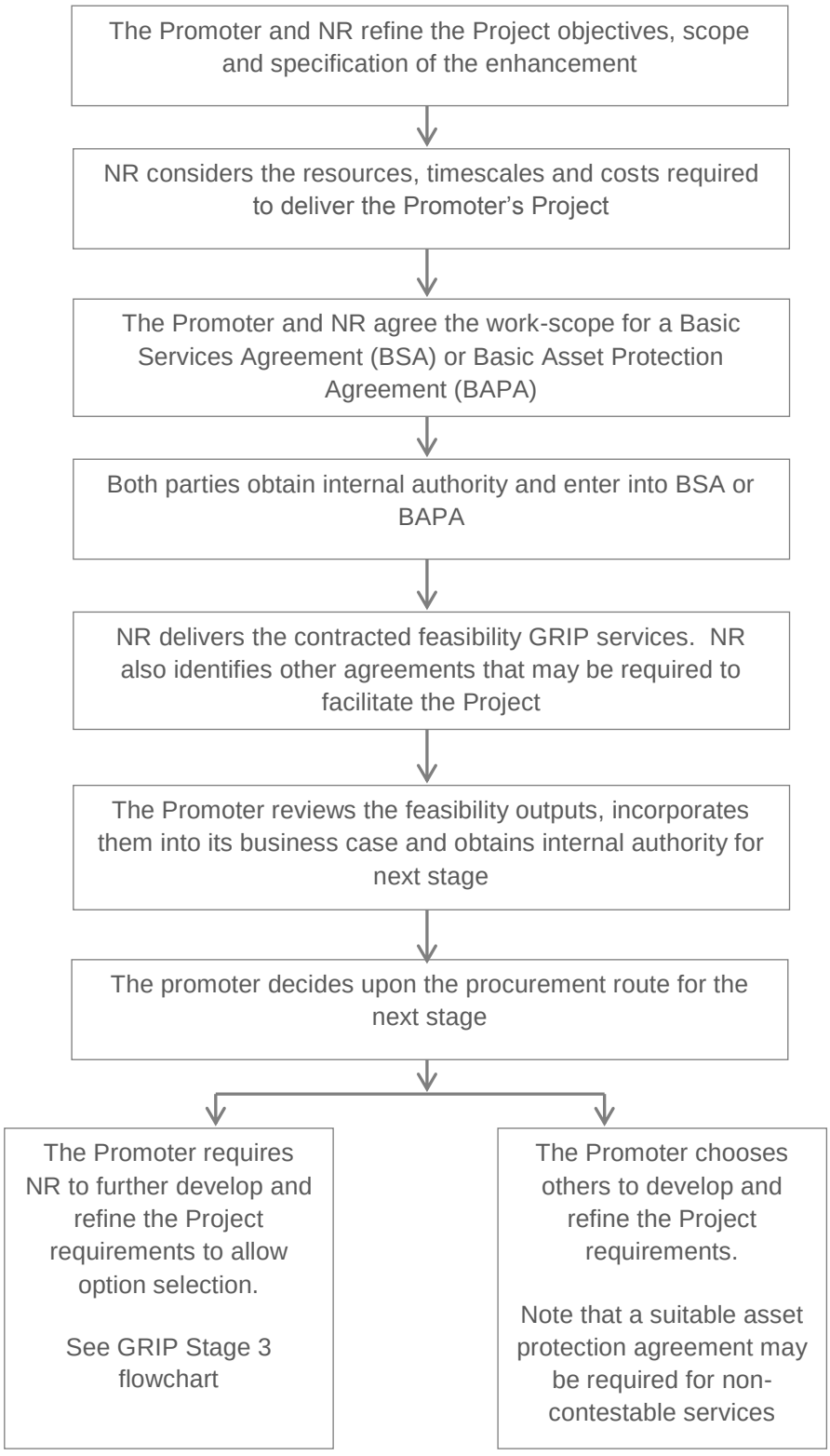
GRIP Stage 1: Output Definition

Flowchart of the enhancement project ideas, initiation and prioritisation process:



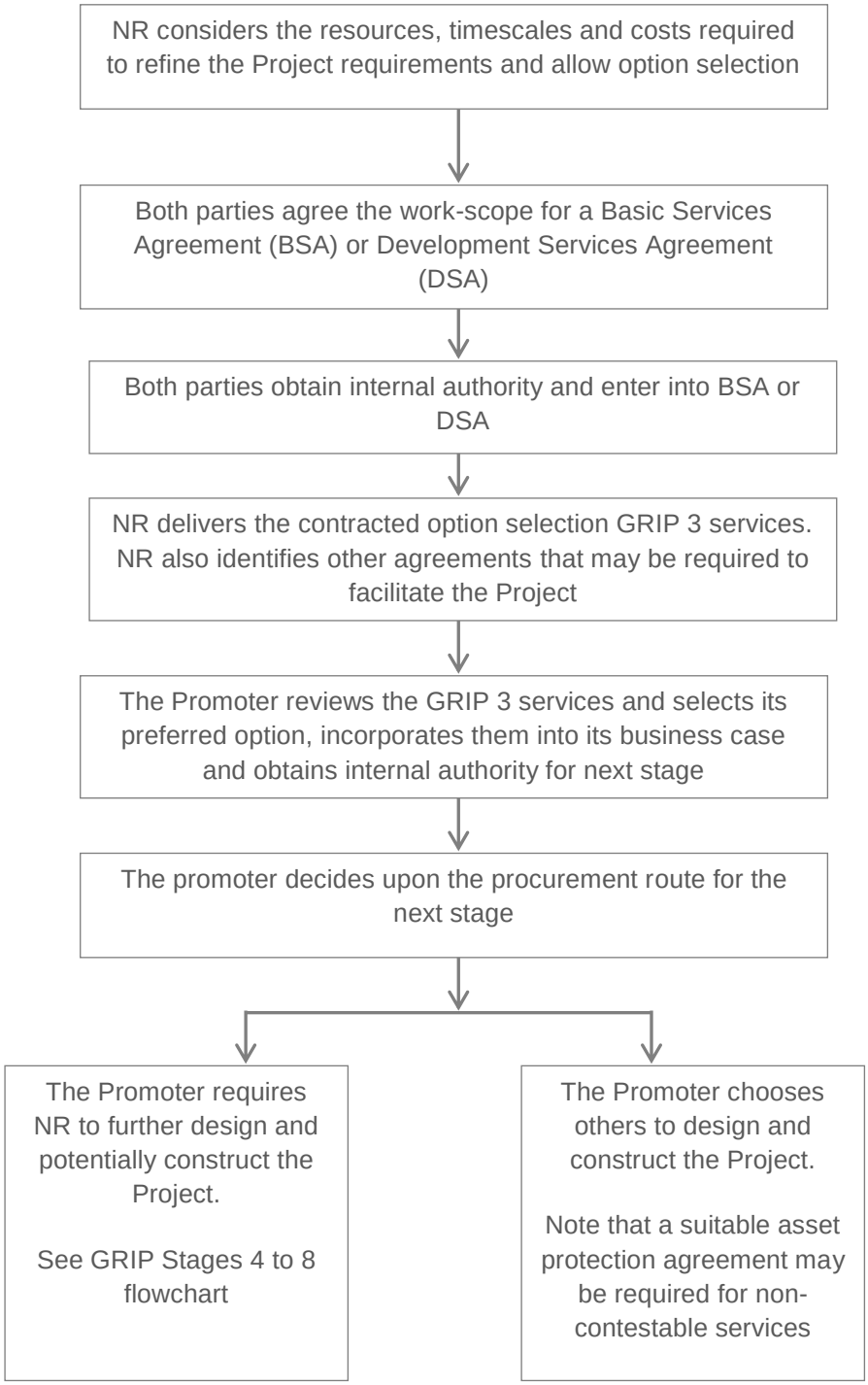
GRIP Stage 2: Project Feasibility

Flowchart of the initial project development process: Provision of basic services by Network Rail (GRIP stages 1 to 2).



GRIP Stage 3: Option Selection

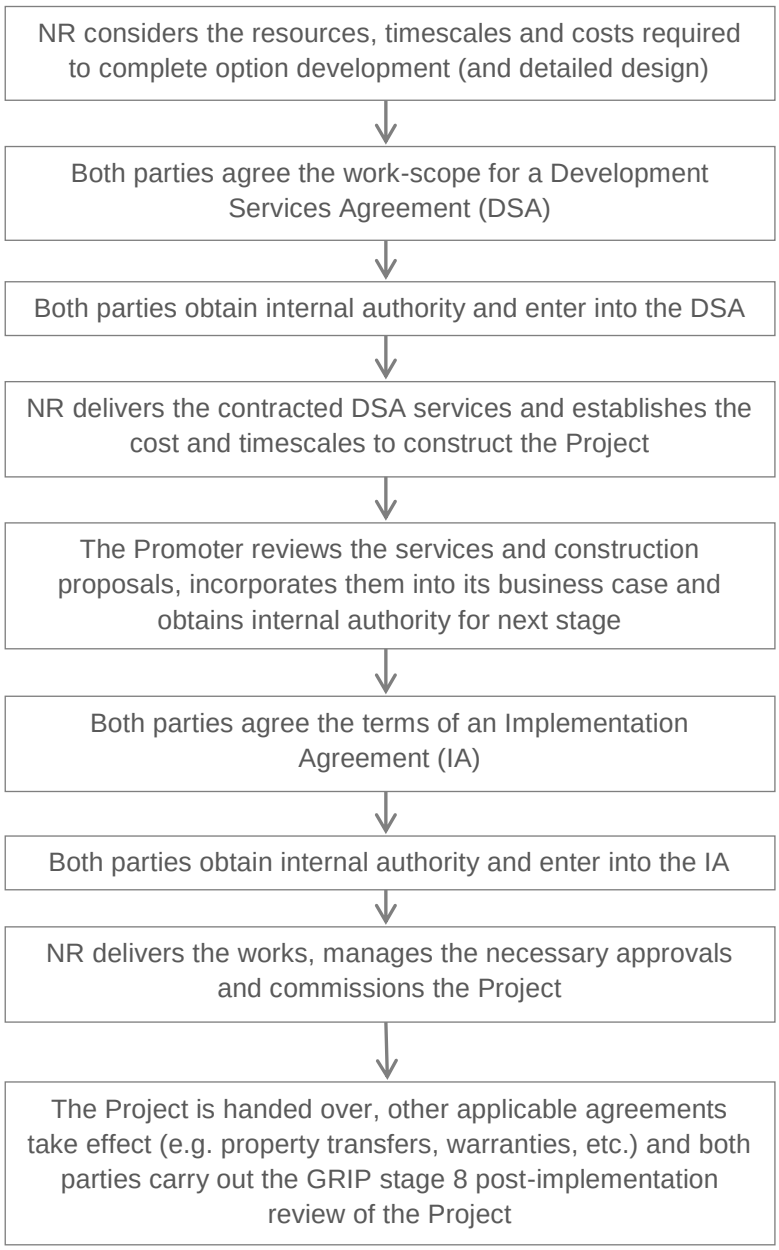
Flowchart of the project development process: Provision of development services by Network Rail.



GRIP Stage 4 to 8: Option Development, Design, Construction, Handover & Close Out

Flowchart of the project implementation process.

Under a fixed or an emerging cost contract with Network Rail, we will provide detailed design, procurement, construction, commissioning and project completion. (GRIP Stages 5 to 8) noting that if we are required to provide a fixed price for the cost of the implementation works, this will generally be contracted from the end of GRIP Stage 5.



Appendix D: Criteria for Assessing Promoters' Requirements

The key constraints on our stewardship of the network are:

- funding;
- network access;
- availability of materials, machinery and manpower;
- asset knowledge; and
- our obligations under our network licence and contracts.

These constraints set the context within which we can pursue our objectives and outputs. All of these are permanent constraints: they will always affect our approach to network stewardship.

Promoters' schemes must meet the following criteria:

Financial constraints

A requirement is regarded as reasonable if it satisfies one or more of the following conditions:

- it can be achieved at no extra net cost to us, including future maintenance or operational liabilities;
- it can be achieved at no extra net cost to us as it forms part of a scheme which we're expected to undertake to renew or enhance the network;
- the promoter commits to pay extra funds, or procure the payment of additional funds to us based on the cost of delivering and financing the enhancement, including a return which is commensurate with the risks we carry; or
- the funding for the expenditure involved is explicitly provided for at an access charges review.

Compatibility with existing commitments

A requirement is regarded as reasonable if it satisfies all of the following conditions:

- it does not conflict with the existing access rights of other operators, including local output commitments;
- it is not designed to give unfair advantage over other bidders in future franchise negotiations;
- it does not impede our future ability to deliver the published strategy on any route, including performance objectives for that route;
- it is consistent with our regulatory obligations under our network licence, and statutory duties under the Railways Act 2005; and
- we can operate the revised infrastructure or service in a safe and efficient manner which is consistent with our safety case and existing processes and procedures.

Where a proposed scheme conflicts with an existing route strategy, we would consider amending the strategy, subject to discussion with our funders and other operators on the route.

Deliverability criteria

To avoid diverting resources that we need for the safe, efficient and reliable running of scheduled services, we will consider a requirement as reasonable if it satisfies all of the following conditions:

- the requirement is clearly defined, and its scope and timescale for delivery are realistic;
- the output is measurable, verifying that all parties can agree when delivery has been achieved;
- we have, or can obtain, the necessary resources to implement the scheme;
- network access can be made available; and
- delivering the scheme does not compromise our ability to deliver the existing programme of works on the route.

Notwithstanding the above, where there are constraints on our ability to deliver a scheme we will work with

promoters and stakeholders to find ways to relieve these constraints.

Where we are only facilitating the delivery of a scheme, our ability to efficiently contribute to the scheme's delivery will depend on the promoter's adherence to the agreed programme plan as described in the contractual agreement, as well as the management structure and expertise they use to discharge their obligations.

Deliverability constraints will not generally affect the vast majority of schemes that are delivered by a promoter. However, when any scheme is delivered, whether by us or a promoter, we must also take into account the stewardship obligations as set out in our network licence.

For example, this might affect areas where a number of schemes are being proposed at a specific time, such as during the London Olympics. If these schemes make exceptional demands on resources, we may not be able to deliver every scheme at the same time whilst operating our network efficiently.

Appendix E: Services Provided by Network Rail

The specific type of services we provide to a promoter will depend on the nature of the project and how many services you wish us to provide as against those services being provided by your team. We will consider projects on an individual basis according to the specific requirements and whether it is appropriate to provide a particular service.

The lists below are for guidance only, but outline the services we can provide to a promoter to facilitate an enhancement project

We'll discuss and agree your service requirements and our charges for these services with you before taking action or incurring charges. We will not charge for providing services for which we are already funded.

In broad terms, the services we can provide are:

Contestable services:

- Project development;
- Design management; and
- Scheme implementation through management contracting.

Non-contestable services:

- Asset protection;
- Engineering safety management; and
- Provision of asset information and booking of possessions;
- Railway operations, and
- Applications for Network Change (see Appendix G)

Contestable Services: development, design management and implementation services

Development, design management and implementation services are generally contestable, and are associated with facilitating an enhancement project for a promoter. As well as using our own staff, we may also procure these services from contractors and consultants in our supply chain. The services include:

- Programme management services including:
  - programme management and integration services;
  - project management services;
  - procurement, appointment and management of sub-consultants;
  - quality assurance;
  - logistics and access planning;
  - constructability review; and
  - risk and value management for programme and project.
- Systems integration;
- In-house design studies;
- Maintenance, operation and performance assessments;
- Technical review and validation;
- Advising on the details of relevant maintenance, performance and renewal strategies to assist in the development process
- Timetable development and assessment;
- Developing acceptance criteria and managing the acceptance process;
- Technical and operational assistance;
- Identifying issues related to coordination with other railway projects;
- Network integration and co-ordination services;
- Facilitating access to the network to undertake agreed enabling works;
- Site surveys and other geotechnical investigations;
- Administration and management of rail industry processes;
- Support for applying for, and exercising powers under, a Transport and Works Act Order;

- Compliance checking of statutory and regulatory obligations;
- Facilitating use of statutory consents, including permitted development rights, where appropriate; and
- Property related advice
- Implementation of works through management contracting.

Non-Contestable Services:

Non-contestable services are associated with protecting the integrity and safety of the rail network. We will facilitate asset protection services, including the following items:

Access to data:

- Access to company standards, sectional appendix and hazard directory; and
- Access to and provision of drawings, asset data and relevant information about the existing network.

Asset protection - safety

- Access to the network, including audit and compliance review of project safety management system;
- Agreement of level crossing risk assessments and forwarding to ORR safety directorate for approval;
- Compliance with supplier's licence;
- Acceptance of project safety case through safety review group/rolling stock acceptance board;
- Acceptance of compliance with Network Rail safety and environmental plan;
- Acceptance of proposed changes, including designs, drawings and operational layout safety within engineering safety management processes; and
- Safety directorate at ORR and London Fire and Emergency Planning Authority (LFEPA) acceptance submission, where we are the duty holder.

Asset protection - engineering safety management

- Acceptance of maintenance regime processes and strategies, including infrastructure maintenance interface strategy;
- Engineering strategy proposals for the application and integration of new technologies, including product acceptance, and forwarding to Her Majesty's Railway Inspectorate for type approval if needed;
- Acceptance of maintainability criteria, performance measures, acceptance criteria, and reliability criteria processes (both project-specific and route-wide); and
- Handback strategy.

Railway Operations:

- Publication of operating notices;
- Timetable – agreement of appropriateness of development timetable in relation to train service specification;
- Administration of possessions booking;
- Publication of notices under the regulated station change process, network change, or depot change – see Appendix G for further information; and
- Agreements for using existing operational land and railway assets.

Appendix F: Approval in Principle

Every project reaching the 'approval in principle' stage of the investment lifecycle will be assessed on its individual merits. To give promoters some guidance about reaching the 'approval in principle' stage, we outline below our general assessment methodology and criteria.

The basic concept of an 'approval in principle' derives from Network Rail standard NR/GN/CIV/133. This states that approval in principle requires that 'competent persons are satisfied that appropriate standards have been used in the design, and the scheme selected meets the remit'.

In practice, different companies (including London Underground) have different definitions of when a project has reached the 'approval in principle' stage.

To clarify our position, we deem that the 'approval in principle' stage is relevant when a decision is made to launch a detailed design (GRIP Stage 5) following the selection of a single option for the proposed enhancement.

There must have been sufficient design work to clearly define the project's concept. The design must be detailed enough to make it clear what is intended, and demonstrate that all interfaces between the project and the environment in which the project is to be delivered are identified and addressed with specific action plans. This does not necessarily demand individual designs for the scheme's components.

For example, to obtain an approval in principle for a station platform development, you will need to at least define the length, height, platform ramps, canopies, finishes, lighting levels, stepping distances, and provision of services (electrical supplies and passenger information). At this stage, though, you may not need to detail the design for cable ducts, drains, brackets, building components, fencing – except for, perhaps, the definition of a fence line, or for cable ducts being satisfied that the design provides for an appropriate size of duct, and the ducts to be correctly located in relation to other services for electromagnetic compatibility considerations.

For an enhancement to the rail network infrastructure, approval in principle can be deemed to mean that:

- the design has been assessed by competent people in the relevant disciplines who are satisfied that the design meets with relevant legislation and standards, and they expect it to meet its objectives;
- the competent people are satisfied that the scheme design contains enough information for the detailed design and procurement of the individual elements of the design to proceed safely and effectively; and
- the competent people are satisfied that the design will correctly integrate with other elements of the scheme, and the adjacent environment that the project interfaces with.

As a minimum, the following questions will usually be examined before a scheme reaches the 'approval in principle' stage:

- Have you looked at all the feasible options and found a single preferred option?
- Is the design detailed enough to be clear and unambiguous about what is intended?
- Is the design sufficiently detailed that it is clear that the design is fit for purpose, by comparison with the requirements the design is to meet?
- Have you considered the relevant legislation and other applicable standards in the scheme's design? And is the competent person satisfied that the design complies with the legislation and standards?
- Is the competent person satisfied that the design is adequate to start the detailed design of individual components and assemblies?
- Is the competent person satisfied that the separate elements of the scheme design will, when brought together, have the required functionality and meet applicable legislation and standards. Will they also address interface issues between the project and adjacent buildings and systems?
- Are the residual risks from the scheme's design demonstrably as low as reasonably practicable? Is there a complete and adequate risk register available

- to those who will carry out the detailed design, construction, testing and commissioning?
- Have suitably qualified persons carried out the design, and have they followed an established design process?

Please note that NR/GN/CIV/133 places the responsibility on Network Rail to assess the competence of designers and engineers. We need to be satisfied that they understand their responsibilities, and that these responsibilities have been expressed and agreed in writing.

Appendix G: Risk Management

Promoters' projects place additional responsibilities upon Network Rail to deliver development and design services, asset protection services and works for which it is not funded by the DfT. The template agreements frame the balance of risk and responsibility as between Network Rail and the promoter and introduce two risk funds to deal with Network Rail's contractual risks (the Network Rail Fee) and those risks systemic to the rail industry (the Industry Risk Fee).

Network Rail Fee

The Network Rail Fee (NRF) covers our potential contractual liabilities to the promoter. For each type of agreement we charge a set fee as detailed in Table 1 at the end of this Appendix which reflects the different risk profile in each template.

We pool all Network Rail Fees to meet claims for contractual breach and negligence which are substantiated and cap our liability at the level of the value of the works and/or services being provided (or £100k whichever is the higher), although liability for death, personal injury and fraud is uncapped. This cap on liability for breach and negligence applies to both emerging costs and fixed price agreements. However, subject to the usual qualifications, in the case of fixed price implementation arrangements, there would be no cap in respect of our obligation to deliver the works or services for the agreed fixed price.

Industry Risk Fee

The Industry Risk Fee (IRF) provides appropriate funding support for industry risks. Typically these are the low probability, high impact risks specific to rail industry conditions. For each agreement type we charge an IRF as indicated in Table 1 below. Again, we pool these Industry Risk Fees to meet relevant industry risk claims when they arise.

The IRF covers two broad categories of risk for the promoter:

1. risks which are typically regarded as 'employer' or 'government' risks in a traditional project financing or Private Finance Incentive (PFI) transaction (for example, mandatory changes resulting from a change in the law peculiar to the rail industry, or changes to railway safety standards); and
2. risks relating to events arising elsewhere on the network which have an impact on:
    - the project which results in disruption to the works (for example, a late running disruption caused by a safety critical event), and
    - the network itself where, due to the project's existence, that impact is greater than it would otherwise be.

In the event of a liability arising from an industry risk where the resultant costs are more than £10k, these costs would fall to the IRF and not to the promoter.

Relief Events

The contractor, whether they're appointed by us or by you, will be reimbursed for the increased costs (excluding indirect costs) reasonably and properly incurred as a result of a Relief Event which causes delay or disruption to a project.

The categories of Relief Event are:

- network operation issues;
- cancellation and alteration of possessions due to events outside the control of the project team; and
- the impact of interfacing projects.

The contractor has the usual duty to mitigate such costs to give an incentive for appropriate behavior but the balance of liability will fall to us, and we will recover any compensation we pay from the IRF.

This assumes that in each case neither Network Rail, the promoter nor the contractor is at fault.

Mandatory Variations

After approval of the works at GRIP Stage 4, if the works need to be varied as a result of any change in law or legal requirement expressly applying to the railway industry or the railway works, or as a result of changes railway safety standards, such costs would fall to us, and we will recover any compensation we pay from the IRF.

Network, Station or Depot Change

You will need to pay for costs associated with any network, station or depot change, or any closure processes. This cost can be uncertain and an estimate of the value may be made and a cap agreed. If so, your liability for costs above this limit would be treated as an industry risk.

Land and Noise Claims

Claims made against us at common law or pursuant to the Land Compensation Act 1973 or any regulation made pursuant to that Act which is attributable to the design, carrying out, completion, operation or existence of any works which become a Network Rail asset.

These claims are in respect of nuisance and the diminution of property values due to the implementation of the scheme. Whilst this is a promoter risk, where an estimate of the value has been made and a cap agreed, your liability for costs above this limit would be treated as an industry risk.

Bankruptcy/Insolvency of promoter

Irrespective of the diligence applied to assess creditworthiness of the promoter and steps taken to obtain surety, there's always a possibility of insolvency or bankruptcy. In this event, particularly where the scheme is under way, the cost of termination or completion may require some additional funding above any surety. Given that by definition the promoter would be unable to pay such costs in full, and that such funding was not part of the original cost forecast, the funding shortfall would be funded through the IRF.

Table 1

Type of agreement	Network Rail Fee	Industry Risk Fee
Basic Services Agreement (BSA)	Fee is equal to 5% of the aggregate of the agency costs, consultants' and contractors' costs and personnel costs, as estimated at the scheme commencement date.	Not Applicable
Development services agreement	Fee is equal to 5% of the aggregate of the agency costs, consultants' and contractors' costs and personnel costs, as estimated at the scheme commencement date.	Fee is equal to 2% of the project cost, which is the estimated total cost of the project up to the completion of the current stage of development contracted for.
Basic implementation agreement (emerging cost)	Fee is equal to 5% of the aggregate of the agency costs, consultants' and contractors' costs and personnel costs, as estimated at the scheme commencement date.	Fee is equal to 2% of the aggregate of the agency costs, consultant's and contractors' costs and personnel costs.
Implementation agreement (emerging cost)	Fee is equal to 5% of the aggregate of the agency costs, consultants' and contractors' costs and personnel costs, as estimated at the scheme commencement date.	Fee is equal to 2% of the aggregate of the agency costs, consultant's and contractors' costs and personnel costs.
Basic implementation agreement (fixed price)	Fee is equal to 13% of the aggregate of the agency costs, consultants' and contractors' costs, personnel costs and QRA (risk assessment for any variation undertaken at a P50 probability in respect of the risks owned by Network Rail or capped to the promoter), as estimated at the scheme commencement date.	Fee is equal to 2% of the aggregate of the agency costs, consultants' and contractors' costs, personnel costs and QRA (risk assessment for any variation undertaken at a P50 probability in respect of the risks owned by Network Rail or capped to the promoter).
Implementation agreement (fixed price)	Fee is equal to 13% of the aggregate of the agency costs, consultants' and contractors' costs, personnel costs and QRA (risk assessment for any variation undertaken at a P50 probability in respect of the risks owned by Network Rail or capped to the promoter), as estimated at the scheme commencement date.	Fee is equal to 2% of the aggregate of the agency costs, consultants' and contractors' costs, personnel costs and QRA (risk assessment for any variation undertaken at a P50 probability in respect of the risks owned by Network Rail or capped to the promoter).
Asset protection agreement (including basic)	Fee is equal to 10% of the aggregate agency costs, consultants' and contractors' costs and personnel costs, as estimated at the scheme commencement date.	Fee is 2% of the total estimated costs of the project up to its completion, including construction costs, contractors' costs, regulated change costs and Network Rail costs.

Appendix H: Regulated Change Processes

The Network Change process

Before undertaking any proposed changes to the rail network, Network Rail (or a train operator if they are sponsoring the change) must follow the Network Change consultation process. This is a formal process which allows a proposer to seek agreement from all affected parties that the change may go ahead, and to agree what compensation (if any) will be paid to cover the impact of the change.

A Network Change must take place on a piece of the network that we own and can be either:

- Physical – like carrying out a piece of enhancement work on the infrastructure; or
- Operational – like a change to the permitted speed on a line which will last for more than six months.

In both physical and operational cases, the change must materially affect the network's operation or the operation of trains on the network to be a formal Network Change. This materiality test is a subjective test which varies in different circumstances. When confronted with the question on whether it is a material change or not, ask yourself if the change will mean that the train driver will do something different. If so, it might be a Network Change.

Only Access Parties (parties with a Track Access Contract) can propose a Network Change. If a third party wishes to do so, they must secure the agreement of an Access Party (Network Rail or a train operator) to sponsor the change. In our case, we'll always need an Asset Protection Agreement with the proposing party and, through the Asset Protection Agreement, Network Rail will normally seek reimbursement for the compensation costs that Network Rail will need to pay any Access Beneficiary as a result of the work that a sponsor will do on our network.

We set out the consultation process in Part G of the Network Code but before the formal consultation, we advise the sponsor to carry out an informal consultation with anyone who might be affected by the proposed change. This is important so there are 'no surprises' when the formal consultation period begins.

Formal consultees are:

- any Access Beneficiary (including freight and passenger operators) affected by the proposed change;
- DfT;
- ORR;
- each passenger transport executive that may be affected by the proposed change;
- Transport for London if it is affected by the proposed change; and
- Transport Scotland if it is affected by the proposed change.

The sponsor must then produce a formal Network Change notice which we will distribute to each consultee.

We'll then put a summary of the notice on our website, along with the formal responses we receive.

The Network Code specifies that for changes we propose, consultees must have a minimum of 30 days to respond. For changes proposed by an Access Beneficiary, this must be a minimum of 60 days. However, we might extend these deadlines for large, complex or far-reaching proposals.

If the project is complex and involves changes to the network or consequential changes to vehicles, then the complex procedure could be used.

When responding to a proposed Network Change, only Access Parties are entitled to accept or reject the change and, if applicable, claim compensation (see below).

Non-Access Party consultees like Passenger Transport Executives can only comment on the proposal, although they can refer any disputes to the ORR for determination.

Reasons for rejection include:

- there is inadequate information about the proposal;
- the proposed change would breach an access contract between Network Rail and an operator;
- implementing the change would result in a material deterioration in the performance of a train operator's service which they couldn't be adequately compensated for
- the proposed change does not consider the Access Beneficiary's reasonable expectations for future use of the relevant part of the network; and
- a change proposed by a train operator may also be rejected if it would result in an adverse effect on the maintenance or operation of the network.

Alternatively, Access Parties may accept the change.

In either case, Access Parties can claim compensation to cover the consequences of the proposed change.

Such compensation should be:

> *'an amount equal to the amount of the costs, direct losses and expenses (including loss of revenue) which can reasonably be expected to be incurred…' (Condition G2.2) taking into account any 'benefit (if any) to be obtained or likely in the future to be obtained' (Condition G2.3).*

However, please note that, compensation for disruptive possessions is paid according to Schedule 4 of the Track Access Contract.

It is the sponsoring party's responsibility to work through any issues raised during the consultation process so there are no outstanding objections. If this means changing the network change proposal, this must be formally advised to all consultees, who must be given adequate opportunity to consider the revision and provide any comments, rejections or acceptances.

The Network Change proposal may only be implemented if:

- there are no outstanding objections; and
- the parties have agreed either the compensation payable, or agreed on the methodology for determining the amount.

Upon approval we will write to all consultees and publish the change on our website. We are then either entitled or required (according to whether the change was proposed by us or a train operator) to implement the Network Change.

Any Access Party involved in a Network Change consultation is entitled to refer an unresolved disagreement to the access disputes panel under the specific rules in Part G and in the access dispute resolution rules (in the annex to the Network Code). There is a further right of appeal to the ORR if any party to an access dispute panel dispute is dissatisfied by the determination. Such an appeal should adhere to the rules in part M of the Network Code.

Station change

The station change procedure is for when a development entails changes to a station lease area, physical or operational changes to a station, or changes that affect the content or drafting of Station Access Conditions and Annexes.

This is a procedure governed by the regulated 'station access conditions' for each station. At franchised stations the conditions are part of the station leases granted by Network Rail, and in the access arrangements between the train operator tenant and other train operators who use the station. At stations we manage the arrangements

apply directly between us and the station users via the access agreements which also bind the user into the managed station access conditions.

Under the station change procedure, a change proposal can be promoted by us, by any train operator or by a third party where they are investing over £50,000 capital expenditure on the enhancement or alteration of the station in connection with related schemes of development or regeneration. A third party's right to promote a station change was introduced in the revised station access conditions issued by ORR in November 2013. The procedure involves consultation by the party promoting the change with the other station users, and generally also the DFT or TS, and the ORR. This type of station change is always a Material Change proposal.

If changes are to be made to a station, the regulatory requirements are satisfied by making a Station Change Proposal, securing approval of all relevant parties and registering the approved change with the ORR. For a detailed definition of a 'Change' please see the National Station Access Conditions 2013. The specific definition is found on page 6 in the Definitions section. For Managed Stations refer to the Independent Station Access Conditions 2013 - Page 7 .

The National Station Access Conditions 2013 (NSACs) and Independent Access Conditions 2013 (ISACs) also introduced new types of station change proposal where the type of Change Proposal required is determined by the nature of the physical works and/or by the materiality of the impact of the Change Proposal on the operators at the Station. There are three types of Station Change: Non-Discretionary Change, Notifiable Change and Material Change. There is also a specific definition of Exempt Activity that does not require a Station Change. For a definition of each type of Change Proposal refer to the National Station Access Conditions 2013 for franchised stations. The definitions of each type of change can be found on pages 17 – 19 and the change procedures are contained within Parts B and C of the National Station Access Conditions. For Managed Stations see the Independent Station Access Conditions 2013. The definition of each type of change is on pages 16 – 19 and the change procedures are contained within Parts 2 & 3.

The selection of the correct type of Change Proposal is important for the change proposer as it has cost and time implications for the project - payment of costs and compensation to affected parties may be required but is not a requirement of all types of Station Change Proposal. Additionally, consultees may challenge the type of change proposal put forward if they disagree and this can cause project delays in resolving the dispute and potentially issuing a new change proposal as a different type of change.

Projects involving extensive physical works will usually fall within the definition of a Material Change Proposal and all station change proposals promoted by third parties must be issued as Material Change proposals. Under a Material Change Proposal, consultees will either be qualifying or non-qualifying consultees, depending upon the financial impact upon them of the Change Proposal. Under this type of change, all qualifying consultees must approve the proposal and the proposer is required to offer to enter into a templated Cooperation Agreement with each qualifying consultee. The Cooperation Agreement sets out how the parties will co-operate during the project and includes a financial undertaking from the promoter of the Change dealing with the payment of compensation to each qualifying consultee to cover the net costs and losses they will incur as a direct result of the change proposal.

Additionally, the proposer of a Material Change must provide a Relevant Undertaking to all qualifying consultees which provides the detail of the indemnity and/or insurance it is putting in place to ensure appropriate compensation is available to cover any costs or losses incurred if the development is not implemented in accordance with the terms of the original Material Change Proposal.

In the circumstances where Network Rail agree to issue the Station Change Proposal on behalf of a promoter, the indemnity costs arising from the Financial Undertaking within the Co-Operation Agreement and from the Relevant Undertaking need to be built in to the business case for the proposal. In cases where Network Rail agree to promote the change on behalf of a promoter who otherwise qualifies to promote the change in their own right, Network Rail will recover all associated costs and compensation payments incurred as a direct result of promoting the change from the promoter.

Station Changes require the approval of the ORR where consequential amendments are required to the station

access agreements with users of the station, or, where the change proposal is likely to materially diminish the number of passengers or trains that are able to use the station for a period in excess of 28 days. However, ORR approval is not required where the change proposal falls within one of the general approvals, which are pre-approved amendments to a station, for example, adding facilities to station amenities. Where the general approvals don't apply, a specific approval will be needed. This requires the station change promoter to approach the ORR for specific approval. For more information see General Approval (Stations) 2013.

All types of station change, once approved by consultees, must be registered with and, where falling outside of the general approvals, be approved by the ORR in advance of any works starting, or the station change will lapse and no longer be valid, requiring a new change proposal to be circulated and approved.

For further information on the station change procedures please refer to ORR Template Documentation

Depot change (Light Maintenance Depots)

The procedure for depot change was not updated in 2013 by the ORR but does have some similarities to the station change procedure

Depot change is required when a development entails changes to a depot lease area or physical or operational changes to a light maintenance depot or changes that affect the content or drafting of Depot Access Conditions and Annexes.

The depot change procedure is governed by the regulated 'depot access conditions' for each light maintenance depot which form part of the depot leases granted by Network Rail, and in the access arrangements between the depot operator tenant and other passenger service operators who use the depot.

Under the depot change procedure, a change proposal can be promoted by Network Rail, or by the Depot Facility Owner, or any User at that Depot. At the moment, third parties can't promote such proposals. The procedure involves consultation by the party promoting the change with the other depot users, and generally also the DFT or TS, and the ORR.

A proposal for change to a depot must be sent to the Depot Facility Owner to distribute to the consultees; being all users of the depot, Network Rail and the DfT/Transport Scotland as franchising authority. A minimum period of 45 days is given for the users and Network Rail to submit an objection in relation to the proposal. A change proposal is deemed to have been accepted at the expiry of the 45 days period if none of the users nor Network Rail have issued an objection. DfT/Transport Scotland is a consultee but it does not have to give consent under the depot change procedure.

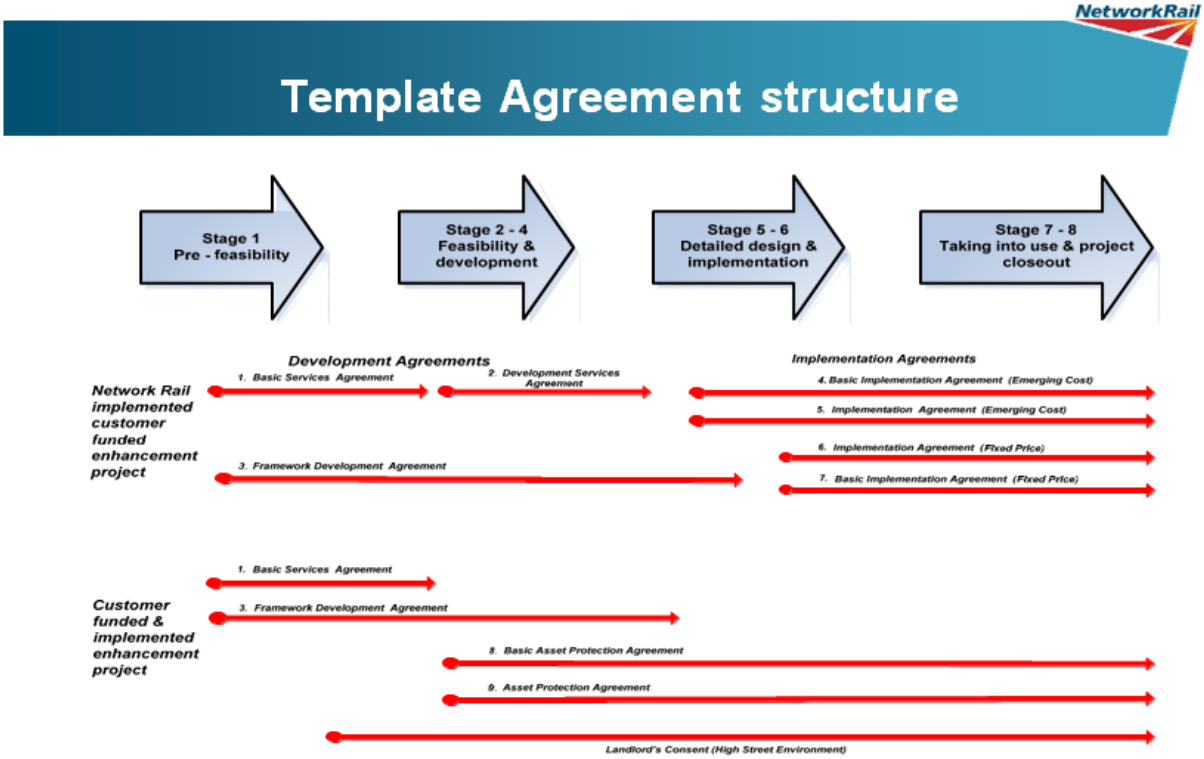
Depot Changes require the approval of the ORR where consequential amendments are required to the depot access agreements with users of the depot, or, where the change proposal is likely to materially and adversely affect the capacity of the depot in relation to the provision of light maintenance services for a period longer than 28 days. However, ORR approval is not required where the change proposal falls within one of the general approvals, which are pre-approved amendments to depots and the contractual documentation. Where the general approvals do not apply, a specific approval will be needed. This requires the Depot Facility Owner to approach the ORR for specific approval. For more information see General Approval (Depots) 2013.

Most Network Rail promoted change proposals need unanimous consent or lack of objection from users. Additionally Network Rail is required to offer an indemnity to each "Relevant Operator" offering to compensate for the material adverse effect on their existing and future business. Such indemnity costs need to be built in to the business case for the proposal.

For further information on all of the above refer to the Network Code and particularly Part G of the code at:

http://orr.gov.uk/rail/access-to-the-network/the-network-code

Appendix I: Template Agreement Structure



This flow chart illustrates the correct agreement to use depending on the specifics requirements of the promoter and the stage in the lifecycle of the project.