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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 3: Route-wide effects

M32

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Department for Transport

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Contents

Tables

Figures

Preface

The Environmental Statement

This document is Volume 3 of the Environmental Statement (ES) that accompanies the deposit of the hybrid Bill for the High Speed Rail (Crewe – Manchester) hybrid Bill (hereafter referred to as the Bill). This Bill would authorise:

- the Phase 2b Western Leg, which comprises the section of the proposed High Speed Two (HS2) rail network from Crewe to Manchester, with connections onto the West Coast Main Line;
- a number of works that are required beyond the route, such as to the existing conventional rail network, to enable the operation of the Western Leg; and
- provision for future Northern Powerhouse Rail services to connect with HS2.

Collectively, these are referred to in this ES as 'the Proposed Scheme'. The ES describes the Proposed Scheme and reports its likely significant environmental effects and the measures proposed to mitigate adverse effects.

The hybrid Bill for Phase One of the HS2 network, between London and the West Midlands, was the subject of an ES deposited in November 2013. The Phase One hybrid Bill received Royal Assent in February 2017. The main works on Phase One commenced in April 2020.

The hybrid Bill for Phase 2a of the HS2 network, between the West Midlands and Crewe, was the subject of an ES deposited in July 2017. The Phase 2a Bill received Royal Assent in February 2021.

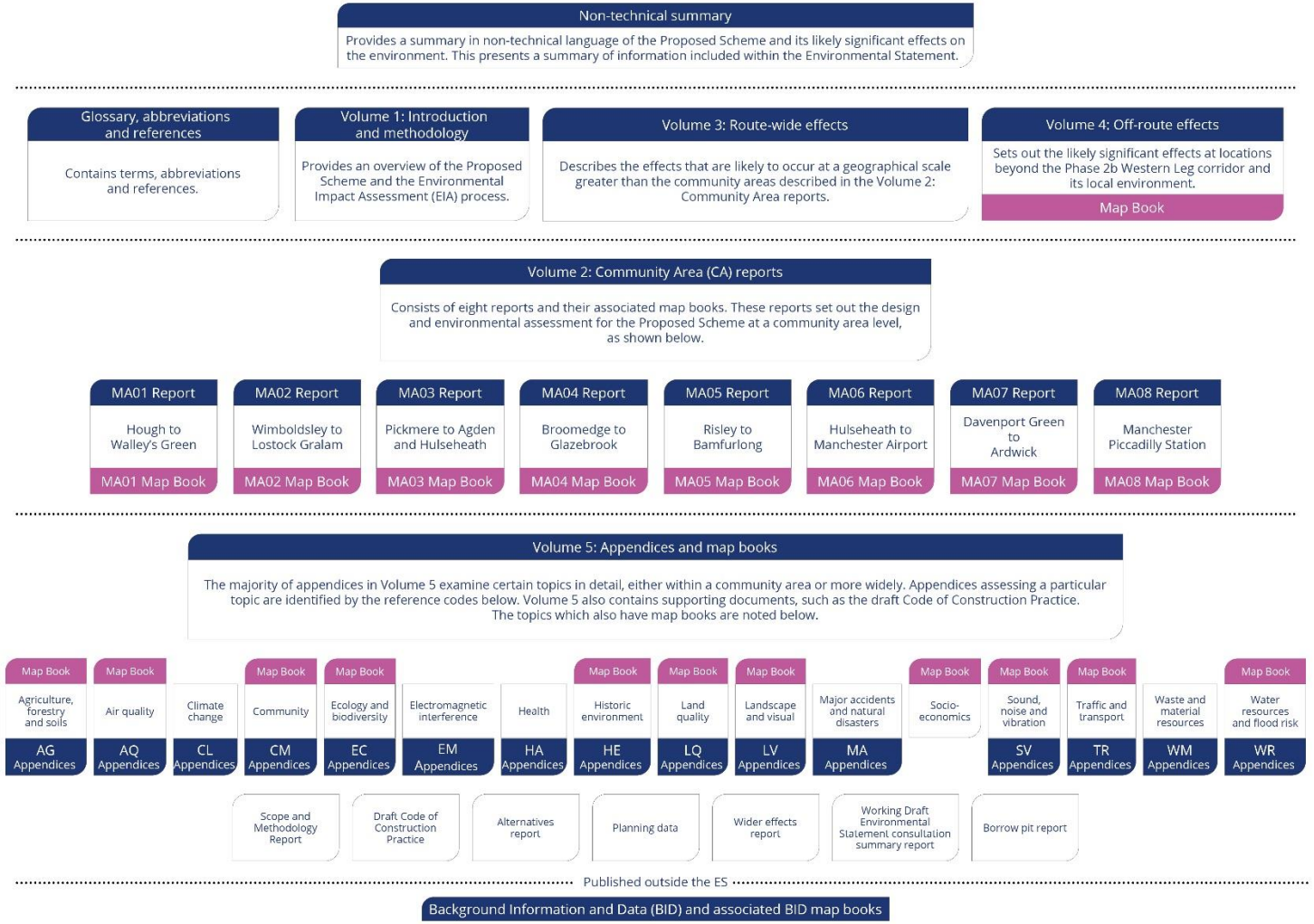
Consultation on the Environmental Statement

The public has an opportunity to comment on this ES which accompanies the deposit of the Bill. The period of public consultation on the ES extends for at least 56 days (eight weeks) after the first newspaper notices that follow deposit of Bill documents in Parliament.

Structure of the Environmental Statement

This report is part of the suite of documents that make up the ES for the Proposed Scheme. The structure of the ES is shown in Figure 1 and described in more detail in Volume 1. The ES has been prepared by persons who have sufficient expertise to ensure the completeness and technical quality of the statement.

Figure 1: Structure of the Environmental Statement



1 Introduction

1.1 Overview of High Speed Two

1.1.1 High Speed Two (HS2) is a new high speed railway proposed by the Government to connect major cities in Britain. It will transform intercity and long distance passenger rail travel in the UK, providing the first major increase in intercity rail capacity for over a century and freeing up substantial capacity for rail travel and freight on the conventional rail network. London, Birmingham, Manchester and cities in the Midlands, the North and Scotland will be served by high speed trains running at speeds of up to 360 kilometres per hour (kph) (225 miles per hour (mph)) on HS2 lines and on the existing conventional rail network. As part of the Proposed Scheme, new stations will be built at Manchester Piccadilly and Manchester Airport, in addition to the new stations in London and the West Midlands included in HS2 Phase One.

1.2 Purpose of this report

1.2.1 This volume of the ES presents the likely significant effects of the construction and operation of the Proposed Scheme on the environment that have been identified on a route-wide basis. The report also describes the means to avoid, prevent, reduce or compensate for the likely significant adverse route-wide effects of the Proposed Scheme on the environment, along with any proposed monitoring measures.

1.2.2 The Proposed Scheme has been the subject of an environmental impact assessment (EIA). During the development of the Phase 2b proposals, a working draft ES was consulted on to help inform the design and assessment of the Proposed Scheme (comprising the Western and Eastern legs of Phase 2b at that stage). The findings of the assessment of the Proposed Scheme (Phase 2b Western Leg), are reported in an Environmental Statement (the ES)

1.2.3 This report should be read in conjunction with the Volume 2, Community Area reports and their corresponding map books. This report presents the route-wide effects for each environmental topic reported in the Volume 2, Community Area reports, and four additional sections describing the effects relating to climate change, major accidents and disasters, waste and material resources and electromagnetic interference. The community area reports present the elements of the Proposed Scheme. They also identify the likely significant environmental effects of the construction and operation of the Proposed Scheme, as well as any proposed monitoring and mitigation measures, as appropriate to the respective area of study. Volume 1, Section 9, also sets out the general approach to environmental monitoring during construction and operation of the Proposed Scheme for each environmental topic. Only additional monitoring above what is reported in Volume 1,

Section 9, is reported in this report. The draft Code of Construction Practice (CoCP)[1] includes commitments to monitoring of significant effects during construction.

1.2.4 An assessment of potential environmental effects beyond the Phase 2b route corridor and its associated local environment has also been undertaken and this 'off-route' assessment is reported in Volume 4, Off-route effects and its corresponding map book.

1.3 Scope of this report

1.3.1 The effects reported in this volume are those considered to be appropriately assessed at a geographical scale greater than that presented within the Volume 2, Community Area reports and Volume 4, Off-route effects. These include:

- overall effects on the agricultural, forestry and soil resource;
- overall effects relating to climate change;
- effects on ecological resources of greater than local importance and on protected species;
- route-wide effects on health;
- landscape and visual effects where there is the potential for these to occur at a geographical scale greater than the community areas;
- effects that could result from major accidents and disasters;
- overall socio-economic effects;
- route-wide traffic and transport effects;
- effects associated with the off-site disposal to landfill of solid waste during construction and operation;
- route-wide effects on water resources and on flood risk; and
- the risk of electromagnetic interference (EMI) at potentially sensitive receptors along the route of the Proposed Scheme.

1.3.2 Certain environmental topics are less likely to report significant route-wide effects (i.e. air quality, community, historic environment, land quality, and sound, noise and vibration). Where there are not considered to be significant route-wide effects, the environmental topic is introduced and reasons for this conclusion are presented. The report concludes with a section summarising the potential combined impacts of Phase One, Phase 2a and the Proposed Scheme.

1.3.3 Given that each environmental topic assesses effects in a way appropriate to that topic, the approach to route-wide effects varies between topics. The extent and basis of the route-wide assessment presented in this report is, therefore, explained in each of the topic sections. The scope of each topic and the general approach to assessment for this ES is described in

[1] Volume 5: Appendix CT-002-00000, draft Code of Construction Practice (CoCP).

Volume 1, Introduction and methodology and the Phase 2b EIA Scope and Methodology Report (SMR)[2].

[2] Volume 5: Appendix CT-001-00001, Environmental Impact Assessment Scope and Methodology Report.

2 Agriculture, forestry and soils

2.1 Introduction

2.1.1 This section provides an assessment of the route-wide impacts and likely significant effects on agriculture, forestry and soils arising from the construction and operation of the Proposed Scheme. The impacts and likely significant effects on individual farm holdings are reported in the Volume 2, Community Area reports, and where appropriate, Volume 4, Off-route effects.

2.1.2 At a national level, paragraph 170 of the National Planning Policy Framework (NPPF)[3] states that planning policies and decisions should contribute to and enhance the natural and local environment by protecting and enhancing soils, valued landscapes and geological conservation interests. It goes on to state that new and existing development should not contribute to unacceptable levels of soil pollution or other pollution.

2.1.3 Paragraph 170 of the NPPF also advises that the economic and other benefits of the best and most versatile (BMV) agricultural land (Grades 1, 2 and 3a in the Agricultural Land Classification (ALC) system), and of trees and woodland should be taken into account in development decisions. In the footnote to paragraph 171 the NPPF states that where significant development of agricultural land is demonstrated to be necessary, poorer quality land should be used in preference to higher quality land.

2.1.4 In Scotland, the National Planning Framework[4] and Scottish Planning Policy[5] set out the government planning vision and recognise the importance of soil as a physical asset which should be respected, enhanced and made responsible use of. Paragraph 80 of Scottish Planning Policy states that development of prime agricultural land, or land of lesser quality, which is locally important, should not be permitted except where it is essential. Land quality is assessed using the Land Capability Classification for Agriculture in Scotland developed by the James Hutton Institute. Classes 1, 2 and 3.1 are classed as prime agricultural land.

[3] Ministry of Housing, Communities and Local Government (2019), *National Planning Policy Framework*. Available online at: https://www.gov.uk/government/publications/national-planning-policy-framework--2.

[4] Scottish Government (2014), *National Planning Framework 3*. Available online at: https://www.gov.scot/publications/national-planning-framework-3/.

[5] Scottish Government (2014), *Scottish Planning Policy*. Available online at: https://www.gov.scot/publications/scottish-planning-policy/.

2.1.5 As reported in the Phase Two Sustainability Statement 2013[6] and the updated Sustainability Report 2016[7], efforts have been made during the route development and Appraisal of Sustainability process to select a route alignment that avoids the highest quality agricultural land. However, this has not always been possible given the need to satisfy or balance a number of other important environmental and engineering considerations.

2.2 Scope, assumptions and limitations

2.2.1 The study area for the agriculture, forestry and soils assessment covers all land within a 200m-wide corridor centred on the centre line of the route. The resources and receptors that are assessed across the Proposed Scheme are agricultural land, commercial forestry land and soils.

2.2.2 The quality of agricultural land in England and Wales is assessed according to the ALC system, which classifies agricultural land into five grades from excellent quality Grade 1 land to very poor quality Grade 5 land. Grade 3 is subdivided into Subgrades 3a and 3b. The main issue in the assessment of the impacts on agricultural land is the extent to which land of BMV agricultural quality (Grades 1, 2 and 3a) is affected by the Proposed Scheme. However, the extent to which all land (BMV and lower quality ALC) is affected is also an important consideration. Adopting the route-wide level methodology set out in the EIA Scope and Methodology Report (SMR)[2], the proportion of each grade of agricultural land required for the Proposed Scheme is compared to national estimates of each grade of land as a measure of the significance of effect on the national resource of agricultural land.

2.2.3 Land quality in Scotland is assessed using the Land Capability Classification for Agriculture in Scotland system. It is used for ranking land on the basis of its potential productivity and cropping flexibility and is a seven class system. Four of these classes are subdivided into divisions. Class 1 is land with the highest potential flexibility, and Class 7 land is of very limited agricultural value[8]. Classes 1, 2 and 3.1 are classed as prime agricultural land.

2.2.4 Soil fulfils a number of functions and services for society in addition to those of food and biomass production, which are central to social, economic and environmental sustainability. These are outlined in sources such as the Soil Strategy for England[9] and the Government's

[6] Temple-ERM (2013), *Sustainability Statement - Volume 1: main report of the Appraisal of Sustainability.* Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/401154/pc205_vol_1_sustainability_statement_180713.pdf.

[7] Temple-RSK (2016), *High Speed Rail: Phase 2b Preferred Route - Sustainability Statement including Post Consultation Update*. Available online at: https://www.gov.uk/government/publications/hs2-phase-2b-sustainability-statement-2016.

[8] James Hutton Institute, *Land Capability for Agriculture in Scotland*. Available online at: https://www.hutton.ac.uk/learning/exploringscotland/land-capability-agriculture-scotland.

[9] Department for Environment, Food and Rural Affairs (2009), *Soil Strategy for England.* Available online at: https://www.gov.uk/government/publications/safeguarding-our-soils-a-strategy-for-england.

White Paper, The Natural Choice: securing the value of nature[10] and the importance of soil health is reinforced in the policies set out in the 25 year Environment Plan[11]. They include:

- the storage, filtration and transformation of water, carbon and nitrogen in the biosphere;
- the support of ecological habitats, biodiversity and gene pools;
- support for the landscape;
- the protection of the historic environment;
- the provision of raw materials; and
- the provision of a platform for human activities, such as construction and recreation.

2.2.5 The significance of effect on soils is a result of the magnitude of impact on the soil resource (the degree to which disturbed soil resources are reused as part of the Proposed Scheme and, if necessary, on other projects in a manner that enables the resource to continue to fulfil one or more of the primary soil functions) and the soil's susceptibility to the impacts of handling during construction and the re-instatement of land.

2.2.6 The assessment of forestry in this section relates to land being used for commercial forestry. Commercial forestry is considered as a commercial land use feature, providing resources such as timber or fuel. The qualitative effects on forestry land and woodland are addressed principally in Section 6, Ecology and biodiversity of this report. The resulting function or service provided by soil attributes are assessed in other sections, notably Section 7, Ecology and biodiversity; Section 8, Historic environment; and Section 16, Water resources and flood risk of this report.

2.2.7 Assumptions that have been used in assessing the effects of the Proposed Scheme are set out in Volume 1, Section 8. These assumptions include the restoration of agricultural use, and the handing back of land used temporarily to the original landowner. It is assumed that buildings and other farm infrastructure on the land holding would not be replaced as this will ultimately be at the discretion of the landowner. For this reason, financial compensation is not a consideration in the assessment of effects on farm holdings.

2.3 Environmental baseline

2.3.1 The majority of land within the study area is rural with the main exceptions being near Crewe, and in Manchester. Within the study area of the Proposed Scheme, farm holdings are dominated by large dairy and arable farms and smaller, urban fringe holdings are characterised by equestrian uses.

[10] HM Government (2011), *The Natural Choice: securing the value of nature*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/228842/8082.pdf.

[11] Department for Environment, Food and Rural Affairs (2018), *A Green Future: Our 25 Year Plan to Improve the Environment.* Available online at: https://www.gov.uk/government/publications/25-year-environment-plan.

2.3.2 Detailed soil profile characteristics have been acquired from both publicly available sources and the site surveys undertaken. The distribution of agricultural land in the different grades is shown in Table 1 and Table 2.

2.3.3 Table 1

Table 1: Distribution of grades of agricultural land in the study area in England

Agricultural land quality	Area within study area (ha)	Percentage of agricultural land area within study area
Grade 1	50.5	2.5
Grade 2	260.8	13.1
Subgrade 3a	545.0	27.3
BMV subtotal	**856.3**	**42.9**
Subgrade 3b	911.6	45.7
Grade 4	227.5	11.4
Grade 5	0	0
Total agricultural land	**1,995.4**	**100**

Table 2: Distribution of grades of agricultural land in the study area in Scotland

Agricultural land capability	Area within study area (ha)	Percentage of agricultural land area within study area
Class 1	-	-
Class 2	-	-
Class 3.1	19.8	17.5
Prime agricultural land	**19.8**	**17.5**
Class 3.2	41.2	36.5
Class 4.1	6.8	6
Class 4.2	16.2	14.4
Class 5.1	-	-
Class 5.2	28.4	25.2
Class 5.3	-	-
Class 6.1	-	-
Class 6.2	0.5	0.4
Class 6.3	-	-
Class 7	-	-
Total agricultural land	**112.9**	**100**

2.3.4 At a route-wide level, soils provide additional functions and services for society in addition to those of food and biomass production. The key functions for soil route-wide are as water stores for flood attenuation and the provision of ecological habitats. Peat has a higher organic matter content than other soils and represents a large reservoir of organic carbon. Peat is present within the study area to the west of Manchester.

2.3.5 The sensitivity of the soils disturbed by construction activity reflects their susceptibility to the impacts of handling during construction and the re-instatement of land. The sensitivity of

soils within the study area, acquired from both publicly available sources and the site surveys undertaken, is set out in Table 3, which shows that the majority of soil in the study area is of high sensitivity.

Table 3: Route-wide soil sensitivity (England and Scotland)

Soil sensitivity	Area within study area (ha)	Percentage of agricultural land area within study area
High sensitivity - Soils with high clay and silt fractions (clays, silty clays, sandy clays, heavy silty clay loams and heavy clay loams) and organic and peaty soils where Field Capacity Days (FCD) are 150 or greater. Medium textured soils (silt loam, medium silty clay loam, medium clay loam and sandy clay loam) where FCD are 225 or greater.	1,170.9	55.5
Medium sensitivity - Soils with a high clay and silt fraction (clay, silty clay, sandy clay, heavy silty clay loam and heavy clay loam) and organic and peaty soils where FCD are fewer than 150. Medium textured soils (silt loam, medium silty clay loam, medium clay loam, sandy clay loam) where FCD are fewer than 225. Soils with a high sand fraction (sands, loamy sands, sandy loams and sandy silt loams) where FCD are 225 or greater.	718	34.1
Low sensitivity - Soils with a high sand fraction (sands, loamy sands, sandy loams and sandy silt loams) where FCD are fewer than 225.	219	10.4

2.3.6 There is no commercial forestry land within the study area nor within a 4km reference area along the route of the Proposed Scheme.

2.4 Avoidance and mitigation measures

2.4.1 Soil resources from the areas required temporarily and permanently for the Proposed Scheme will be stripped and stored in line with good practice techniques. This will enable agricultural land that is required temporarily for construction to be returned to agricultural use, the design objective being to avoid any reduction in long term capability, which would downgrade the quality of agricultural land. This will also enable agricultural land to be converted to other uses where required by the Proposed Scheme, such as to support landscape planting and biodiversity, and to a suitable condition whereby they will be able to fulfil the identified function.

2.5 Assessment of effects during and following construction

Temporary effects

2.5.1 In England, the total area of agricultural land required temporarily during the construction of the Proposed Scheme, will amount to approximately 1,995ha, of which approximately 856ha (43%) will be BMV agricultural land. Approximately 1,140ha (57%) will be poorer quality agricultural land. Of this total, it is anticipated that approximately 1,068ha will be restored and available for agricultural use following construction as shown in Table 4.

Table 4: Agricultural land required for the construction of the Proposed Scheme in England

Agricultural land quality	Area required (ha)	Percentage of agricultural land (%)	Area to be restored (ha)
Grade 1	50.5	2.5	23.1
Grade 2	260.8	13.1	178.1
Subgrade 3a	545.0	27.3	344.6
BMV subtotal	**856.3**	**42.9**	**545.7**
Subgrade 3b	911.6	45.7	436.4
Grade 4	227.5	11.4	86.1
Grade 5	0	0	0
Total	**1,995.4**	**100.0**	**1,068.2**

2.5.2 BMV land is a receptor of medium sensitivity nationally, as 43% of farmland in England is estimated to be BMV. The disturbance during construction to approximately 856ha of BMV land is assessed as an impact of medium magnitude, as BMV land makes up 43% of the agricultural land requirement. The effect of the Proposed Scheme on BMV land during the construction phase in England is therefore assessed as moderate, which is significant.

2.5.3 In Scotland, the total area of agricultural land required temporarily during the construction of the Proposed Scheme, will amount to approximately 113ha, of which approximately 20ha (18%) will be prime agricultural land. Approximately 93ha (82%) will be poorer quality agricultural land. Of this total, it is anticipated that approximately 76ha will be restored and available for agricultural use following construction as shown in Table 5.

Table 5: Agricultural land required for the construction of the Proposed Scheme in Scotland

Agricultural land quality	Area required (ha)	Percentage of agricultural land (%)	Area to be restored (ha)
Class 1	-	-	-
Class 2	-	-	-
Class 3.1	19.8	17.6	14.2
Prime agricultural land	**19.8**	**17.6**	**14.2**
Class 3.2	41.2	36.5	27.5
Class 4.1	6.8	6	4.9

Agricultural land quality	Area required (ha)	Percentage of agricultural land (%)	Area to be restored (ha)
Class 4.2	16.2	14.4	8.3
Class 5.1	-	-	-
Class 5.2	28.4	25.2	20.4
Class 5.3	-	-	-
Class 6.1	-	-	-
Class 6.2	0.5	0.4	0.5
Class 6.3	-	-	-
Class 7	-	-	-
Total	**112.8**	**100**	**75.8**

2.5.4 The disturbance during construction to approximately 20ha of prime agricultural land comprising 18% of the agricultural land requirement, is assessed as an impact of low magnitude. Prime agricultural land is assessed as a receptor of medium sensitivity because of its moderate abundance in this locality. The effect of the Proposed Scheme on prime agricultural land during the construction phase in Scotland is, therefore, assessed as minor adverse, which is not significant.

2.5.5 On completion of construction, temporary facilities will be removed and the topsoil and subsoil reinstated in accordance with the agreed end use for the land. Some permanently displaced soils may be used to restore land to agriculture or other uses with slightly deeper topsoil and subsoil layers, where appropriate. This could improve the quality of agricultural land locally, for example where droughty soils are limited by soil depth, subject to the soil resource plans to be prepared during the detailed design stage.

2.5.6 Successful soil handling is dependent upon movements being undertaken under appropriate conditions and using appropriate equipment. The principles of soil handling are well established and set out in advisory material such as the Department for Environment, Food and Rural Affairs (Defra) Code of Practice for the Sustainable Use of Soils[12]. These principles will be followed throughout the construction period, as set out in the draft Code of Construction Practice, and will ensure the magnitude of impact on soil will be negligible (meaning that soil retains its pre-existing functions on-site) and the effect will not be significant irrespective of the soil's susceptibility to the effects of handling during construction and re-instatement of the land.

2.5.7 The total area for agricultural land required for the construction of the Proposed Scheme in England and Scotland are shown in Table 6.

[12] Department for Environment, Food and Rural Affairs (2009), *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.* Available online at: https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites.

Table 6: Agricultural land required for the construction of the Proposed Scheme in England and Scotland

Country	Area required (ha)	Area to be restored (ha)
England	1,995.4	1,068.2
Scotland	112.8	75.8
Total	**2,108.2**	**1,144**

Permanent effects

2.5.8 In England, the area of agricultural land that will be permanently required for the Proposed Scheme will be approximately 927ha, of which approximately 311ha (34%) is BMV land and approximately 617ha (67%) is poorer quality land, as shown in Table 7.

Table 7: Agricultural land required permanently in England

Agricultural land quality	Total area required (ha)	Percentage of agricultural land (%)	National estimates (%)
Grade 1	27.4	3.0	2.7
Grade 2	82.7	8.9	18.8
Subgrade 3a	200.4	21.6	20.7
BMV subtotal	**310.5**	**33.5**	**42.2**
Subgrade 3b	475.3	51.3	*
Grade 4	141.4	15.3	*
Grade 5	0	0	*
Total agricultural land	**927.2**	**100**	

** For the purpose of this assessment, only BMV is considered significant in respect of national estimates.*

2.5.9 Of this total requirement, approximately 30ha (3%) will be used for newly planted woodlands on agricultural land for visual screening and habitat creation to mitigate environmental effects arising from the Proposed Scheme. This mitigation is described in Volume 2, Ecology and biodiversity and Volume 2, Section 7, Landscape and visual. A total of approximately 12ha (1%) of the total agricultural land requirement will be engineered to provide replacement floodplain storage. Some of the land required is BMV land which will be subject to downgrading in agricultural land quality.

2.5.10 The proportion of Grade 1 land required permanently is 3%, which is slightly greater than the national figure of this grade in England. The proportion of Grade 2 land required permanently is significantly less than that for England (9% compared to 18.8%), whilst the proportion of Subgrade 3a land required permanently is slightly greater than the national figure (21.6% compared to 20.7%). It is apparent, therefore, that within the BMV land category, the highest proportion of land required permanently, is Subgrade 3a.

2.5.11 The highest proportion of agricultural land required permanently will be non-BMV land, the proportion of non-BMV land required permanently being approximately 475ha (51% of the agricultural land within the study area).

2.5.12 BMV land is a receptor of medium sensitivity nationally, as 43% of farmland in England is estimated to be BMV. The permanent requirement for approximately 311ha of BMV land is assessed as an impact of medium magnitude, as BMV land makes up approximately 34% of the overall agricultural land requirement. The permanent effect on BMV land is, therefore, assessed as moderate, which is significant. However, the BMV land required permanently for the Proposed Scheme represents less than 0.01% of the BMV agricultural land in England[13].

2.5.13 The permanent requirement for approximately 927ha of all grades of agricultural land represents about 0.01% of the 9.1 million hectares of utilised agricultural land in England[14].

2.5.14 In Scotland, the area of agricultural land that will be permanently required for the Proposed Scheme will be approximately 37ha, of which approximately 6ha (15%) is prime agricultural land and approximately 31ha (85%) is poorer quality land, as shown in Table 8.

Table 8: Agricultural land required permanently in Scotland

Agricultural land quality	Total area required (ha)	Percentage of agricultural land (%)
Class 1	-	-
Class 2	-	-
Class 3.1	5.6	15.2
Prime agricultural land	**5.6**	**15.2**
Class 3.2	13.6	36.8
Class 4.1	1.8	5.0
Class 4.2	7.9	21.3
Class 5.1	-	-
Class 5.2	8.0	21.7
Class 5.3	-	-
Class 6.1	-	-
Class 6.2	-	-
Class 6.3	-	-
Class 7	-	-
Total	**36.9**	**100**

2.5.15 The permanent requirement for approximately 6ha of prime agricultural land comprising 15% of the agricultural land requirement, is assessed as an impact of low magnitude. Prime agricultural land is assessed as a receptor of medium sensitivity because of its scarcity in this locality. The permanent effect on prime agricultural land is, therefore, assessed as minor adverse, which is not significant.

2.5.16 The total area for agricultural land required permanently in England and Scotland is shown in Table 9.

[13] From Provisional ALC mapping Grade 1, 2 and half of Grade 3 totals 5,348,541 hectares.

[14] Department for Environment, Food and Rural Affairs (2018), Farming Statistics Final Land Use, Livestock Populations and Agricultural Workforce at June 2017 – England.

Table 9: Agricultural land required permanently in England and Scotland

Country	Higher quality land required (ha)	Lower quality land required (ha)	Total area required (ha)
England	310.5	616.7	927.2
Scotland	5.6	31.3	36.9
Total	**316.1**	**648**	**964.1**

2.6 Assessment of effects during operation

2.6.1 The presence and spread of noxious weeds (particularly ragwort) will be controlled within the operational infrastructure and land, using an appropriate management regime that identifies and remedies areas of weed growth that might threaten adjoining agricultural interests.

2.6.2 No route-wide level significant effects on agriculture, forestry and soils have been identified as a result of the operation of the Proposed Scheme.

3 Air quality

3.1 Introduction

3.1.1 This section of the report considers the route-wide impacts and likely significant effects on air quality arising from the construction and operation of the Proposed Scheme. Changes in pollutant concentrations are assessed against air quality standards which have been set for the protection of human health and the natural environment.

3.2 Scope, assumptions and limitations

3.2.1 The scope, assumptions and limitations for the air quality assessment are described in Volume 1, Section 8 and the EIA Scope and Methodology Report (SMR)[2].

3.3 Environmental baseline

3.3.1 The environmental baseline for air quality is described within the relevant Volume 2, Community Area reports. The main pollutants of concern for local air quality are nitrogen dioxide (NO_2) and fine particulate matter (particles of size less than 2.5µm and 10µm, referred to as $PM_{2.5}$ and PM_{10} respectively).

3.4 Assessment of effects during construction

3.4.1 Air quality impacts from construction activities could arise from two sources: directly from the construction sites; and indirectly from changes in the volume, composition and location of traffic on the highway network.

3.4.2 The main air pollutant emitted from construction sites is dust, which can potentially be carried a few hundred metres from construction sites. Dust generation from the Proposed Scheme will be strictly controlled by the application of best practice measures set out in the draft Code of Construction Practice (CoCP)[1]. The result will be that significant effects from dust are not likely to occur at properties and other receptors outside the construction sites.

3.4.3 The emissions of other pollutants from activities within the construction and any borrow pit sites will be relatively small in comparison to existing local emission sources from fixed sources and highway traffic. They will be controlled by measures set out in the draft CoCP and are unlikely to cause a significant air quality effect.

3.4.4 Construction traffic and changes in the volume and location of traffic on the highway network will result in effects further away from the construction sites. The geographic extent of these effects has been assessed within the Volume 2, Community Area reports, and where appropriate, Volume 4, Off-route effects. It is not anticipated that there will be significant air quality effects on a route-wide basis associated with construction of the Proposed Scheme.

3.5 Assessment of effects during operation

3.5.1 As described in the EIA SMR, there will be no direct atmospheric emissions from the operation of trains that will cause an impact on air quality. Indirect emissions from sources such as rail and brake wear have been assumed to be negligible.

3.5.2 The operation of the Proposed Scheme will result in changes to road traffic volumes and location due to realignments, diversions and changes in traffic flows, which may have an impact on air quality in some locations along the route of the Proposed Scheme, as recorded within the relevant Volume 2, Community Area reports. It is not anticipated that there will be any significant air quality effects on a route-wide basis arising from these changes during operation of the Proposed Scheme.

3.6 Benefits beyond the project boundary

3.6.1 It is expected that with the operation of the Proposed Scheme, there will be a shift of road, rail and domestic air passengers switching to high speed rail. This is due to the Proposed Scheme offering additional rail capacity, reduced journey times and increased capacity for freight services. It has been assumed that this modal shift will reduce car journeys across Britain. An air quality assessment has been undertaken for the modal shift by calculating the change in emissions for nitrogen oxides (NOx) and particulate matter (PM_{10} and $PM_{2.5}$). The following data sources have been used for this assessment:

- Traffic data PLANET Framework Model (PfMv9.6);
- Department for Environment Food and Rural Affairs (Defra) Emission Factors Toolkit (EFT)[15];
- Vehicle fleet composition projections[16]; and
- Fleet-weighted road transport emission factors[17].

3.6.2 Traffic data have been obtained from PfM in the form of annual vehicle kilometres (vkm) per travel mode for a 'without scheme' and a 'with scheme' scenario in 2039 (representing the first year of operation). The 'without scheme' scenario includes HS2 Phase One and HS2 Phase 2a as committed schemes. The four modes of transport assessed are:

- VK3 - Car vkm to access long distance rail (including London);
- VK4 - Highway long distance trips vkm;

[15] Department for Environment, Food and Rural Affairs (2020), *Emissions Factor Toolkit*. Available online at: https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html.

[16] Department for Transport (DfT) (2020), *TAG Data Book v1.13.1*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/898797/tag-data-book.xlsm.

[17] National Atmospheric Emissions Inventory (2019), *Vehicle fleet composition projections (Base 2019)*. Available online at: https://naei.beis.gov.uk/resources/rtp_fleet_projection_NAEI_2016_Base_2018_v1.1.xlsx.

- VK5 - Highway local trips vkm (from regional models); and
- VK7 - Air access vkm.

3.6.3 The change in annual vkm between the 'with scheme' and 'without scheme' scenarios for 2039 (obtained from PfM) are presented in Table 10 for each transport mode.

Table 10: Annual vkm per travel mode (absolute numbers from PfM)

Transport mode	Change in annual vkm
VK3 (Car vkm access to long distance rail)	161,806,269
VK4 (Highway long distance trips vkm)	-385,689,058
VK5 (Highway local trips vkm)	-62,462,317
VK7 (Air access vkm)	-23,921,413
Total	**-310,266,518**

3.6.4 NOx and particulate matter (PM_{10} and $PM_{2.5}$) emissions have been calculated for each transport mode using fleet composition predictions from the Transport Analysis Guidance (TAG) workbook and the National Atmospheric Emissions Inventory, and vehicle emission factors from the EFT. The traffic modelling data indicates that the modal shift will reduce passenger car journeys on motorways and urban roads across the UK.

3.6.5 A speed of 70mph (113kph) was assumed for motorways and 30mph (48kph) for urban roads. Vehicle emissions were assumed to be the latest Euro standard (Euro 6c/6d) for passenger cars and encompass conventional, fully hybrid, plug-in hybrid and electric vehicles.

3.6.6 Electric vehicles were assumed to have no exhaust emissions, therefore only emissions from brake and tyre wear were taken into account for PM_{10} and $PM_{2.5}$ emissions.

3.6.7 The vehicle fleet mix from the TAG workbook provides a conservative assumption on the uptake of electric vehicles in the fleet by 2039 (Table 11).

Table 11: Car fleet mix from the TAG workbook for 2039

Year	Petrol	Diesel	Electric
2039	41%	28%	31%

3.6.8 Taking into account the change in vkm, the predicted fleet mix and vehicle emission factors, the total tonnes of pollutant emissions have been calculated for the modal shift due to the Proposed Scheme (Table 12). Overall, the modal shift is predicted to bring improvements to air pollutant emissions in 2039 of 20.7 tonnes of NOx, 5.4 tonnes of PM_{10} and 3.3 tonnes of $PM_{2.5}$.

Table 12: Pollutant emissions (in tonnes) with TAG workbook fleet split

Scenario	NOx (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Without scheme	7,766.4	2,014.3	1,235.3
With scheme	7,745.6	2,008.9	1,232.0
Change	-20.7	-5.4	-3.3

Sensitivity test

3.6.9 A sensitivity test was undertaken to capture a more optimistic uptake of electric vehicles in the fleet mix. Data was provided by the Department for Transport (DfT)[18], as shown in Table 13, taking into account a more rapid decarbonisation of the UK transport sector in line with the Department for Business, Energy and Industrial Strategy's Ten Point Plan.

Table 13: Car fleet mix from DfT for 2039

Year	Petrol	Diesel	Electric
2039	17%	6%	78%

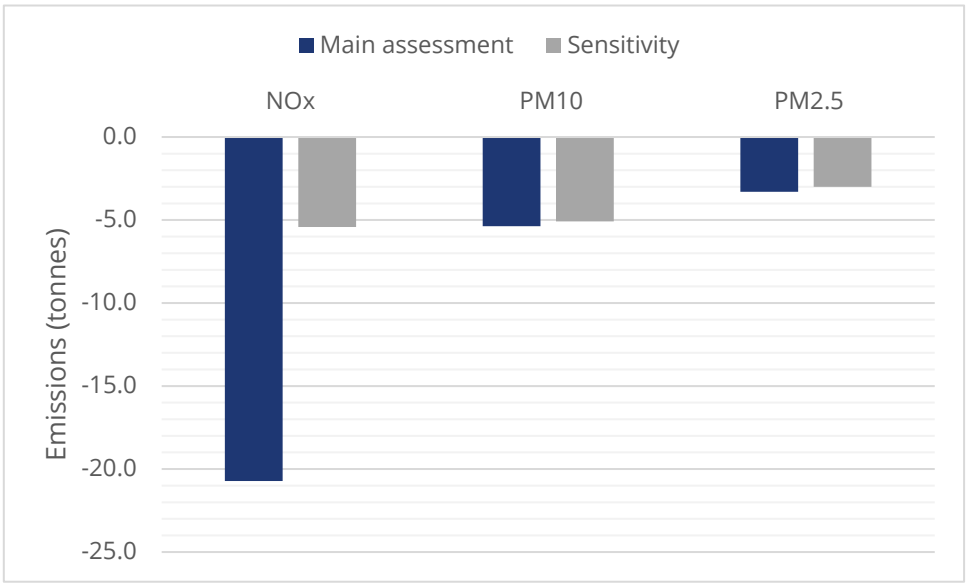
3.6.10 The total tonnes of pollutant emissions from the modal shift sensitivity test due to the Proposed Scheme is presented in Table 14 and a comparison against the main assessment presented in Figure 2. Overall, the modal shift is predicted to bring improvements to air pollutant emissions in 2039 of 5.4 tonnes of NOx, 5.1 tonnes of PM_{10} and 3.0 tonnes of $PM_{2.5}$. This is smaller than the main scenario due to the assumed increased uptake of electric vehicles which leads to a reduced scale of improvement for air quality, especially for NOx. This is also reflected in the overall pollutant emissions both with and without the Proposed Scheme.

Table 14: Pollutant emissions (in tonnes) with DfT fleet split

Scenario	NOx (tonnes)	PM_{10} (tonnes)	$PM_{2.5}$ (tonnes)
Without Proposed Scheme	2,029.8	1,903.6	1,124.6
With Proposed Scheme	2,024.3	1,898.5	1,121.6
Change	-5.4	-5.1	-3.0

[18] Department for Transport (DfT) (2021), Emissions and fleet mix data (covering road, aviation and rail) has been provided by DfT and Network Rail to inform a Net Zero transport decarbonisation scenario, which is consistent with the 10 point plan.

Figure 2: Reduction in pollutant emissions between main assessment and sensitivity test



3.6.11 Nevertheless, the anticipated reduction of over 300 million vehicle kilometres travelled because of the modal shift from the Proposed Scheme will bring an improvement in air pollutant emissions between 5.4 and 20.7 tonnes of NOx, 5.1 to 5.4 tonnes of PM_{10} and 3.0 to 3.3 tonnes of $PM_{2.5}$ (depending on the uptake of electric vehicles).

4 Climate change

4.1 Introduction

4.1.1 This section of the report presents the three route-wide assessments undertaken within the climate change topic:

- the greenhouse gases (GHG) assessment;
- the in-combination climate change impacts assessment; and
- the climate change resilience assessment.

4.1.2 The GHG assessment quantifies and reports the GHG emissions associated with construction and operation of the Proposed Scheme in the form of the 'carbon footprint'. A carbon footprint is the total GHG emissions associated with a particular scheme, policy or development. The GHG emissions are converted into tonnes of carbon dioxide equivalent (tCO_2e), which standardises the global warming potential of the main GHG[19] into one index based on the global warming potential of carbon dioxide (CO_2). Hereafter in this report, the term carbon is used to refer to the combined GHG emissions.

4.1.3 The in-combination climate change impacts assessment considers the combined effect of the Proposed Scheme and potential climate change impacts on the receiving environment during construction and operation[20].

4.1.4 The climate change resilience assessment considers potential climate change impacts on the design, construction and operation of the Proposed Scheme.

4.1.5 As stated in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) Synthesis Report[21], mitigation (i.e. reducing carbon emissions) and adaptation (i.e. responding to climate change impacts) are complementary approaches to reducing risks of climate change impacts. Mitigation, in the short-term and medium-term, can substantially reduce climate change impacts in the latter decades of the 21st century. Benefits from adaptation can be realised now to address current risks, and can be realised in the future to address emerging risks. Innovation and investments in environmentally sound infrastructure

[19] The seven main GHG are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). Source: National Atmospheric Emissions Inventory (2017), Overview of greenhouse gases. Available online at: http://naei.defra.gov.uk/overview/ghg-overview.

[20] The term in-combination climate change impacts refers to the combined effect of the impacts of the Proposed Scheme and potential climate change impacts on the receiving environment. It is not to be confused with the EIA terms 'combined effects' or 'cumulative effects'. The term 'potential climate change impacts' is not to be confused with the EIA term 'future predicted baseline'.

[21] Intergovernmental Panel on Climate Change (2014), *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available online at: http://ar5-syr.ipcc.ch/topic_summary.php.

and technologies can both reduce carbon emissions and enhance resilience to climate change.

4.2 Greenhouse gases assessment

Legal and policy framework

International level

4.2.1 The IPCC's Fifth Assessment Report (AR5)[22] strengthened its statement on human influence being the dominant cause of the observed global average temperature increases from very likely (>90% certain) in the previous assessment report (Fourth Assessment Report (AR4)[23]) to extremely likely (95–100% certain).

4.2.2 A global climate agreement—the Paris Agreement[24]—was adopted at the 21st Conference of the Parties (COP21) and was subsequently ratified by the UK in November 2016. A central aim of the Paris Agreement is to strengthen the global response to climate change by limiting the global temperature increase this century to below 2 degrees Celsius (°C) above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5°C . To achieve this aim, the Paris Agreement additionally sets a target for net zero[25] global carbon emissions in the second half of this century. The IPCC's Special Report on Global Warming of 1.5°C[26] (SR15) states that limiting the risk of global warming to 1.5°C requires a step change in adaptation and mitigation investments, policy instruments, accelerated innovation and behavioural change.

4.2.3 2021 saw the staging of the 26th Conference of the Parties (COP26) in Glasgow. COP26 updated national plans for climate action, known as National Determined Contribution (NDC), under the five-year ratchet mechanism introduced under the Paris Agreement. The UK's new NDC will see the nation reduce carbon emissions by 68% by 2030, compared to 1990 levels. The new NDC is set at a level commensurate with long term national commitments on decarbonisation and is informed by work undertaken by the UK Climate Change Committee (CCC).

[22] IPCC (2013), *Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available online at: https://www.ipcc.ch/report/ar5/wg1/.

[23] IPCC (2007), *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Available online at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html.

[24] United Nations (2015), *Paris Agreement*. Available online at: https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf.

[25] Net-zero means 'a balance between anthropogenic emissions by sources and removals by sinks of carbon emissions in the second half of this century'. As sourced from Article 4 Paragraph 1 of United Nations (2015). Available online at: https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf.

[26] IPCC (2018), *Special Report – Global Warming of 1.5°C*. Available online at: https://www.ipcc.ch/sr15/.

National level

4.2.4 The Climate Change Act 2008 (2050 Target Amendment) Order 2019[27] came into force in June 2019 and requires a 100% reduction in carbon emissions by 2050 (i.e. net-zero carbon emissions). To ensure that regular progress is made towards the net-zero target a series of carbon budgets are set by the CCC. The CCC was established in 2008 and is the UK's independent advisor on tackling climate change. It sets targets, advises on areas of research and investment, and monitors progress against the carbon budgets.

4.2.5 The sixth carbon budget[28] was published in January 2021 and is a landmark budget as it's the first budget responding to the Government's more challenging net zero target. The sixth carbon budget sets the UK's net GHG emissions limit at 965 million tonnes of carbon dioxide equivalent ($MtCO_2e$) between 2033-2037, a 78% reduction from 1990 to 2035. It sets out a range of measures to reduce emissions from surface access, including the need to shift journeys onto lower-carbon modes of transport. In June 2021 Government enshrined the sixth carbon budget into law.

4.2.6 In November 2020 the Government set out its Ten Point Plan for a Green Industrial Revolution[29]. The Ten Point Plan will ensure that the UK's electricity grid continues to decarbonise by supporting investment in both offshore wind and nuclear power generation. In parallel the sale of new diesel and petrol vehicles will end in 2030, with all new vehicle sales required to have '*significant*' zero emissions capability (e.g. plug-in hybrid or full hybrids) from 2030 and be 100% zero emissions from 2035. The plan will also help accelerate the transition to public transport modes such as rail. Investment will focus on enhancing and renewing the existing rail network, as well as the electrification of railway lines.

4.2.7 In March 2021 the Government published its Industrial Decarbonisation Strategy[30] which builds on commitments from earlier strategies and policy consultations such as the 2020 Ten Point Plan for a Green Industrial Revolution. This strategy presents an indicative roadmap to net zero for UK Industry, covering sectors such as: metals and minerals, chemicals, food and drink, paper and pulp, ceramics, glass, oil refineries and other less energy intensive manufacturing. Combined these industrial sectors account for 16% of UK carbon emissions (72 $MtCO_2e$). The ambition is to reduce carbon emissions from the Industrial sector by two thirds by 2035 through a mixture of carbon capture, carbon sequestration, switching to low carbon fuels, implementing resource and material efficiency

[27] *Climate Change Act 2008 (c.27)* (2050 Target Amendment). Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/ukdsi/2019/9780111187654.

[28] Committee on Climate Change (2020), *The Sixth Carbon Budget - The UK's path to Net Zero*. Available online at: https://www.theccc.org.uk/publication/sixth-carbon-budget/.

[29] HM Government (2020), *The Ten Point Plan for a Green Industrial Revolution*. Available online at: https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution.

[30] HM Government (2021), *Industrial Decarbonisation Strategy*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/970229/Industrial_Decarbonisation_Strategy_March_2021.pdf.

measures, and developing a thriving market for low carbon materials. This strategy builds on the UK's efforts to switch towards greener energy sources.

4.2.8 The Department for Transport (DfT) Transport Decarbonisation Plan (TDP)[31], published in July of 2021, sets out how the Government intends to decarbonise the transport sector in line with the legally binding carbon budgets and delivering net zero by 2050. HS2 is one of several major infrastructure projects that is fundamental to this. The Government intends to achieve this by prioritising key areas including: accelerating modal shift to public and active transport; and decarbonising how we get our goods. The TDP includes specific commitments, actions and timings, such as:

- Creating infrastructure which encourages public and active travel, whilst reducing our reliance on cars;
- Phasing out all new non-zero carbon emission road vehicles by 2040 (subject to consultation);
- Ending the sale of all non-zero emission HGVs from 2040, with lighter HGVs from 2035;
- Delivering net zero domestic aviation by 2040 (subject to consultation); and
- Removing all diesel-only trains by 2040, and the entire rail network reaching net zero by 2050.

4.2.9 The TDP acknowledges that there is uncertainty associated with the rate of technological advances, the precise mix of future zero emission solutions, or how travel behaviour may change. The Government will monitor progress against the TDP's targets and publish regular updates.

4.2.10 On the 1st January 2021 the UK's participation in the European Union's Emissions Trading System (EU ETS)[32] was replaced by the UK Emissions Trading Scheme (UK ETS)[33] covering England, Scotland, Wales and Northern Ireland. The UK ETS operates in a similar manner to the EU ETS. It is a cap-and-trade mechanism whereby a limit on GHG emissions is set for energy intensive sectors such as electricity generation, cement and steel production, and commercial flights within the EU. Organisations covered by the cap are allowed to trade emission allowances[34] with one another.

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[31] Department for Transport (2021), *Decarbonising Transport: A Better, Greener Britain*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002285/decarbonising-transport-a-better-greener-britain.pdf.

[32] European Commission (2017), *EU Emissions Trading System*. Available online at: https://ec.europa.eu/clima/policies/ets_en.

[33] HM Government (2021), *UK Emissions Trading Scheme*. Available online at: https://www.gov.uk/government/publications/participating-in-the-uk-ets/participating-in-the-uk-ets.

[34] Net-zero means carbon emissions can continue but must be balanced by negative emissions technologies. These range from tree-planting through to technological solutions that draw carbon from the air, or bioenergy with carbon capture and storage (BECCS). Definition from Carbon Brief (2017), *Paris Summit 2015. 13 February 2015. Briefing: The 15 options for net-zero emissions in the Paris climate text*. Available online at: https://www.carbonbrief.org/briefing-the-15-options-for-net-zero-emissions-in-the-paris-climate-text.

Scope, assumptions and limitations

4.2.11 The scope, assumptions and limitations for the GHG assessment are set out in Volume 1, Section 8, the EIA Scope and Methodology Report (SMR)[2] and in Volume 5 (Greenhouse gas calculation methodology (CL-004-00000)).

4.2.12 As detailed in the EIA SMR the GHG assessment takes a life cycle assessment (LCA) approach consistent with the principles set out in BS EN 15978[35], BS EN 15804[36] and PAS 2080[37] standards. The scope of the GHG assessment is outlined in Table 15.

Table 15: Scope of the carbon assessment

Life cycle stage	Inclusions	Exclusions
Before use stage	• Product manufacturing • Transport of construction materials from the factory gate to the construction site • Construction processes including water use • Emissions and removals from land use change during construction	• Preliminary desk-based studies • Transport of construction plant equipment to and from site
Use stage	• Emissions and removals from land use change during operation • Repairs and maintenance • Replacement • Refurbishment • Operation of infrastructure including energy and water use • Operation of HS2 rolling stock	• N/A
End of life	• 'End of life' deconstruction, transport, waste processing and disposal	• N/A
Benefits and loads beyond the system boundary	• Benefits and loads associated with modal shift of passenger and freight journeys. • Emissions resulting from construction works to third party assets impacted by the Proposed Scheme.	• Use stage and end of life emissions associated with third party assets. • Impacts associated with material recycled content and material energy recovery beyond the system boundary.

Environmental baseline

4.2.13 An environmental baseline provides a reference point against which the impact of a new project can be compared to. The existing and future environmental baselines for the Proposed Scheme are based on a 'without the Proposed Scheme' scenario.

[35] British Standards Institution (2011), *Sustainability of Construction Works – Assessment of environmental performance of buildings – Calculation method*. BSI Limited, London, UK.

[36] British Standards Institution (2012), *Sustainability of Construction Works – Environmental Products Declarations. Core Rules for the product category of construction products*. BSI Limited, London, UK.

[37] Construction Leadership Council & the Green Construction Board (2016), *PAS 2080: 2016: Carbon Management in Infrastructure*. BSI Limited, London, UK.

Carbon footprint

4.2.14 Table 16 summarises the Proposed Scheme's carbon footprint, also referred to as the 'base case' later in this chapter to facilitate a sensitivity analysis. The carbon footprint has been quantified for construction (2025-2038) as well as operation from 2038 up to 2050 (UK's climate change target year) and 120 years (to align with the assumed design life). The carbon footprint is based on a 'reasonable worst-case scenario'. For example, it is assumed that there will be no carbon emissions reduction improvements within the cement and steel industries between the time of this assessment and the construction of the Proposed Scheme, and that the carbon intensity of UK grid electricity will reduce in accordance with HM Treasury's Green Book Guidance. However, there is a level of uncertainty with future carbon projections, whether with the rate at which the UK grid decarbonises, or the efficiency of steel and concrete manufacturing. Uncertainty is addressed under the sensitivity section later in this chapter.

Table 16: The Proposed Scheme's carbon footprint up to the year 2050 and over 120 year operational period

Work stage	Tonnes CO_2e		
	Life cycle stage	Up to 2050	120 years
Construction	Before use stage		5,022,000
Operation	Use stage	391,000	5,769,000
	Benefits and loads beyond project boundaries[38]	-618,000	-3,888,000

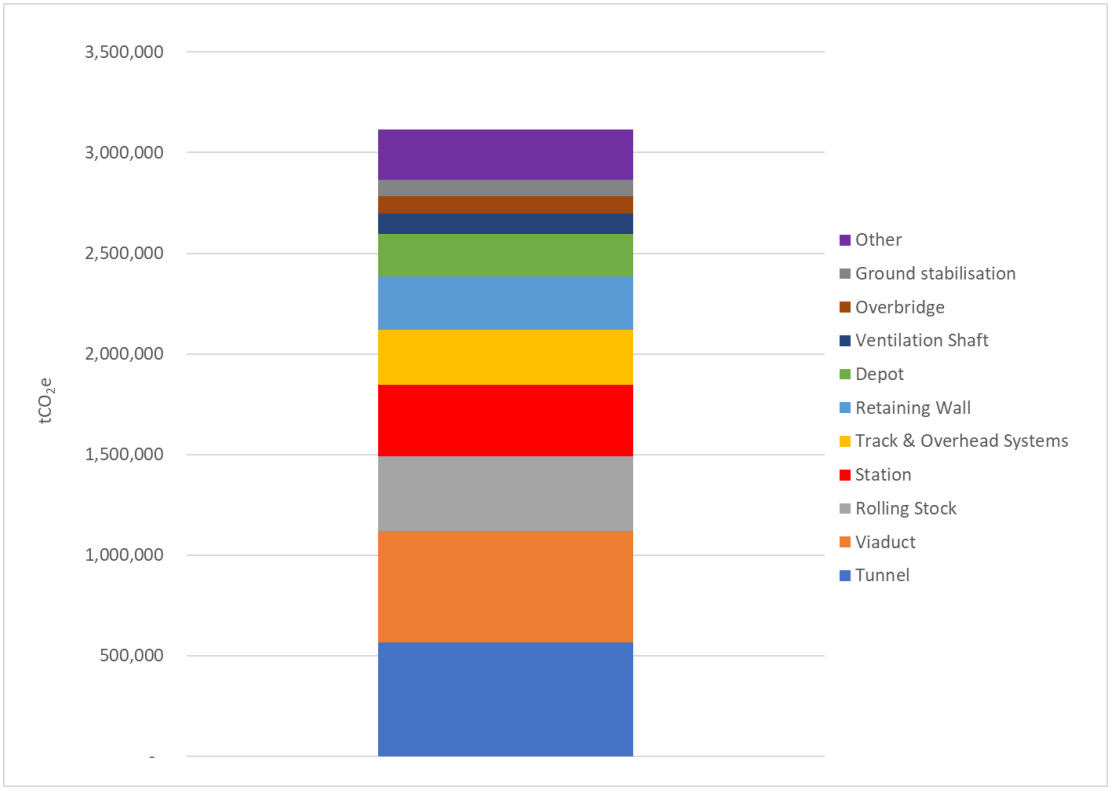
Before use stage emissions

Product manufacturing

4.2.15 Product manufacturing stage emissions are 3,114,000 tCO_2e for the Proposed Scheme, constituting 62% of the construction carbon emissions. Figure 3 presents the product manufacturing stage carbon emissions broken down by asset type. Notable contributions to total product manufacturing stage emissions are tunnels (18%), viaducts (18%), the manufacturing of rolling stock (12%) and stations (11%). The 'other' category in Figure 3 is composed of the following civil assets: electricity distribution, highway works, tunnel portals, signalling and communication, underbridges, culverts, embankments, the manufacturing of tunnel boring machines, aqueducts, balancing ponds and temporary construction compounds.

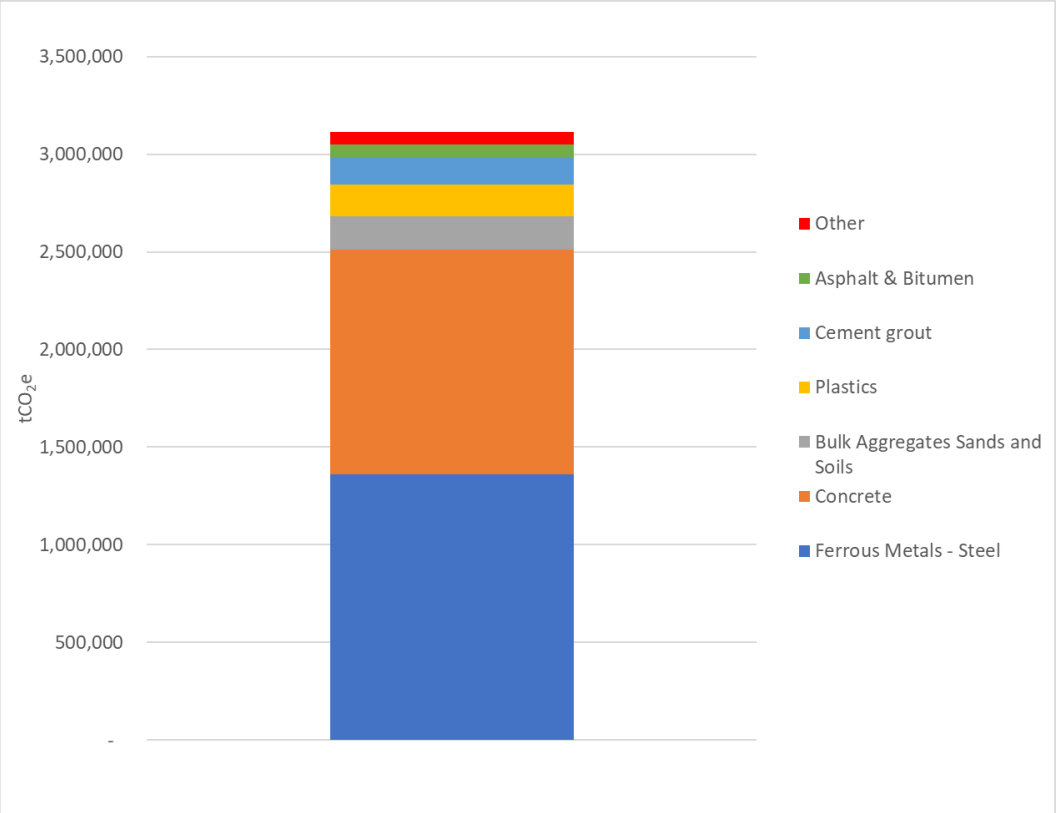
[38] The benefits and loads stage is the net carbon emission figure, which includes loads (i.e. increase in carbon emissions) from additional surface access journeys to access the Proposed Scheme, and benefits (i.e. reduction in carbon emissions) from freight and passenger modal shift.

Figure 3: The Proposed Scheme's product manufacturing stage carbon emissions by asset type



4.2.16 Figure 4 presents manufacturing stage carbon emissions by material type with steel and concrete accounting for 44% and 37% of manufacturing emissions respectively. The 'other' category contains materials such as rubber, glass, electrical items, paints and bricks.

Figure 4: The Proposed Scheme's product manufacturing stage carbon emissions by material type



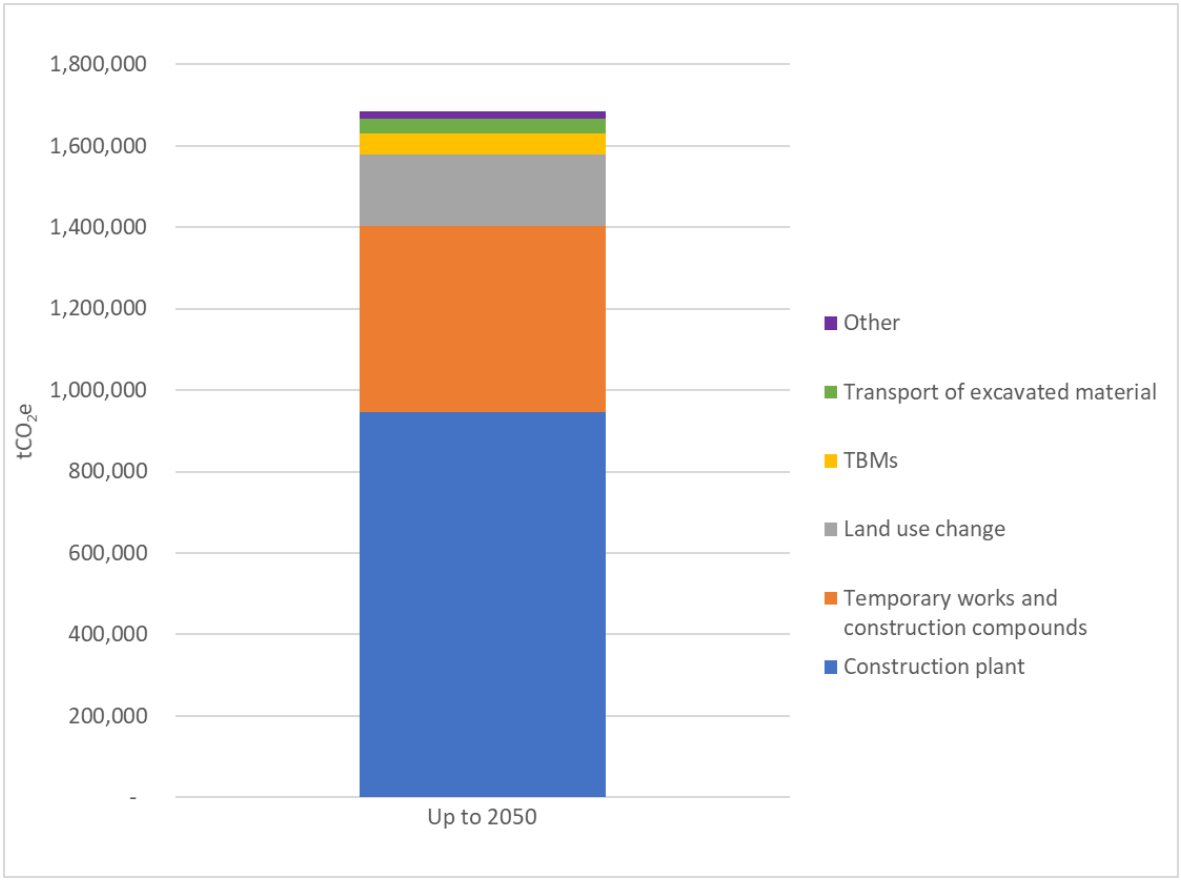
Transport to work sites

4.2.17 Carbon emissions from the transport of material to construction compounds are 223,000 tCO_2e. This represents approximately 4% of the construction carbon emissions.

Construction and installation processes

4.2.18 Carbon emissions from construction and installation processes are 1,685,000 tCO_2e (34%) of the construction carbon emissions. Figure 5 presents a breakdown of construction and installation process related carbon emissions by source. The majority of carbon emissions, 945,000 tCO_2e (56%) result from construction plant operations followed by 457,000 tCO_2e (27%) associated with the setup of temporary works and construction compounds. Land use change accounts for 177,000 tCO_2e (11%) and is associated with the displacement of carbon sinks (e.g. soil and trees) brought about during the construction process. Tunnel boring machines are the fourth most carbon intensive construction activity with 50,000 tCO_2e (3%). The 'other' category in Figure 5 is composed of the following construction activities: construction waste transport, compounds water use, demolition waste transport and disposal and construction worker accommodation waste.

Figure 5: The Proposed Scheme's construction and installation processes stage carbon emissions by activity up to 2050



Use stage emissions

4.2.19 Figure 6 and Figure 7 present the operational carbon emissions by life cycle stage including net operation carbon emissions between 2038 (Proposed Scheme opening year) and 2050, as well as over a 120-year operational period respectively.

Figure 6: The Proposed Scheme's operational carbon emissions by life cycle stage between opening year 2038 and 2050

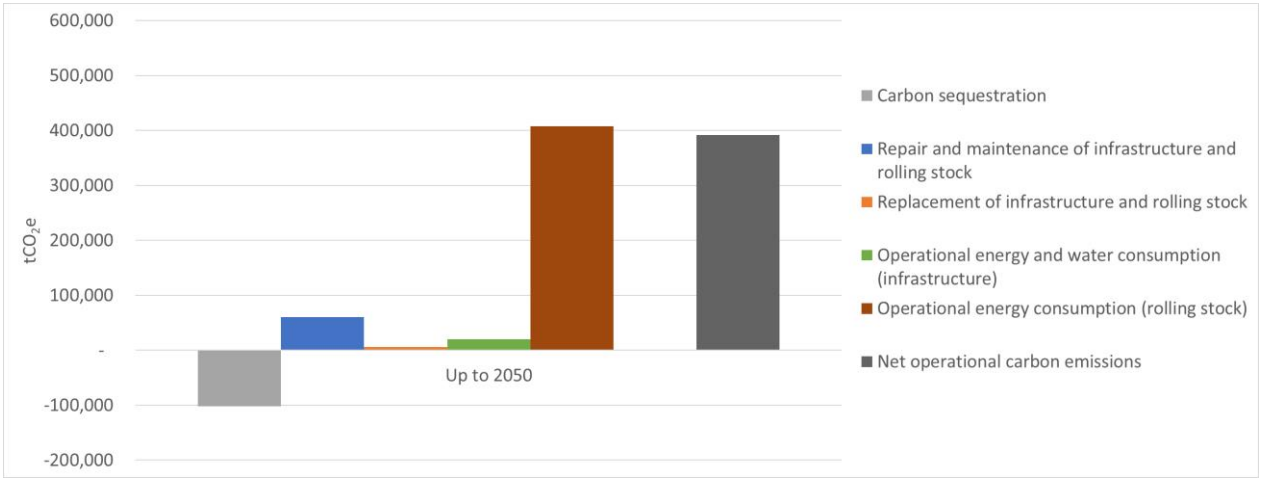
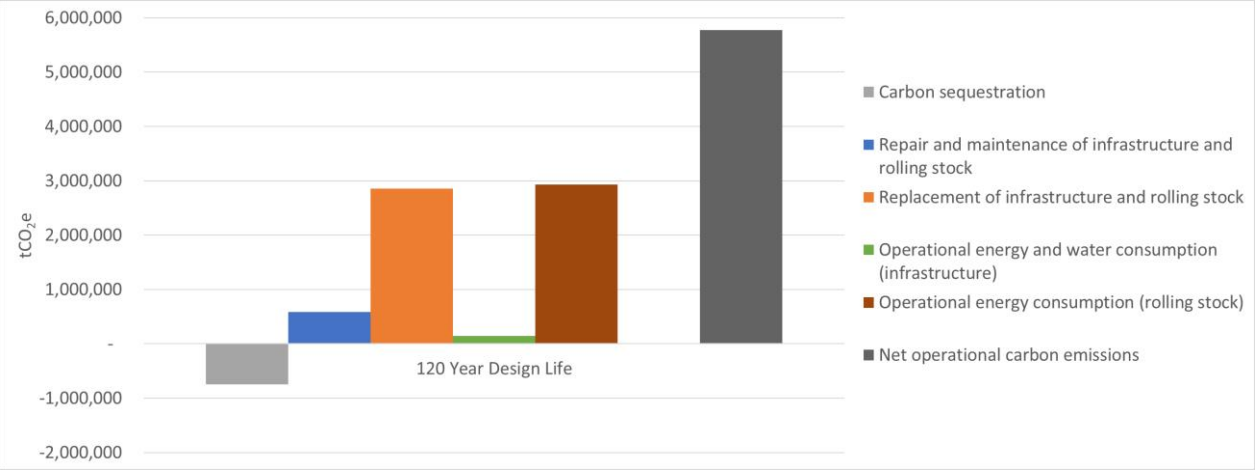


Figure 7: The Proposed Scheme's operational carbon emissions by life cycle stage over a 120-year operational period



Carbon sequestration from tree planting and other land uses

4.2.20 Between 2038 (opening year) and 2050 it is forecast that 102,000 tCO_2e will be sequestered (i.e. removed from the atmosphere) by newly planted trees and creation of other land uses (e.g. grassland and wetlands) included as mitigation within the Proposed Scheme. This is different to land use change emissions reported during the construction phase (see Figure 5) which reports carbon emissions released through soil and land disturbance.

4.2.21 Figure 7 illustrates how over 120 years the same land uses are estimated to sequester 747,000 tCO_2e.

Repair and maintenance

4.2.22 Infrastructure and rolling stock repair and maintenance emissions are reported at 60,000 tCO_2e by 2050, increasing to 589,000 tCO_2e over the 120-year design life of the Proposed Scheme.

Replacement

4.2.23 The carbon emissions associated with replacement of infrastructure assets and rolling stock is estimated at 6,000 tCO_2e by 2050, increasing to 2,851,000 over 120 years.

4.2.24 Rolling stock are assumed to be replaced every 35 years with an estimated carbon impact of 1,107,000 tCO_2e over 120 years.

Operational energy and water use of infrastructure

4.2.25 Carbon emissions associated with the energy consumed to operate asset integrated systems (e.g. signalling and communications), and water use within stations and depots, are reported at 20,000 tCO_2e by 2050, reaching 147,000 tCO_2e over 120 years.

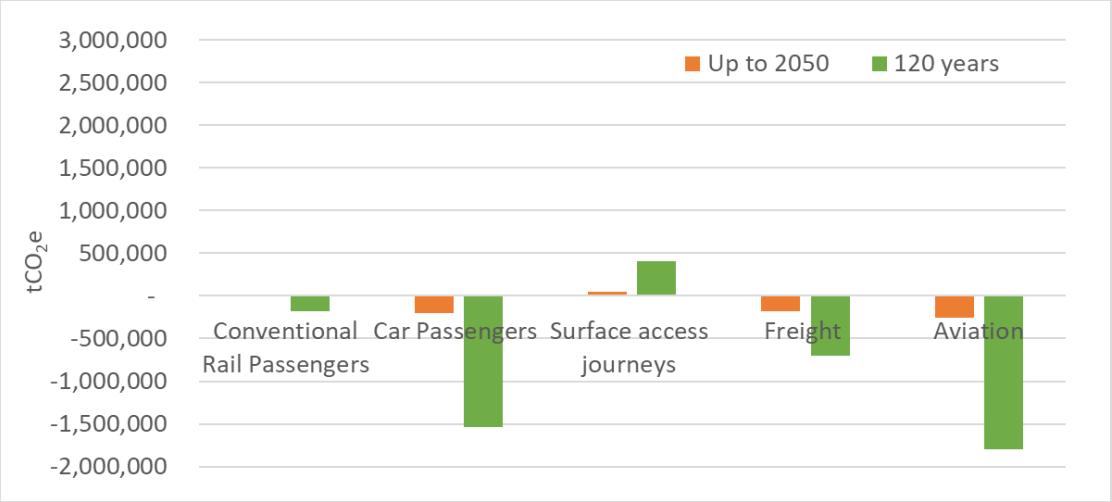
Operation of rolling stock

4.2.26 The largest contributor to the Proposed Scheme's use stage emissions is from the electricity required to operate the rolling stock. Between 2038 (opening year) and 2050 these are calculated at 407,000 tCO_2e, reaching 2,929,000 tCO_2e over the Proposed Scheme's 120-year design life. This is based on the grid decarbonisation projections set out in HM Treasury's Green Book guidance.

Benefits and loads beyond the project boundary

4.2.27 Figure 8 presents the carbon emissions breakdown for benefits and loads beyond the project boundary between 2038 (opening year) and 2050, and over the Proposed Scheme's 120-year design life. These benefits and loads are a result of modal shift of passenger and freight journeys. By 2050 the Proposed Scheme's net carbon benefit is estimated at 618,000 tCO_2e, increasing to 3,888,000 over 120 years.

Figure 8: The Proposed Scheme's carbon emissions for benefits and loads beyond the project boundary up to 2050 and over a 120-year operational period



Benefits

4.2.28 By 2050 the benefits from modal shift include: 207,000 tCO_2e by car passengers switching to high speed rail and 258,000 tCO_2e by domestic air passengers switching to high speed rail, as well as road freight moving on to existing rail lines due to released capacity from the Proposed Scheme (saving 199,000 tCO_2e).

4.2.29 Modal shift benefits are expected beyond 2050 and over the Proposed Scheme's 120-year design life. Over 120 years the benefits from modal shift brought about by the Proposed Scheme include: 1,538,000 tCO_2e avoided from car passenger trips; 1,794,000 tCO_2e avoided from domestic air travel; 786,000 tCO_2e avoided from road freight movements; and 181,000 tCO_2e avoided from conventional rail passenger trips. Modal shift benefits are expected to slow down as the UK transport sector decarbonisation rate accelerates towards 2050 and beyond, along with the wider UK economy, in order meet the net zero carbon target.

Loads

4.2.30 By 2050 the Proposed Scheme is expected to generate 51,000 tCO_2e through additional passenger surface access journeys to and from the Proposed Scheme. This is expected to increase to 411,000 tCO_2e over the Proposed Scheme's 120-year design life.

Benchmarking

UK carbon targets and budgets

4.2.31 Table 17 compares the Proposed Scheme's construction carbon emissions to the UK's carbon budgets for the construction period. The construction programme is expected to run from 2025 to 2038 and will therefore intersect the fourth (2023-27), fifth (2028-32), and sixth (2033-37) carbon budgets. Construction carbon emissions from the Proposed Scheme are expected to contribute approximately 0.13% of the UK's total carbon budget between 2025 and 2038[39].

Table 17: Proposed Scheme's construction carbon emissions as a proportion of the fourth, fifth, sixth and estimated seventh UK carbon budgets

Carbon budgets and Carbon footprint	Carbon emissions
UK fourth (2023-2027), fifth (2028-2032) and sixth (2033-2037) carbon budgets	4,650 $MtCO_2e$
Estimated UK carbon budget for construction period (2025-2038)	3,860 $MtCO_2e$
Proposed Scheme's construction carbon footprint	5.02 $MtCO_2e$
Proposed Scheme's construction – proportion of UK carbon budgets	0.13%

Transport sector comparisons

4.2.32 Opening year (2038) operational carbon emissions from the energy use of the rolling stock are estimated at 44,306 tCO_2e. This is equivalent to less than 0.05% of all UK transport-related carbon emissions (102 $MtCO_2e$) projected by the Department for Business, Energy & Industrial Strategy (BEIS)[40] in 2035. Each year BEIS publishes UK greenhouse gas emissions projections which currently reach up to 2035. The BEIS projections provide a useful context for comparison to the Proposed Scheme's 2038 opening year rolling stock emissions.

4.2.33 Operational carbon emissions associated with the Proposed Scheme are expected to gradually decrease as the UK grid is decarbonised over time. This is reflected in the per passenger kilometre carbon emissions (CO_2e/p.km) associated with the operation of the

[39] UK carbon budget for the construction period estimated from the applicable years from each budget. This uses three years of the fourth (2025, 2028 and 2027), the whole of the fifth (2028-2032) and sixth (2033-2037) carbon budgets, and one year of the estimated seventh (2038), giving a total of 3,960 $MtCO_2e$ for the period 2025-2038.

[40] Department for Business, Energy & Industrial Strategy (2019), *Updated energy and emissions projections: 2018. Annex A.* Available online at: https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2018. Data only forecast to 2035, but given rate of change in prior 3 years, transport sector in 2038 will likely be same as 2035 emissions.

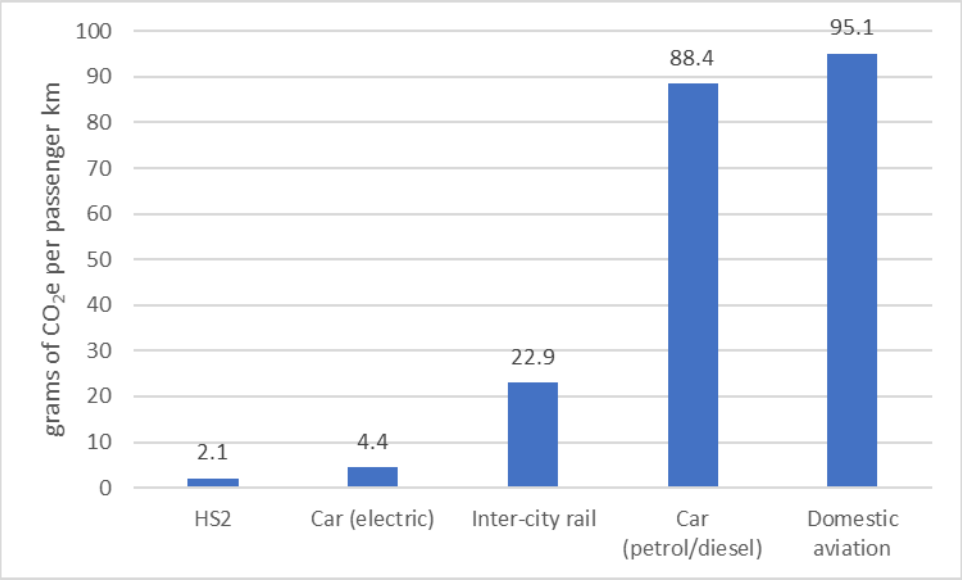
rolling stock. Table 18 shows how carbon emissions reduce from 2.08 gCO_2e/p.km in 2038 (opening year) down to 1.10 gCO_2e/p.km by 2050 (the UK's net zero target year) based on the UK grid decarbonisation projections set out in HM Treasury's Green Book guidance.

Table 18: The Proposed Scheme's Operational carbon emissions 2038 to 2050 and beyond

Year	2038	2050 and beyond
gCO_2e/p.km	2.08	1.10

4.2.34 Figure 9 benchmarks the Proposed Scheme's emissions per passenger kilometre for the opening year (2038) against rail, road and air travel[41]. In terms of emissions per passenger kilometre, the Proposed Scheme's 2.08 gCO_2e/p.km compared to intercity rail[42] at 22.9 gCO_2e/p.km; average of petrol and diesel cars at 88.4 gCO_2e/p.km; electric cars at 4.4 gCO_2e/p.km; and UK domestic flights[43] at 95.1 gCO_2e/p.km.

Figure 9: The Proposed Scheme's carbon emissions per passenger kilometre compared to alternative transport modes in 2038 (opening year)



[41] Electric car comparator for 2038 accounts for vehicle efficiency improvements, an average vehicle occupancy from Department for Environment, Food and Rural Affairs (https://www.gov.uk/government/statistical-data-sets/nts09-vehicle-mileage-and-occupancy), and uses the same grid decarbonisation scenario as HS2. Petrol and diesel cars use the same occupancy assumption as electric cars, and also account for predicted vehicle efficiency improvements. Domestic aviation assumes aircraft efficiency improvements and biofuel updates.

[42] It should be noted that the intercity rail forecast is for the entire conventional rail network, including the predicted mix of both diesel and electric trains in 2038, as well as decarbonisation of the grid for the electrified portion of the network.

[43] Domestic aviation forecast includes assumptions for aircraft efficiency improvements and biofuel uptake as advised by DfT and does not include assumptions on radiative forcing or uptake of electric planes.

Sensitivity analysis

4.2.35 The GHG assessment presented earlier in this chapter, and referred to as the base case, covers a long timescale and as such requires a number of assumptions to be made. The calculated carbon footprint is sensitive to these assumptions and there is a level of uncertainty around the assessment of GHG emissions when projecting into the future. Many of these projections are dependent on the future policy context for the UK, and the strategies adopted by different sectors of the UK (transport, manufacturing, power) to progress towards net zero by 2050. The majority of sensitivities are temporal in nature associated with projecting a long way into the future. Accordingly, sensitivity analyses has been undertaken looking at different scenarios and assumptions that would affect the Proposed Scheme's base case emissions in the future. This is set out in the following sections.

Decarbonisation of manufacturing and construction

4.2.36 In order for the UK to meet its net zero target for 2050, all sectors must address and reduce the carbon impact of their operations. The results of the base case assessment, assume no decarbonisation of the manufacturing sector between now and the construction period. However, any reduction in the carbon intensity of product manufacturing prior to the completion of the construction of the Proposed Scheme will reduce the GHG impact of its construction. The manufacturing of concrete and steel contribute approximately 81% of the base case product stage GHG emissions (36%[44] and 45% respectively), so appropriate to consider a sensitivity analysis on the potential impact of a decarbonised concrete and steel sector on the product stage emissions of the Proposed Scheme.

4.2.37 The UK Concrete and Cement Industry Roadmap to Beyond Net Zero (2020)[45] identified a range of measures to reduce the GHG impact of concrete manufacturing to net zero by 2050, including alternative fuels, low clinker content cements, energy efficiency measures, the use of Carbon Capture and Storage (CCS) and a reduction in transport emissions through modal shift and a cleaner fleet mix. Assuming a linear decarbonisation of the concrete and

[44] This figure covers in-situ concrete, precast concrete, sprayed concrete, tunnel concrete (units all in cubic metres). This represents 1.1 $MtCO_2e$ out of 3.114 $MtCO_2e$ across all represented life cycle stages. Concrete blocks & pre-cast slab track are excluded from this number because these are accounted for on a 'per-kilometre' basis rather than volume (cubic meters or tonnes).

[45] UK Concrete (2020), *UK Concrete and Cement Industry Roadmap to Beyond Net Zero – UK concrete is essential, sustainable, protecting people, innovating, helping to tackle climate change and enabling great design.* Available online at: https://thisisukconcrete.co.uk/TIC/media/root/Perspectives/MPA-UKC-Roadmap-to-Beyond-Net-Zero_October-2020.pdf.

cement sector to net zero by 2050, this would result in a 13.8%[46] reduction in the carbon intensity of concrete manufacturing before the start of construction of the Proposed Scheme in 2025 and a reduction of 58.6%[46] by the end of the construction period in 2038. The reduction in product manufacturing stage emissions from concrete will depend on the profile of construction consumption across the construction period and the level of sector decarbonisation at the point of consumption. However, it could result in a reduction in GHG emissions of between 150,000 tCO_2e and 635,000 tCO_2e in comparison to the base case.

4.2.38 The Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050 for Iron and Steel (2015)[47] present a range of short, short-medium, medium, and medium-long term opportunities to reduce the energy and carbon intensity of iron and steel production. The CCC sixth carbon budget has recommended that the sector is fully decarbonised by 2035 to support the wider national transition to net zero. Assuming a linear decarbonisation to achieve this challenging target by 2035, this would result in a 29%[48] reduction in the carbon intensity of steel manufacturing by the construction start date of the Proposed Scheme and a 100% reduction before the end of construction. As with concrete, the reduction in product manufacturing stage emissions will depend on the profile of steel consumption across the construction period. This could result in a reduction in GHG emissions between 400 tCO_2e and 1.4 $MtCO_2e$ compared to the base case. It would also remove a large proportion of the 0.8 $MtCO_2e$ associated with manufacturing replacement steel during operation. The CCC's recommendation provides an indication of the potential positive impact of this sectoral change.

4.2.39 The decarbonisation of the concrete and steel sectors between the point of the GHG assessment and the construction of the Proposed Scheme therefore has the potential reduce product stage GHG emissions by up to 2 $MtCO_2e$; a 66% reduction compared to the base case. Product stage GHG emissions may also be reduced due to the decarbonisation of sectors associated with the production of other materials. Further reduction in GHG emissions, in comparison to the base case, can also be expected during operation due to the decarbonisation in the manufacturing of replacement materials.

[46] This assumes a 100% reduction in emissions by 2050 composed of: alternative fuels (-16%), low clinker content cements (-12%), energy efficiency measures (-4%), transport (-7%) and use of carbon capture and storage (CCC) (-61%). A 100% reduction in emissions between 2021 and 2050 would result in an average decarbonisation rate of 3.4% per year. There are four years between 2021 and 2025 (the construction start year) resulting in a pre-construction decarbonisation of 13.8%. There are 17 years between 2021 and 2038 (the construction end year) resulting in a maximum decarbonisation of 58.6% decarbonisation by the end of HS2 construction.

[47] Department of Energy and Climate Change and Department for Business, Innovation and Skills (2015), *Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050 Iron and Steel.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/416667/Iron_and_Steel_Report.pdf.

[48] This assumes a linear rate of decarbonisation of steel product manufacturing between 2021 and 2035. This would result in a rate of decarbonisation of 7.1% per year. There are four years between 2021 and 2025 (the construction start year) resulting in a pre-construction decarbonisation of 28.6%.

Grid electricity

4.2.40 The Proposed Scheme's operational energy consumption related carbon emissions are partly dependent on the carbon intensity of UK grid electricity (gCO_2e/kWh).

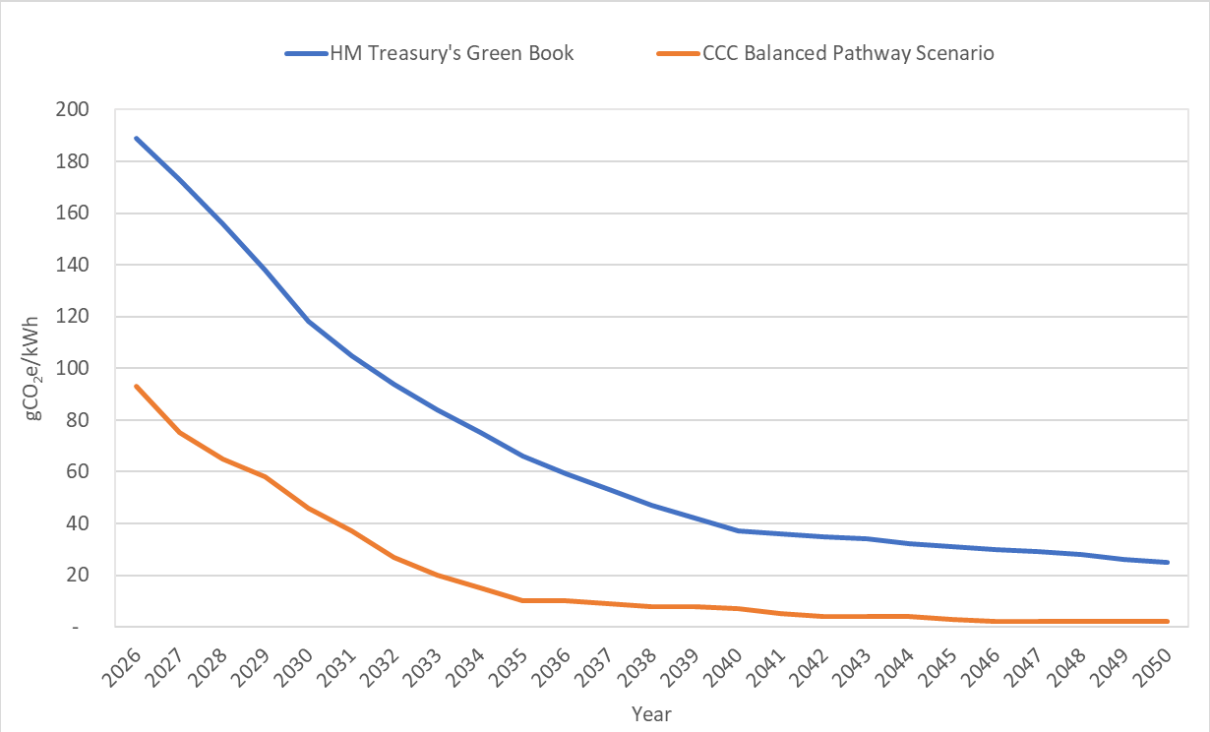
4.2.41 The base case assessment adopts HM Treasury's Green Book guidance[49] of 47 gCO_2e/kWh in 2038 (opening year) and gradually reducing to 25 gCO_2e/kWh by 2050. This represents a 'reasonable worst-case'. For the UK to meet its net zero target most cost effectively a more ambitious rate and extent of decarbonisation is likely necessary. The 6th Carbon Budget from the CCC[50] (the Government's own independent advisors) advises that UK grid intensity emissions should reach 2 gCO_2e/kWh by 2050 under the 'Balanced Pathway' scenario (see Figure 10). If this were the case, the Proposed Scheme's rolling stock and infrastructure operational carbon emissions between 2038 (opening year) and 2050 would reduce by 374,000 tCO_2e (88% reduction). Over the Proposed Scheme's 120-year design life the cumulative operational savings reach 2,805,000 tCO_2e (91% reduction).

4.2.42 The Proposed Scheme could be powered with zero carbon energy from its opening year (2038) by actively procuring 100% renewable electricity. Rolling stock and infrastructure operational carbon emission would be zero (100% reduction), a reduction of 426,000 tCO_2e by 2050 and 3,068,000 tCO_2e over the base case GHG assessment.

[49] Department for Business, Energy and Industrial Strategy (2020), *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal*. Available online at: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal.

[50] Climate Change Committee (2021), *The Sixth Carbon Budget – The UK's path to Net Zero*. Available online at: https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf.

Figure 10: UK grid electricity decarbonisation projections



Modal shift

4.2.43 Modal shift carbon emissions (see Figure 8 and Figure 9) are highly sensitive to the rate at which the wider UK transport sector decarbonises (e.g. the rate at which petrol and diesel cars are phased-out) and rate at which the UK grid decarbonises. To illustrate this sensitivity Figure 11 and Figure 12 present how rail and road modal shift carbon emissions may vary depending on the underlying assumptions. The sensitivity analysis assumes more rapid decarbonisation of the UK transport sector than the base case, where the uptake of electric vehicles is consistent with BEIS' Ten Point Plan[51], and a faster grid decarbonisation trajectory reflecting CCC's Balanced Pathway Scenario[50].

4.2.44 The modal shift assessment is also sensitive to other factors which have not been considered in the sensitivity analysis, for example potential changes in Government policy which could for instance, encourage modal shift to active and public transport or influence uptake of electric vehicles. The faster UK grid decarbonisation rate in the sensitivity analysis would reduce modal shift savings compared to the base case (see Figure 8) for conventional rail and freight as these modes transition from diesel to electric. A faster grid decarbonisation combined with a UK car fleet mix which is 98% electric by 2050 (as opposed to 46% electric by 2050 under the base case) would result in a reduction in car passenger modal shift savings. This would also reduce base case emissions associated with passenger surface access journeys to and from the Proposed Scheme. The reduction in savings for

[51] Department for Transport (DfT) (2021), Emissions and fleet mix data (covering road, aviation and rail) has been provided by DfT and Network Rail.

conventional rail, car passengers and freight and the reduction in emissions for surface access journeys by 2050 and over 120 years are presented in Table 19.

Figure 11: Modal shift sensitivity analysis results, by mode type, up to 2050

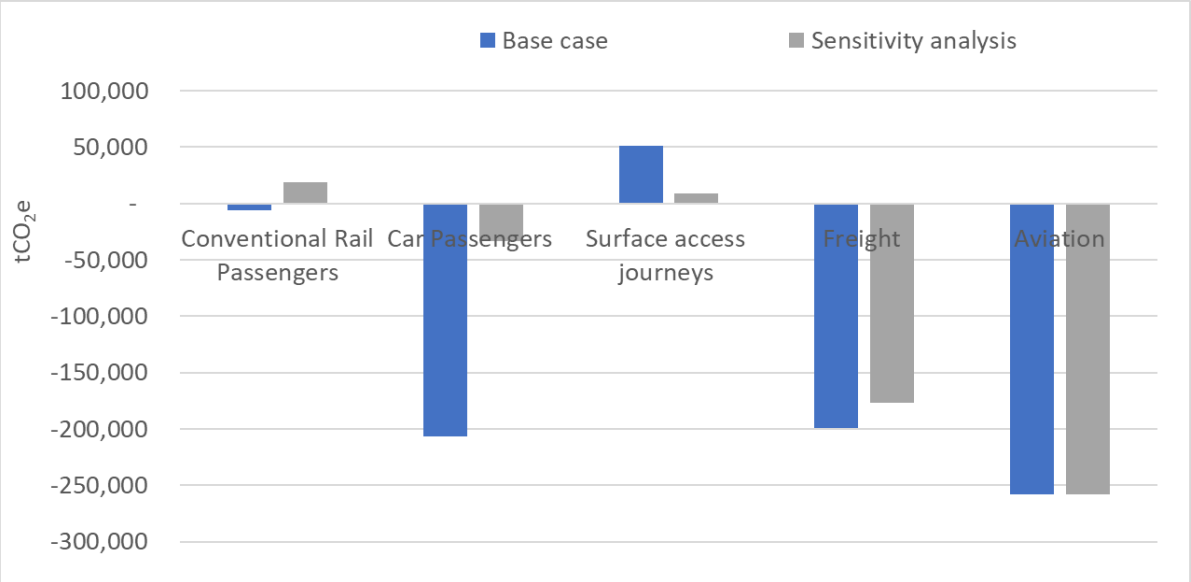


Figure 12: Modal shift sensitivity analysis results, by mode type, over 120 years

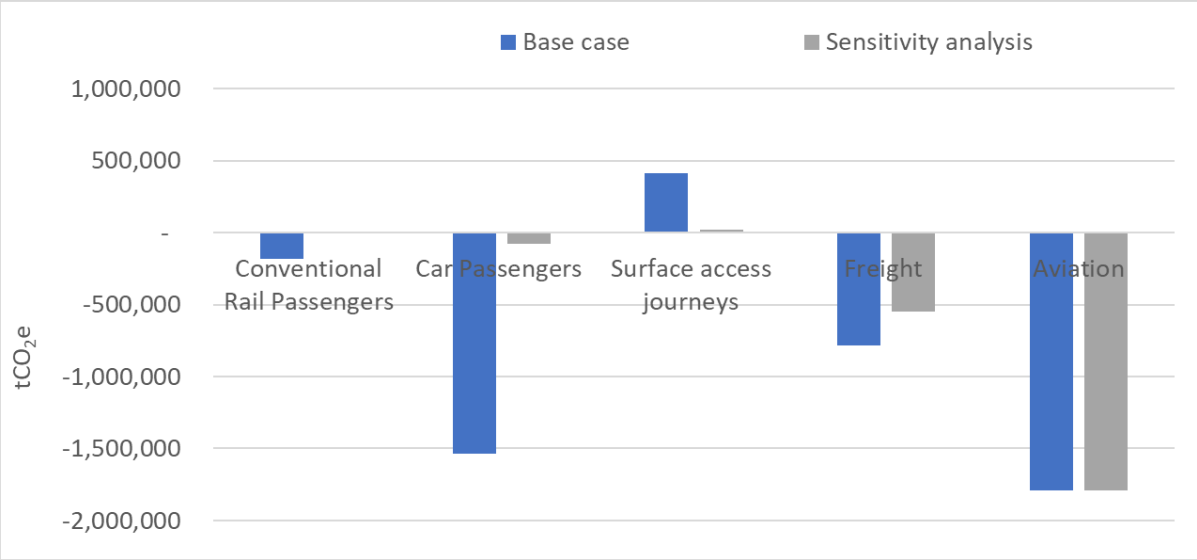


Table 19: Reduction in carbon savings and carbon emissions associated with modal shift under the sensitivity analysis compared to the base case

	Up to 2050	120 years
Reduction in modal shift savings under sensitivity analysis (tCO_2e)		
Conventional rail	-25,000	-185,000
Car passengers	-173,000	-1,461,000
Freight	-23,000	-236,000
Reduction in modal shift emissions under sensitivity analysis (tCO_2e)		
Surface access journeys	42,000	391,000

4.2.45 The sensitivity analysis indicates that a faster grid decarbonisation and a UK car fleet which is 98% electric by 2050 would result in a net reduction in modal shift savings across all modes of 179,000 tCO2e (29% reduction) by 2050 and 1,492,000 tCO2e (38% reduction) over 120 years compared to the base case.

4.2.46 While the sensitivity analysis shows that the Proposed Scheme would result in less modal shift savings in comparison to the base case, the faster grid decarbonisation underlying this would be a positive outcome for the UK. The Proposed Scheme would continue to contribute to a multi-modal zero carbon network.

Approach to mitigation and low carbon design

4.2.47 One of the themes of HS2 Ltd's Environmental Policy is to minimise the carbon footprint of HS2 and deliver low-carbon, long distance journeys that are supported by low-carbon energy. As part of the commitment to minimising the carbon footprint of the Proposed Scheme, HS2 Ltd implements a carbon management process. The carbon management process involves:

- setting appropriate carbon reduction targets;
- determining baselines against which to assess carbon reduction performance;
- establishing metrics (e.g. Key Performance Indicators) for credible carbon emissions quantification and reporting;
- selecting carbon emissions quantification methodologies;
- reporting at appropriate stages to enable visibility of performance; and
- continual improvement of carbon management and performance.

4.2.48 The carbon management process has been independently verified to the industry best practice standard PAS 2080: Carbon Management in Infrastructure. Verification demonstrates that effective controls are in place for reducing whole life carbon.

4.2.49 The GHG assessment establishes a benchmark for the Proposed Scheme and will be used as a tool to assess the potential to reduce carbon across the design, construction and operational phase. Opportunities will be identified to avoid carbon in the scheme design and reduce embedded carbon in construction materials and carbon emissions from construction works. Where reasonably practicable, the energy requirements of the Proposed Scheme will be reduced and energy efficiency of operations will be maximised. Low carbon energy will be used or generated insofar as reasonably practicable.

4.2.50 The application of the carbon management process to early design stages of the Proposed Scheme has supported identification of opportunities to reduce carbon, some of which are location-specific, and some of which are applicable across the route of the Proposed Scheme. Opportunities appropriate to this stage of design include:

- optimising the alignment of the Proposed Scheme to minimise route length and associated carbon impacts in construction and operation;
- maximising use of existing infrastructure;

- low energy design strategies for stations and depots; and
- maximising management and reuse of excavated material in the construction process for landscaping and other mitigation measures.

4.2.51 The carbon management process will continue to be applied as the design of the Proposed Scheme develops. Future opportunities to reduce carbon arising from construction have also been identified, including:

- the use of low carbon power for construction compounds and for operation of large plant (such as tunnel boring machines);
- increasing recycled content in materials, and replacement of materials with recycled alternatives; and
- use of less carbon intensive concrete blends.

4.2.52 The future design and delivery of the Proposed Scheme must be considered against the wider climate change policy context in the period between now and when the Proposed Scheme becomes operational in 2038 and the UK commitment to achieving net zero by 2050. Opportunities expected to offer carbon reduction include:

- modern methods of construction, whereby offsite construction can reduce waste and transport impacts;
- greater emphasis on circular economy principles reducing the impact of materials and components within the Proposed Scheme; and
- alternatives to diesel use for construction plant and the use of grid-powered electrical construction plant.

4.2.53 The potential realisation of these opportunities would be supported by HS2 Ltd's supplier innovation programme and the carbon management process.

4.2.54 The use of electricity for operating rolling stock, stations, and rail systems is a prominent carbon source within the lifetime impacts of the Proposed Scheme. The procurement of zero carbon electricity for the operation of the Proposed Scheme offers a considerable opportunity to reduce these impacts.

4.2.55 HS2 Ltd's Net Zero Carbon Plan seeks to accelerate the ambition of the construction industry to realise net zero during the construction phase of the Proposed Scheme and also to procure zero carbon electricity from day one of operation. These aspirations have not driven the main results of this assessment but have been considered as part of the sensitivity analysis.

Conclusion

4.2.56 The Proposed Scheme provides a low carbon transport system which supports the transition of the UK to net zero by 2050. The significant passenger capacity of the Proposed Scheme, combined with its ability to draw power from an increasingly decarbonised national grid,

means that it will be an effective low carbon transport solution for travel between Crewe and Manchester.

4.2.57 Transport currently represents the single greatest sectoral contributor to national GHG emissions, and historically it has remained broadly unchanged in terms of national emissions while other sectors (most notably the power sector) are decarbonising. Rail is the most carbon efficient mass transit transport system available – benchmarking against other transport modes indicates the Proposed Scheme would result in the lowest emissions per passenger kilometre versus other transport modes during operation based on the projected 2038 opening year.

4.2.58 HS2 will be part of a multi-modal zero carbon network, and the scheme would release capacity in the wider UK passenger rail network. The Proposed Scheme will also allow additional capacity on the existing rail freight network, supporting a shift from road freight to lower carbon rail freight options. Benefits outside of the project boundary including modal shift and freight benefits from released capacity result in savings of 0.6 million tCO_2e between the opening year (2038) and 2050, and over 3.8 million tCO_2e over the Proposed Scheme's 120-year design life.

4.2.59 The assessment forecasts operational emissions at 0.4 million tCO_2e by 2050 and 5.8 million tCO_2e over the Proposed Scheme's design life, including electricity consumption to operate the rolling stock. Although this includes grid decarbonisation in line with HM Treasury, current published data sources still anticipate some non-zero carbon energy sources by 2050 when the UK government is targeting to achieve Net Zero emissions. The Proposed Scheme can operate on zero-carbon electricity from day one through electricity supply agreements which is being considered. This is an area of uncertainty that has been acknowledged within the sensitivity analysis with projections from different published sources resulting in different emissions forecast scenarios. However, the results presented for the base case have taken a conservative approach to present a reasonable worst-case scenario to avoid understating impacts.

4.2.60 The carbon emissions associated with the construction of the Proposed Scheme are substantial, as might be expected from a national level infrastructure scheme. The construction carbon footprint is estimated at 5.0 million tCO_2e. As has been set out in the benchmarking section, the construction emissions from the Proposed Scheme can be accommodated within these budgets without placing significant burden on the UK's ability to stay within carbon budgets and meet its 2050 net zero target. National carbon cap and trade schemes such as the UK Emissions Trading Scheme (ETS) provide necessary mechanisms to drive carbon reduction within the Proposed Scheme's supply chain. There are various cross-value chain initiatives in the steel and concrete sectors in the UK and Europe which have the opportunity to reduce emissions for these carbon hotspots within the construction carbon footprint. As shown in the sensitivity analysis, these policy and industry-led activities could result in additional carbon savings of up to 2.0 million tCO_2e (40% reduction of construction carbon emissions), thus providing confidence that actual emissions for the Proposed Scheme will likely be less than those presented.

4.2.61 HS2 Ltd is committed to minimising insofar as is reasonably practicable carbon emissions by implementation of its Environmental Policy which is supported by a PAS2080 compliant carbon management system. HS2 Ltd will be engaging with the supply chain to mitigate emissions and reduce from the stated results. The results presented in this assessment provide a start-point to identify carbon hotspots and to focus carbon reduction activities.

4.3 In-combination climate change impacts assessment

Legal and policy framework

International level

4.3.1 The Paris Agreement[24] established a global goal on adaptation, strengthening resilience and reducing vulnerability to climate change. As part of this, the UK has agreed to engage in adaptation planning processes and implementation of action.

4.3.2 As a party to the Paris Agreement on climate change, the UK submitted its first Adaptation Communication to the UNFCCC on 12 December 2020[52]. This report sets out what the UK is doing to prepare for the effects of climate change.

National level

4.3.3 The relevant European Directive for the in-combination climate change impacts assessment is the EIA Directive 2014/52/EU[53] and the related EC Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment[54]. The regulations implementing this Directive were transposed into UK legislation in May 2017[55]. This recognises the issue of climate change and the need to assess the impacts of projects on climate, and their vulnerability to climate change.

4.3.4 The Climate Change Act 2008 requires the UK Government to undertake a national Climate Change Risk Assessment (CCRA) every five years. The CCC published the Independent

[52] UNFCCC (2020), *The UK's Adaptation Communication to the United Nations Framework Convention on Climate Change*. Available online at: https://www.gov.uk/government/publications/the-uks-adaptation-communication-to-the-united-nations-framework-convention-on-climate-change-unfccc-2020.

[53] *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.* Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052.

[54] European Commission (2013), *Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment.* European Union Publications Office. Available online at: http://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf.

[55] *The Town and Country Planning (Environmental Impact Assessment) Regulations 2017.* (S.I 2017 No. 571), Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/uksi/2017/571/pdfs/uksi_20170571_en.pdf.

Assessment of UK Climate Risk in 2021[56], and this will inform the third CCRA, which is due in 2022. This assessment identifies a range of risks and opportunities, which are relevant to the in-combination climate change impacts assessment, including the following, which are identified in a group of highest priority risks: risks to the viability and diversity of terrestrial and freshwater habitats; risks to soil health from increased flooding and drought; risks to natural carbon stores and sequestration; risks to crops and trees.

4.3.5 Following the CCRA, the third National Adaptation Programme (NAP) will be published in 2023. This will, detail the Government's long-term strategy to address the main climate change risks and opportunities for the UK. The CCC and its Adaptation Sub-Committee conduct an independent assessment of progress by the NAP every two years. These progress reports contribute towards the wider understanding of national climate change risks, including risks specific to the transport sector and rail infrastructure.

4.3.6 In addition to the NAP, the UK Government has set out plans to transform the UK's infrastructure networks within the National Infrastructure Strategy (NIS)[57]. The NIC sets out the importance of ensuring that national infrastructure is resilient to future climate change, and that the interlinkages between climate change, natural habitats and biodiversity loss are considered appropriately.

4.3.7 In 2018 the UK Government published A Green Future: Our 25 Year Plan to Improve the Environment[11]. This plan sets out the government's stated ambition in a number of environmental policy areas in England. Core areas of focus include reducing flood risk and tackling climate change through increasing the resilience of UK infrastructure and the natural environment.

Guidance and industry standards

4.3.8 The Institute of Environmental Management and Assessment (IEMA) has published guidance on climate change resilience and adaptation[58] in response to the requirements specified in EIA Directive 2014. This guidance provides an approach to undertaking assessments of in-combination climate change impacts within the EIA process in the UK, and HS2 Phase One and Phase 2a is included as a case study in this guidance.

[56] Climate Change Committee (2021), *Independent Assessment of UK Climate Risk*. Available online at: https://www.theccc.org.uk/publication/independent-assessment-of-uk-climate-risk/.

[57] HM Treasury (2020), *National Infrastructure Strategy*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938051/NIS_final_print.pdf.

[58] Institute of Environmental Management and Assessment (2020), *Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation*. Available at: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020.

Scope, assumptions and limitations

4.3.9 The scope of the in-combination climate change impacts assessment is summarised in Table 20. For further detail on the scope refer to Section 8 of the EIA SMR.

Table 20: Summary of scope of the in-combination climate change impacts assessment

Scope	Description
Technical	Identification and assessment of potential climate change impacts during construction and operation for all environmental topics.
Spatial	The assessment is route-wide and is based on the study areas within which other environmental topics are undertaking their own assessment of effects.
Temporal	Construction phase and a 120-year operational period.

Assumptions

4.3.10 The assumptions which have informed the assessment are as follows:

- the assessment has assumed that embedded mitigation measures included in the design, construction and maintenance of the Proposed Scheme are sufficient to address the effects of the Proposed Scheme under current climatic conditions. The assessment focuses on whether changes in climate will exacerbate the effects of the Proposed Scheme, thereby requiring additional mitigation measures; and
- the assessment has assumed a trend of increased global carbon emissions in the atmosphere in the coming decades, in line with Representative Concentration Pathways (RCPs) used in UKCP18. Increased global carbon emissions will lead to increased global temperatures. In turn this is a general assumption used in the climate models which are the basis of the climate trends used to inform the assessment. To present a range of plausible future climate scenarios, that take the uncertainty in future mitigation action into consideration, the data used in the in-combination climate change impacts assessment for future climate projections covers RCP 4.5 and 8.5, which are considered to represent a broad range of possible outcomes. It is recognised that other outcomes are possible.

Limitations

4.3.11 The limitations of the in-combination climate change impacts assessment are as follows:

- the assessment relies on trends identified from current model projections of climate change. Although the ability to model climate change is constantly evolving, limitations remain in the ability of modelling to simulate the real world; and
- climate projections used in the assessments/baseline only extend to 2099 and some aspects of the projections only extend to 2079. Thus, projections do not cover the full lifetime of the Proposed Scheme.

Environmental baseline

4.3.12 The Climate data and Information report (Volume 5: Appendix CL-001-00000) presents an overview of the current climate conditions, projected climate change trends and related information. The document is based on the UK Climate Projections 2018 (UKCP18), which is the latest set of climate projections for the UK.

4.3.13 These climate change projections have been used to define the climate change trends used in the climate change resilience (CCR) and in-combination climate change impacts (ICCI) assessments for the Proposed Scheme. A summary of the projected climate trends used in the climate change assessments is provided within Table 21.

Table 21: Projected climate trends informing the Proposed Scheme climate change assessments

Projected future climate trend
Increase in mean, maximum and minimum daily temperatures across all seasons
Increased frequency of heatwaves
Decreased frequency of cold weather events (e.g. snow and ice)
Increased frequency of heavy rainfall events
Increased frequency of dry spells
Increased frequency of windstorm events in the second half of the 21st Century
Decrease in relative humidity
Hotter and drier conditions in summer
Warmer and wetter conditions in winter
Changes in temperature and rainfall patterns*
Increased frequency of extreme weather events (e.g. dry spells, heavy rainfall events, heatwaves)
Increased frequency of lightning events in the second half of the 21st century
Decreased frequency of fog events in the second half of the 21st century

** This climate trend relates primarily to the complex relationship between changing climatic parameters and species' behaviour and migration patterns.*

Embedded mitigation

4.3.14 Embedded mitigation measures refer in this context to those measures which have been incorporated within the design of the Proposed Scheme.

4.3.15 For each of the environmental topics, embedded specific mitigation measures have been extensively reviewed and assessed in order to determine whether they are sufficient in the context of future climate change. The mitigation measures are categorised as:

- measures which will be implemented within the construction phase of the Proposed Scheme; and
- measures which will be included in the development of maintenance, monitoring and/or replacement strategies for the operational phase of the Proposed Scheme.

4.3.16 Examples of in-combination climate change impacts which could occur during the construction period and the relevant mitigation measures which will be implemented include:

- climate change has the potential to increase the likelihood of shortages of water supply, potentially affecting the ability to use water-based systems (such as water spray and damping down) to suppress dust. Therefore, mitigation measures to source water for the suppression of dust and measures to suppress dust which are not water dependent (such as the use of enclosures, covering stockpiles, installing hard surface roads and reducing speed limits on site) have been specified in the draft Code of Construction Practice (CoCP)[1];
- increased frequency of dry spells could make the restoration of soils to their original condition more difficult. Measures such as protecting agricultural land adjacent to the construction site, provision and maintenance of appropriate stock-proof fencing and avoidance of traffic over the land leading to soil compaction have been specified in the draft CoCP; and
- increased frequency of heavy rainfall events may cause travel delays or congestion and therefore lengthened traffic impacts during the construction phase. Mitigation measures are therefore in place, such as the production of a route-wide traffic management plan, which is specified in the draft CoCP.

4.3.17 Examples of in-combination climate change impacts that could occur during the operational phase and the relevant mitigation measures which will be implemented include:

- climate change has the potential to compromise the establishment or function of landscape mitigation and habitat creation. Therefore, ecological mitigation measures such as consideration of climate change and potential future drought conditions when sizing and locating ponds and the selection of plant and tree species from a range of latitudes will ensure the future resilience of biodiversity to climate change;
- increased frequency of dry conditions has the potential to reduce the effectiveness of landscape planting. Maintenance, such as watering ornamental plants as required, and monitoring and weeding newly planted trees, will be carried out in order to mitigate against impacts such as vegetation die back due to dry conditions; and
- increased wind speeds have the potential to increase the spread of invasive species along the route of the Proposed Scheme. An appropriate monitoring and management regime will be implemented to identify and remedy areas of weed growth in order to avoid the occurrence of invasive, non-native species.

4.3.18 Increased frequency of heavy rainfall events could result in flooding, which has the potential to increase travel distance and congestion on roads already affected by the Proposed

Scheme because of a need to take alternative routes. Mitigation measures, such as ensuring that drainage design for new roads as part of the Proposed Scheme include climate change allowances, will be implemented to reduce the risk of flooding along such routes.

Results and conclusions

4.3.19 The results of the in-combination climate change impacts assessment are summarised below for construction and operation. Further details about the assessment results are included in the Results of climate change assessments in Volume 5: Appendix CL-002-00000.

Assessment of effects during construction

4.3.20 All identified potential in-combination climate change effects during construction are mitigated by the implementation of the measures contained within the draft CoCP, Volume 3, Route-wide effects and existing topic specific mitigation measures. These mitigation measures are summarised in Volume 5: Appendix CL-002-00000 and examples of embedded mitigation previously outlined.

4.3.21 Assessment of effects during operation A significant in-combination climate change effect has been identified specifically for Annandale Depot, an off-route works location. The impact relates to the release of treated wastewater to surface watercourses and associated water bodies, potentially affecting water quality. Further details are provided in the Water resources and flood risk chapter in this report. The potential in-combination impact is that an increased frequency of dry spells could reduce flows in watercourses near the depot, increasing sensitivity to wastewater treatment discharges which could increase the negative effect on water quality. Although measures to prevent pollutants from entering watercourses will help to prevent an increase in the significance of the effect, additional mitigation may be needed to reduce the risk.

4.3.22 All other potential in-combination climate change effects during operation are mitigated by embedded topic specific mitigation measures (examples of embedded mitigation previously summarised). Therefore, no additional mitigation measures to address adverse effects on the ability of resources and receptors to adapt to climate change during operation are proposed beyond those described above.

4.4 Climate change resilience assessment

Legal and policy framework

International level

4.4.1 The Paris Agreement[24] established a global goal on adaptation, strengthening resilience and reducing vulnerability to climate change. As part of this, the UK has agreed to engage in adaptation planning processes and implementation of action.

4.4.2 As a party to the Paris Agreement on climate change, the UK submitted its first Adaptation Communication to the UNFCCC on 12 December 2020[52]. This report sets out what the UK is doing to prepare for the effects of climate change.

National level

4.4.3 The relevant European Directive for the climate change resilience assessment is EIA Directive 2014/52/EU[53] and the related EC Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment[54]. The regulations implementing this Directive were transposed into UK legislation in May 2017. This recognises the issue of climate change and the need to assess the impacts of projects on climate, and their vulnerability to climate change.

4.4.4 The Climate Change Act 2008 requires the UK Government to undertake a national Climate Change Risk Assessment (CCRA) every five years. The Committee for Climate Change published the Independent Assessment of UK Climate Risk in 2021, and this will inform the third CCRA, which is due in 2022. This assessment reports that transport faces challenges from flooding, heat, erosion, subsidence and extreme weather, and the severity of these risks is projected to increase as the climate continues to change. The assessment recognises that the impact of climate change will lead to costly disruption of loss of service without additional adaptation, and that climate risks must be considered for existing, retrofitted and new assets. It also notes that the interconnected nature of infrastructure systems means that impacts on transport networks can impact on other infrastructure assets, and that impacts on other infrastructure sectors can impact on transport infrastructure.

4.4.5 Following the CCRA, the third National Adaptation Programme (NAP) will be published in 2023. This will detail the Government's long-term strategy to address the main climate change risks and opportunities for the UK. The CCC and its Adaptation Sub-Committee conduct an independent assessment of progress by the NAP every two years. These Progress reports contribute towards the wider understanding of national climate change risks, including risks specific to the transport sector and rail infrastructure.

4.4.6 In addition to the NAP, the UK Government have set out plans to transform the UK's infrastructure networks within the NIC[57]. This NIC sets out the importance of ensuring that national infrastructure is resilient to future climate change, through consideration of expected effects at the design stage, and building in cost-effective mitigation over the whole life cycle of the asset.

4.4.7 In 2018 the UK government published A Green Future: Our 25 Year Plan to Improve the Environment[11]. This plan sets out the government's stated ambition in a number of environmental policy areas in England. Core areas of focus include reducing flood risk and tackling climate change through increasing the resilience of UK infrastructure and natural environment.

4.4.8 The 25 Year Environment Plan also committed the UK government to ensuring that all policies, programmes and investment decisions consider the possible extent of climate change this century.

4.4.9 In November 2020, the Government set out its Ten Point Plan for a Green Industrial Revolution[29]. The Ten Point Plan sets a foundation for delivering a net zero economy and will help accelerate the transition to public transport modes such as rail. The Plan acknowledges that the pathway to achieving net zero emissions needs to be undertaken in parallel with adaptation action, building resilience to the effects of climate change.

4.4.10 In March 2021, the Government published its Industrial Decarbonisation Strategy[30] which builds on commitments from earlier strategies and policy consultations such as the 2020 Ten Point Plan for a Green Industrial Revolution. This strategy presents an indicative roadmap to net zero for UK Industry and reiterates the need for adaptation action, to build resilience to the effects of climate change.

4.4.11 2021 saw the staging of the 26th Conference of the Parties (COP26) in Glasgow.

Guidance and industry standards

4.4.12 The National Infrastructure Commission[59] recently published a report that presents a framework for ensuring resilient infrastructure systems in the UK. This report recognises that disruption to infrastructure will be exacerbated by climate change and recommends that operators plan ahead to ensure they are resilient to future changes.

4.4.13 IEMA has published guidance on climate change resilience and adaptation[58] in response to the requirements specified in EIA Directive 2014. This guidance provides an approach to undertaking assessments of climate change resilience within the EIA process.

Scope, assumptions and limitations

4.4.14 The scope, assumptions and limitations for the climate change resilience assessment are set out in in the EIA SMR Table 222.

Table 22: Summary of scope of the climate change resilience assessment

Scope	Description
Technical	Identification and assessment of potential climate change risks for HS2 assets within the Proposed Scheme
Spatial	The assessment is route-wide
Temporal	The temporal scope is the 120-year design life of the Proposed Scheme, which includes both construction and operation

[59] National Infrastructure Commission (2020), *Anticipate, react, recover. Resilience infrastructure systems*. Available online at: https://nic.org.uk/app/uploads/Anticipate-React-Recover-28-May-2020.pdf.

Assumptions

4.4.15 The assumptions which have informed the assessment are as follows:

- the assessment has assumed that embedded mitigation measures included in the design, construction and maintenance of the Proposed Scheme are sufficient to address the effects of the Proposed Scheme under current climatic conditions. The assessment focuses on the resilience of the Proposed Scheme to changes in climate; and
- the assessment has assumed a trend of increased global carbon emissions in the atmosphere in the coming decades, in line with RCPs used in UKCP18. Increased global carbon emissions will lead to increased global temperatures. In turn this is a general assumption used in the climate models which are the basis of the climate trends used to inform the assessment. To present a range of plausible future climate scenarios, that take the uncertainty in future mitigation action into consideration, the data used in the in-combination climate change impacts assessment for future climate projections covers RCP 4.5 and 8.5, which are considered to represent a broad range of possible outcomes. It is recognised that other outcomes are possible.

Limitations

4.4.16 The limitations of the climate change resilience assessment are as follows:

- the assessment relies on current model projections of climate change. Although the ability to model climate change is constantly evolving, limitations remain in the ability of modelling to simulate the real world;
- climate projections used in the assessments/baseline only extend to 2099 and some aspects of the projections only extend to 2079. Thus, projections do not cover the full lifetime of the Proposed Scheme; and
- there are limited high speed rail assets in the UK and therefore limited data/evidence on this type of asset, and the assessment therefore uses evidence from other similar infrastructure, both in the UK and internationally, such as Network Rail.

Environmental baseline

4.4.17 The Environment baseline previously summarised (section 4.3.12 – 4.3.13) also applies to the climate change resilience assessment.

Embedded mitigation

4.4.18 The mitigation of climate change related risks during operation is provided through one or more of the following categories of resilience measures:

- measures embedded within the outline design of the Proposed Scheme;
- measures which will be considered and developed during detailed design of the Proposed Scheme;

- measures which will be implemented within the construction phase of the Proposed Scheme; and
- measures which will be included in the development of maintenance, monitoring and/or replacement strategies for operational phase of the Proposed Scheme.

4.4.19 Examples of mitigation measures within these categories are summarised below:

- during the outline design stage, tunnel ventilation analysis has been undertaken considering the impacts of climate change on temperature to inform the ventilation capacity requirements;
- during the detailed design stage, geotechnical analysis will be undertaken in accordance with HS2 Technical Standards to develop the earthworks design and to mitigate the effects of geohazards that impact on slope stability. This shall be used to ensure robust embankment design, for example the selection of appropriate earthwork materials (i.e. those not susceptible to shrink-swell) and crest or toe drainage;
- during the detailed design stage, Overhead Contact Systems will be managed through the development of asset-specific technical specification documents. These documents will set out the operating thresholds of the asset taking into account climate change over the design life of the asset. For example, the maximum allowable thickness of ice on the overhead line; and
- during the operational stage, train borne equipment and track monitoring systems will assess temperature and the relative rail and track slab position. Alarm systems will indicate if the Critical Rail Temperature is likely to be reached, allowing for action to be taken such as temporary speed restrictions. In the event that rail temperatures may reach a critical temperature, re-stressing of the rails to give a higher Stress Free Temperature (SFT) is possible in situ. The typical service life of the rails is only 20 years. At the time of rail replacement, the appropriate SFT would be reviewed based on the prevailing climate at that time.

Results and conclusions

4.4.20 The results of the climate change resilience assessment are summarised below for construction and operation. Further details about the assessment results are included in the Result of climate change assessments in Volume 5: Appendix CL-002-00000.

Assessment of effects during construction

4.4.21 All climate change related risks to HS2 assets and infrastructure during construction have been assessed to be 'low' or 'medium' risk due to the implementation of the measures contained within the draft CoCP and adherence to relevant health and safety standards. Therefore, no significant climate change resilience effects have been identified and no further climate change resilience measures are proposed.

Assessment of effects during operation

4.4.22 All climate change related risks during operation have been assessed to be 'low' or 'medium' due to a range of mitigation measures (examples of embedded mitigation previously summarised). Therefore, no significant climate change resilience effects have been found and no further climate change resilience measures are required or proposed.

5 Community

5.1.1 Community impacts arising from the construction and operation of the Proposed Scheme are considered to be of predominantly local significance and have accordingly been reported in the Volume 2, Community Area reports, Section 6, and Volume 4, Off-route effects. Impacts on recreational routes that are a 'promoted' destination in their own right, that run through multiple community areas are considered to be localised, and therefore, are also appropriately reported in the individual Volume 2, Community Area reports, and where appropriate Volume 4, Off-route effects.

5.1.2 Localised in-combination effects are also reported at a community area level for both construction and operation in the individual Volume 2, Community Area reports and Volume 4, Off-route effects.

5.1.3 Construction worker impacts on community resources are considered at a route-wide level in Route-wide construction worker impacts in Volume 5: Appendix CM-002-00000. The assessment takes into account the proposed numbers of workers, the type and location of accommodation, expected working hours, the facilities that will be provided on construction compounds, experience from the construction of other similar large projects (such as High Speed One and the Elizabeth line (formerly Crossrail)) and the measures contained in the draft Code of Construction Practice (CoCP)[1] to manage any identified impacts.

5.1.4 It is concluded that there will be no significant effects at a route-wide level on community resources associated with the presence of the temporary construction workforce.

6 Ecology and biodiversity

6.1 Introduction

6.1.1 This section of the report describes route-wide impacts and the likely significant effects identified on ecological resources arising from the construction and operation of the Proposed Scheme.

6.1.2 Significant effects arising from the construction and operation of the Proposed Scheme on individual ecological receptors that are of at least district/borough value are reported within Volume 2, Community Area reports, Section 7, and where appropriate, Volume 4, Off-route effects.

6.1.3 This section of the report considers significant effects at both the regional and national levels, and in-combination effects that are not discussed within the Volume 2, Community Area reports and Volume 4, Off-route effects.

6.1.4 Local/parish level effects for each Volume 2, Community Area report are provided in the Ecological register of local level effects in Volume 5 (Appendices, reports EC-015). This section considers the scope for local/parish level effects identified in the aforementioned appendices, when acting in combination, to result in significant effects (i.e. effects at a district/borough level or above).

6.2 Scope, assumptions and limitations

6.2.1 Where access has been obtained, surveys have been undertaken in accordance with the scope and methodology set out in the EIA Scope and Methodology Report (SMR)[2]. Full details of the survey methods are set out in the Field Survey Methods and Standards (FSMS) annexed to the SMR. Community area specific assumptions and limitations are described in the relevant Volume 2, Community Area reports.

6.3 Designated sites

6.3.1 There are 12 sites of international importance for nature conservation that are relevant to the assessment. These sites are as follows:

- the Midland Meres and Mosses Phase 1 Ramsar Site includes 16 component Site of Special Scientific Interest (SSSI), the closest of which is 1.7km from the Proposed Scheme. It is, located north-east of Sandbach and west of Congleton, near the village of Brereton Heath. Studies to inform the Habitats Regulation Assessment (HRA) and appropriate assessment have established that with the inclusion of mitigation measures there will be no adverse effect on the integrity of the site;
- the Midland Meres and Mosses Phase 2 Ramsar Site includes 18 component SSSI, the closest of which is Black Firs and Cranberry Bog, which is 2.6km from the land required

for the Proposed Scheme and 1.6km from a construction traffic route. It is located to the south of Crewe, and adjacent to the village of Gorstyhill. There is a road within 200m of the site where traffic would increase as a result of the Proposed Scheme, but the predicted increase is very small and no HRA was required in relation to this site. However, during construction there would also be an increase in traffic on roads in proximity to both the Oakhanger Moss and Oak Mere SSSI components. HRAs completed for and appropriate assessment concluded there will be no adverse effect on the integrity of these sites;

- the West Midlands Mosses Special Area of Conservation (SAC) includes 3 component SSSI, the closest of which is 1.7km from the Proposed Scheme. It is located to the south of Crewe, and adjacent to the village of Wybunbury. The Wybunbury Moss SSSI component of the SAC is in close proximity to roads with displaced traffic due to the Proposed Scheme. An HRA screening exercise concluded that there are no likely significant effects on the site;
- Oak Mere SAC is located 9.4km west of the land required for the construction of the Proposed Scheme. However, it is adjacent to the A54 Middlewich Road and A49 Tarporley Road, where there will be increased traffic flows due to traffic diversions required for the construction of the Proposed Scheme. A HRA screening exercise concluded that there will be no likely significant effects on the site;
- Rostherne Mere Ramsar Site is adjacent to the land required for the construction of the Proposed Scheme. It is located south-west of Altrincham, and adjacent to the village of Rostherne[60]. Studies to inform the HRA and appropriate assessment have concluded that with the inclusion of mitigation measures there will be no adverse effect on the integrity of the site;
- Rixton Clay Pits SAC is located to the east of Warrington, near the village of Hollins Green. It is immediately adjacent to a proposed construction traffic route for the Proposed Scheme on the A57 Manchester Road. Studies to inform the HRA and appropriate assessment have concluded that there will be no adverse effect on the integrity of the site;
- Manchester Mosses SAC comprises three separate areas; one located on the east edge of Warrington in the civil parish of Birchwood; the second to the north-east of Warrington, adjacent to the M62 at Holcroft Moss; and the third, the largest, to the south-east of Leigh, east of the village of Glazebury. The Proposed Scheme is adjacent to the Holcroft Moss element. Studies to inform the HRA and appropriate assessment have concluded that with the inclusion of mitigation measures there will be no adverse effect on the integrity of the site;
- Rochdale Canal SAC is 4.6km north of the Proposed Scheme. The canal is designated between the parish of Failsworth, Oldham in Greater Manchester, and the town of Littleborough, north-east of Rochdale. There are construction traffic routes and displaced traffic associated with the Proposed Scheme adjacent to the SAC. For this reason, an HRA

[60] High Speed Two Ltd (2012), *HRA Screening Report for Rostherne Ramsar Site.*

has been undertaken. On the information currently available, it has not been possible to rule out adverse effects from nitrogen deposition, and on a precautionary basis it is therefore concluded that there may be an adverse effect on the SAC that is significant at the international level. Further assessment will be carried out in accordance with Article 6(3) of the Habitats Directive. Documents to inform the Appropriate Assessment for the Rochdale Canal SAC will be made available to Parliament prior to approval of the hybrid Bill;

- the Ribble and Alt Estuaries SPA and Ramsar site is 6.9km from the land required for the construction of the Proposed Scheme at Preston station. The SPA/Ramsar site is downstream of the Preston station site. A HRA screening exercise concluded that there will be no likely significant effects on the site;
- the River Eden SAC is approximately 100m from a construction traffic route that will be used during construction of the Proposed Scheme at Carlisle station. A HRA screening exercise concluded that there will be no likely significant effect on the site;
- the Upper Solway Flats and Marshes SPA/SAC/Ramsar site is 2.6km from the land required for the construction of the Proposed Scheme at Annandale depot. Studies to inform the HRA and appropriate assessment for this site have been completed and the conclusion is that there will be no adverse effects on the integrity of the site; and
- Raeburn Flow SAC is 1.1km from the land required for the construction of the Proposed Scheme at Annandale depot. The potential for surface and groundwater effects has been considered, and it has been agreed with NatureScot that there will be no likely significant effects on the site.

6.3.2 The Proposed Scheme falls within the relevant Impact Risk Zone (IRZ)[61] of 17 SSSI, which are of national importance. There are a further eight SSSI where the Proposed Scheme is not within the IRZ but where there is a potential effect due to air pollution from construction traffic routes or diverted traffic. Of the 25 SSSI, there is one SSSI (Rochdale Canal) where the impacts are predicted to result in a significant adverse effect. Further opportunities to avoid or reduce effects at this site, as well as on the sites identified below, will be considered as the design develops.

6.3.3 There are eight Local Nature Reserves (LNR) that are relevant to the assessment, but none where the impacts will result in a significant adverse effect.

6.3.4 There are 34 non-statutory wildlife sites where there will be significant adverse effects due to the Proposed Scheme. These include 30 Local Wildlife Sites (LWS) in Cheshire and four Sites of Biological Importance in Greater Manchester. These sites are of county/metropolitan value.

6.3.5 A number of other LWS and Sites of Biological Importance lie in the vicinity of the Proposed Scheme and the potential for indirect adverse effects on them was considered as part of the

[61] The Impact Risk Zone is identified for each SSSI to reflect the particular sensitivities of the features for notification and the type of development.

assessment, as reported in the relevant Volume 2, Community Area reports, Section 7. This is a cumulative effect at a regional level.

6.3.6 Collectively, these non-statutory wildlife sites form an important component of ecological networks[62]. They provide 'core habitat'[63] and/or 'stepping stones'[64], which are likely to be important in maintaining the conservation status of a range of habitats and species. These networks benefit the species and habitats for which the sites are designated and a wide range of other species that use them for migration and dispersal. In addition to the adverse effects on these sites identified in the Volume 2, Community Area reports, it is possible that, without mitigation, the construction of the Proposed Scheme could lead to additional adverse effects on other features of the ecological networks of which they form a part at the regional level.

6.3.7 Where a significant adverse effect on the integrity of a non-statutory wildlife site is expected, compensation has been incorporated into the Proposed Scheme to address effects on the conservation status of the habitats and species for which that site was designated. The location, size and form of compensatory habitat creation areas that will be provided has sought, where reasonably practicable, to adhere to the Lawton report[65] principles of more, bigger, better and joined. In so doing, the design of compensatory habitat creation will seek to maintain and enhance existing ecological networks (see Volume 1, Section 9), by enhancing existing core habitats, providing new core habitats, and/or promoting connectivity between habitat fragments. As a result, route-wide effects on ecological networks will be reduced to a level where they are unlikely to be significant.

6.3.8 Where there is a significant effect at a non-statutory wildlife site, it is not possible to directly mitigate the effect on designation status (as the responsibility for designating lies with external bodies). However, it is expected that when mature, the compensatory habitats to be created are likely to meet relevant non-statutory wildlife site criteria. Once ecological compensation areas are of sufficient biodiversity value to meet the relevant criteria they should be formally designated.

6.3.9 Overall, the mitigation and compensation measures proposed will ensure that no permanent significant residual effects at the regional or route-wide levels are likely to occur.

6.3.10 There are 16 woodlands that are either on the Ancient Woodland Inventory (AWI) for England or are considered to be ancient woodlands as a result of the heritage review

[62] Networks of natural habitats which link sites of biodiversity importance and provide routes or stepping stones for the migration, dispersal and genetic exchange of species in the wider environment.

[63] Core habitat may be defined as an area of relatively intact habitat that is sufficiently large to support particular species; as distinct from small fragments of habitat with high edge to centre ratios and which are surrounded by modified land-uses that are hostile to most wildlife.

[64] Stepping stones are small patches of habitat that help to provide connectivity between core areas of habitat, aiding the movement of species between core areas.

[65] Lawton, J (2010), *Making space for nature: A review of England's wildlife sites and ecological network,* Defra, London.

undertaken by HS2 Ltd, where there would be a direct loss due to construction of the Proposed Scheme as listed below:

- Bull's Wood (MA02);
- Winnington Wood (MA02);
- Stanthorne Hall Farm Wood (MA02);
- Leonard's and Smoker Wood (MA02/03);
- Belt Wood (MA03);
- Daisybank Wood (MA03);
- Coroner's Wood (MA04);
- Hennersley Bank (MA06);
- Arden House Wood (MA06);
- East Arden House Wood (MA06);
- Millington Clough (MA06);
- Hancock's Bank Wood (MA06);
- Ryecroft Covert (MA06);
- Sugar Brook Wood (MA06);
- Bollin Bank (MA06); and
- Davenport Green Wood (MA06).

6.3.11 There will be significant adverse effects at a national level in each case.

6.3.12 In Scotland, there is also a loss of ancient woodland at the unnamed woodland south of Railway Cottage where the effect due to construction of the Annandale Depot is also significant at the national level.

6.3.13 The heritage review of woodlands not listed on the AWI undertaken by HS2 Ltd identified one additional woodland that will be directly affected (Birkin Bridge Lodge Wood) which is ancient but is considered to be too small to be included on the AWI (i.e. less than 0.2ha). The overall effect of the Proposed Scheme on ancient woodland is considered to be significant at a national level.

6.4 Habitats

6.4.1 The Proposed Scheme will result in the loss of areas of a range of habitats, including habitats of principal importance (as identified under Section 41 of the Natural Environment and Rural Communities Act, 2006)[66].

6.4.2 Where reasonably practicable, habitat loss has been avoided or reduced. Areas of habitat creation have been identified along the route of the Proposed Scheme to provide

[66] *Natural Environment and Rural Communities Act 2006*. Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/ukpga/2006/16/section/41

compensation where habitat loss has been unavoidable. As described in relation to designated sites, where appropriate, these areas have been identified based on consideration of the goal of working towards the creation of 'bigger, better and more joined up' ecological networks.

6.4.3 A total of 5.7ha of ancient woodland will be lost to the Proposed Scheme, including from the woodlands confirmed as ancient in the heritage review.

6.4.4 Ancient woodland is an irreplaceable resource and this loss is considered to be a permanent adverse residual effect, which is significant at a national level[67]. The loss of woodland will be partly compensated through a range of measures. Ancient woodland soil with its associated seed bank will be translocated to receptor sites that have, wherever possible, been chosen because they link to and/or are adjacent to ancient woodland fragments. This will seek to increase the connectivity of fragmented ancient woodland parcels. Other measures such as planting native tree and shrub species of local provenance, and translocation of coppice stools and dead wood, will be undertaken as part of the bespoke package of compensation for each ancient woodland impacted.

6.4.5 Planting of compensatory areas of lowland deciduous woodland to address losses of both ancient and non-ancient woodland will be undertaken in the vicinity of the woodlands where losses occur. In accordance with the Ecological Principles of Mitigation in the EIA SMR, they are designed to increase the extent of woodland in the vicinity and/or enhance connectivity between woodlands. These planting areas are 138.2ha in extent.

6.4.6 No ancient trees will be lost as a result of the Proposed Scheme but at least 24 veteran trees[68] will be lost. The loss of these trees will be significant at the national level.

6.4.7 In addition to the loss of ancient woodland and veteran trees, other notable habitat losses that will occur that are of regional significance as a consequence of the construction of the Proposed Scheme include:

- semi-natural broadleaved woodland: loss of 53.5ha as a result of the Proposed Scheme as a whole;
- grassland: loss of 27.8ha of unimproved and semi-improved grassland likely to qualify as a habitat of principal importance as a result of the Proposed Scheme as a whole; and
- ponds: loss of 313 ponds across the Proposed Scheme.

6.4.8 On a precautionary basis, assuming the loss of all hedgerows within the land required for the Proposed Scheme, there will be an overall loss of up to 323.3km of hedgerows. This loss is also significant at a regional level. This total, however, includes some hedgerows that are likely to be retained, such as those located within land required for overhead line

[67] Where a loss of habitat is identified at a national level, this includes England and Scotland.

[68] The Natural England/Forestry Commission Standing Advice states that an ancient tree is one which, because of its age, size or condition, is of exceptional biodiversity, cultural or heritage value. All ancient trees are veteran trees. Not all veteran trees are old enough to be ancient, but are old relative to other trees of the same species. Very few trees of any species reach the ancient life-stage.

diversions/realignments and those located within land required for the creation of woodland and grassland habitat.

6.4.9 During construction, the loss and severance of hedgerows will result in a temporary adverse effect on the hedgerow network that is significant at the regional level. In accordance with the Ecological Principles of Mitigation in the EIA SMR and draft Code of Construction Practice (CoCP)[1], efforts will be made (where reasonably practicable) to limit significant effects on species by reducing habitat loss and through the early creation of replacement features.

6.4.10 Loss of hedgerows will be compensated through a range of measures, including translocation of important hedgerows that are a reason for LWS designation, creation of new hedgerows and linear planting features, and tree and shrub planting for landscape purposes. A network of hedgerows and other linear habitat will be planted on either side of the Proposed Scheme. Following reinstatement, it is likely that significant residual effects on the hedgerow network will be offset by the beneficial effects of other linear planting. As such, at a route-wide level no permanent significant residual effects are likely to occur.

6.4.11 Once restoration of arable farmland and compensatory habitat creation is taken into account, the loss of arable field margins and ponds is not likely to give rise to significant adverse residual effects at greater than district/borough level.

6.4.12 The design of the Proposed Scheme includes viaducts across the main watercourses, which will reduce significant effects both by reducing habitat loss during construction and by maintaining links across the Proposed Scheme for relevant species.

6.4.13 The results of a separate Water Framework Directive (WFD) compliance assessment[69] are presented in the Water Framework Directive compliance assessment in Volume 5: Appendix WR-001-00000, with a summary provided in Section 16 of this report.

6.4.14 Where habitats of principal importance will be lost, opportunities for the creation of compensatory habitat have been explored. Overall, approximately 87ha of habitats of principal importance will be lost as a result of construction of the Proposed Scheme, including the various habitats identified above. This is a significant effect at a national level.

6.4.15 A total of approximately 240ha of habitats of principal importance will be created, consisting mainly of lowland mixed deciduous woodland and lowland meadow with some wetland habitats. In addition, there will be further areas of landscape planting of native broadleaved woodland, which will also contribute to habitat creation.

[69] *Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Strasbourg, European Parliament and European Council.*

6.5 Species

6.5.1 The protected and notable species relevant to the assessment are described below.

Bats

6.5.2 Of the UK's 17 resident bat species, 11 have been recorded along the route of the Proposed Scheme as follows:

- common pipistrelle;
- soprano pipistrelle;
- Narthusius' pipistrelle;
- brown long-eared bat;
- noctule;
- Leisler's bat;
- serotine;
- whiskered bat;
- Brandt's bat;
- Natterer's bat; and
- Daubenton's bat.

6.5.3 On a precautionary basis, there are effects on 10 bat population assemblages of significance at the regional level using suitable habitats in the following locations:

- east and north-east of Lostock Gralam (MA02);
- between Wimboldsley and Stanhome (MA02);
- between Stanthorne and Rudheath (MA02);
- between Smoker Brook and the M6 (MA03);
- between the M6, the M56 and the A556 (MA3 and MA06);
- between the M56 (MA03) and the River Bollin and the Bridgewater Canal (MA04);
- west of Dunham Massey (MA03);
- Manchester Ship Canal and Coroner's Wood (MA04);
- between the A556 Chester Road and junction 6 of the M56 (MA06); and
- between the M56 junction 6 and Manchester Airport (MA06).

6.5.4 Key impacts on bats will be those associated with the loss and disturbance of roost sites and the severance of important flight lines through unavoidable habitat removal during construction of the Proposed Scheme. The loss of hedgerows and other habitats that provide connectivity in the landscape will affect the ability of some bat species to move between roost sites and foraging areas. The impact of such a disturbance or displacement will be greatly increased if bats are hampered in moving between breeding sites, hibernation sites and other roosts which they commonly utilise.

6.5.5 There is also a risk of bat mortality due to passing trains. However, when travelling at high speed, trains will pass quickly (approximately four seconds), and therefore, exposure to the risk of collision will be intermittent and of short duration. The point at which these potential impacts will result in a significant adverse effect on the bat population concerned, will differ depending on a number of factors including: the size and status of the bat population, the flight characteristics of the bat species, and the design of the Proposed Scheme at the point the potential impact occurs (i.e. whether the railway is in cutting, on embankment, on viaduct or at grade).

6.5.6 The loss of active roosts located within the land required for the Proposed Scheme will be compensated through the provision of suitable replacement features in accordance with the Ecological Principles of Mitigation identified in the EIA SMR. All replacement provision for loss of active roosts will be provided within land identified as required as part of the Proposed Scheme.

6.5.7 At the route-wide level, the loss of trees and buildings identified as having high potential to support roosting bats will result in a reduction in the availability of a roosting resource in the immediate vicinity of the Proposed Scheme until compensatory planting establishes. As any such losses are likely to represent a small proportion of the roosting opportunities available to the range of populations concerned, it is considered unlikely that these effects will result in a significant effect on the conservation status of the species concerned. However, as a precaution, and to ensure that populations are not constrained by the availability of additional alternative roosting provision (i.e. provision in excess of that legally required due to loss of confirmed roosts), mitigation will be provided within ecological compensation areas, which will comprise the provision of bat boxes and other methods, such as tree surgery, to provide artificial roosting features within retained trees as appropriate.

6.5.8 Site specific measures to address the effects of habitat severance, such as ecological underbridges and appropriately sized culverts, have been provided on a precautionary basis where they are required to address significant effects on the local populations concerned. Planting will be provided to reinstate key commuting routes and to promote the use of suitable safe crossing points across the route of the Proposed Scheme, including those provided by viaducts and other structures as mentioned previously.

6.5.9 Proposed planting will not be sufficiently mature to provide habitat linkages immediately, and therefore, there is the potential for significant temporary adverse effects on bat populations until these habitats establish. A series of measures will be implemented to limit the duration and scale of temporary habitat severance, which include establishing key alternative flight lines as early as is reasonably practicable, and the use of temporary features such as artificial hedgerows. All such measures will be provided in accordance with the Ecological Principles of Mitigation within the EIA SMR.

6.5.10 The implementation of these measures will reduce the scale and intensity of impacts on bat populations as a result of temporary habitat severance. Although temporary adverse effects on bat populations are likely to occur during construction, the resulting effect on the

conservation status of the populations concerned is not expected to be significant, and no in-combination significant adverse effects are likely.

6.5.11 Following the implementation of the measures proposed, bat mortality as a consequence of the Proposed Scheme will be reduced, but not avoided. Through providing safe crossing points and accompanying planting to mitigate potential impacts at high risk locations (taking into consideration the rarity and the conservation status of the species in question), it is expected that mortality will be reduced to a level at which, for each species, it is negligible. An appropriate monitoring programme will be developed in consultation with Natural England, and implemented during operation in order to assist in meeting relevant requirements under the Conservation of Habitats and Species Regulations, 2017[70].

6.5.12 With the implementation of the measures proposed, it is likely that adverse effects on bat populations due to the construction and operation of the Proposed Scheme (including those on rarer bat species), will be reduced to a level that is not significant. The mitigation and compensation provided to address population level effects is also appropriate to ensure that there will be no cumulative effects on the species concerned. Therefore, no significant residual effects on the conservation status of bats are likely to occur.

Great crested newt

6.5.13 The Proposed Scheme will pass through areas within the core geographical range of great crested newt and they are widespread throughout the route of the Proposed Scheme. In some areas, breeding ponds will be lost, terrestrial supporting habitat will be lost and/or fragmentation of habitat will occur. However, in the long term, the Proposed Scheme is not expected to act as a barrier to movement of great crested newts, particularly as the railway track will be designed to allow passage of newts and small animals.

6.5.14 Compensatory habitat, to address impacts on great crested newt and other amphibian populations, will be provided in accordance with the Ecological Principles of Mitigation in the EIA SMR. Compensation will include the provision of replacement ponds, terrestrial habitat and hibernation habitat sufficient to maintain the favourable conservation status of the species.

6.5.15 Wherever reasonably practicable, the required mitigation and compensation will be provided at the location of the individual populations concerned unless there are clear benefits to the species in providing the compensatory habitats elsewhere. In some cases, there will be a requirement to relocate severed populations. In all such cases, the necessary compensation will be provided in accordance with the Ecological Principles of Mitigation in the EIA SMR in proximity to the Proposed Scheme. No significant change in the distribution of the species is expected at a route-wide level. However, some changes in the distribution of the species at the local/parish scale are likely to occur.

[70] *The Conservation of Habitats and Species Regulations 2017*. Her Majesty's Stationery Office, London.

6.5.16 Following the implementation of the measures proposed, it is likely that adverse impacts on great crested newts and other amphibians due to construction and operation of the Proposed Scheme will be reduced to a level that is not significant.

Otter

6.5.17 Otters are present along some parts of the route of the Proposed Scheme and the assessment assumes that this species is likely to have spread to all suitable watercourses within the land required for the construction of the Proposed Scheme by the commencement of operation. At each point where the Proposed Scheme will cross a watercourse suitable for otter, the detailed design will allow for the safe passage of otter. The Proposed Scheme is not expected to affect either the movement of existing populations or the potential continued spread of this species in the future to an extent that will be significant above the local/parish level.

6.5.18 The potential for temporary adverse effects on otter populations as a consequence of disturbance of watercourses during construction will be reduced through the implementation of measures within the draft CoCP and through the implementation of the Ecological Principles of Mitigation in the EIA SMR. Following mitigation, the effect on otters will be reduced to a level that is not significant.

Water vole

6.5.19 Whilst water voles are found throughout England, this species has undergone significant contraction in range during recent years due to habitat loss and increased predation by American mink. Evidence of water vole was found in a small number of watercourses within, and in the vicinity of, the land required for the construction of the Proposed Scheme. Mitigation will be provided within the ecological compensation areas (which form part of the Proposed Scheme) in accordance with the Ecological Principles of Mitigation in the EIA SMR.

6.5.20 Where the Proposed Scheme will cross watercourses, all culverts will be suitably designed to allow dry passage for mammals, such as otter and water vole, to prevent isolation of populations, taking into account flood events, or will have an alternative dry tunnel installed.

6.5.21 The potential for temporary adverse effects on water vole populations as a consequence of disturbance of watercourses during construction will be reduced through the implementation of measures within the draft CoCP and through the implementation of the Ecological Principles of Mitigation in the EIA SMR. Following mitigation, the effects on water vole will be reduced to a level that is not significant.

Birds

6.5.22 For the majority of birds, impacts arising from construction of the Proposed Scheme are not likely to result in permanent adverse effects on breeding and wintering populations. This is because the habitats supporting these species will be recreated once construction is

complete. However, temporary adverse effects on individual populations of less common species, significant at up to county level, are likely to occur for the duration of construction.

6.5.23 Barn owl will be subject to significant adverse effects due to displacement, loss of nesting sites and foraging habitat during construction. In addition, during operation, there is a risk of barn owl mortality due to collision with passing trains resulting in further significant adverse effects. Overall, on a precautionary basis, there will be a residual significant effect on the conservation status of barn owl at the national level.

6.5.24 To offset the likely loss of barn owls from the vicinity of the Proposed Scheme, provision of opportunities such as barn owl nesting boxes in suitable locations further than 3km from the route of the Proposed Scheme will be explored with local landowners. As the availability of nesting sites is a limiting factor for this species, the implementation of these measures will be likely to increase numbers of barn owls within the wider landscape and thus offset the adverse effect. If the proposed mitigation measures for barn owl are implemented through liaison with landowners and relevant stakeholders, the residual effect on barn owl will be reduced to a level that is not significant.

6.5.25 Noise of passing trains has the potential to disturb birds within habitats close to the Proposed Scheme. Birds habituate to loud noises that occur regularly and frequently, and hence, it is considered that this will not generally cause significant effects. There is some evidence to suggest that breeding bird densities can be reduced where there is persistent noise from busy roads due to birds being unable to hear each other's songs[71]. However, this is not expected to occur as a result of the Proposed Scheme, as trains will pass quickly. The effect of train noise on breeding birds is, therefore, not considered likely to result in significant adverse effects.

Common reptiles

6.5.26 The Proposed Scheme will not pass through areas that are known to support England's rarer reptile species (smooth snake and sand lizard). Common reptiles were recorded at a number of locations within the land required for the construction of the Proposed Scheme. Compensatory habitat creation to address loss of habitat supporting reptiles will be provided within ecological compensation areas in accordance with the Ecological Principles of Mitigation identified in the EIA SMR.

6.5.27 Effects will be mitigated at the level of individual populations. As a consequence following the implementation of the measures proposed, it is expected that adverse effects on reptiles will be reduced to a level that is not significant.

[71] Radford, A., Morely, E., and Jones, G. (2012), *The effects of noise on biodiversity*. Defra Report NO0235.

Badger

6.5.28 The badger is common throughout much of lowland England and Scotland and numerous badger setts were found within the land required for construction of the Proposed Scheme.

6.5.29 Mitigation measures to address the potential disturbance of badgers during construction of the Proposed Scheme will be provided in accordance with the Ecological Principles of Mitigation in the EIA SMR. This will include the provision of badger-proof fencing, replacement setts and underpasses where necessary to ensure that there are no significant effects.

Fish

6.5.30 These will not be directly affected by the Proposed Scheme and any indirect effects will be controlled through implementation of measures in the draft CoCP to reduce any effects to a level that is not significant.

Invertebrates

6.5.31 There are a few remaining white-clawed crayfish populations at scattered locations along the route of the Proposed Scheme.

6.5.32 The potential for temporary adverse effects on white-clawed crayfish populations as a consequence of disturbance of watercourses during construction will be reduced through the implementation of measures within the draft CoCP and through the implementation of the Ecological Principles of Mitigation in the EIA SMR. Following mitigation, no significant residual effects on white-clawed crayfish populations are likely to occur.

6.5.33 Potential effects on invertebrate populations such as dingy skipper butterfly and alder leaf beetle will be mitigated within ecological compensation areas through habitat creation in accordance with the Ecological Principles of Mitigation identified within the EIA SMR. Following mitigation, the effects will be reduced to a level that is not significant.

Notable plants

6.5.34 There will be effects on a range of notable plant species. These include Freiberg's screw-moss, wild service tree and grass vetchling. Where effects cannot be avoided, they will be mitigated within habitat creation areas, using measures such as translocation where appropriate, and other measures set out in the Ecological Principles of Mitigation in the EIA SMR. Following mitigation, the effects will be reduced to a level that is not significant.

6.6 Climate change

In developing the ecological compensation and landscaping design of the Proposed Scheme, climate change adaptation has been considered. This is reported in Section 4 of this report.

7 Health

7.1 Introduction

7.1.1 The health effects of the Proposed Scheme are reported at both route-wide and community area levels. This section identifies the impacts of the Proposed Scheme that will affect the population across the route as a whole, or at the wider regional level. It reports changes that are considered to be potentially important for the health of people within this population. Potential health effects arising from localised impacts, which will affect specific communities along the route of the Proposed Scheme, are reported in Volume 2, Community Area reports, and where appropriate, Volume 4, Off-route effects. A list of all the health effects, and where these are reported, is provided in Volume 1, Section 8.

7.1.2 The effects reported in this section are not evenly distributed and may not apply to all individuals or communities along the route of the Proposed Scheme. Where appropriate, the assessments within this section describe those areas, or types of area, where health effects are most likely to occur.

7.2 Scope, assumptions and limitations

7.2.1 The scope, assumptions and limitations for the health assessment are set out in Volume 1, Section 8 and the EIA Scope and Methodology Report[2].

7.2.2 As set out in the EIA SMR, the health assessment is based on a broader understanding of health, consistent with the World Health Organization (WHO) definition of health as 'a state of complete physical, mental and social well-being and not merely an absence of disease or infirmity'. An individual's health is mostly determined by genetics and lifestyle factors, but for a large enough population many other factors, or 'health determinants', are known to be important, and these factors may be affected by the Proposed Scheme.

7.2.3 The assessment has considered the impacts of the Proposed Scheme on a range of environmental and socio-economic 'health determinants', which could result in adverse or beneficial effects on health and wellbeing. This process is documented in the health assessment matrices in Volume 5 (Appendices, reports HA-001). Based on this, a professional judgement has been made to identify those effects on population health and wellbeing that are sufficiently important to report within the health assessment sections found in this report and the Volume 2, Community Area reports and where appropriate, Volume 4, Off-route effects.

7.2.4 The health determinant impacts of relevance to the population along the route as a whole are considered to be:

- impacts during construction:
  - employment and income;
  - housing;

  - transport (traveller stress and road safety); and
  - uncertainty and stress;
- impacts during operation:
  - airborne noise (railway noise); and
  - employment and income.

7.2.5 The health assessment identifies those areas where impacts on health determinants are predicted to occur. In some cases, such as for airborne noise, this comprises a fixed study area (1km either side of the route of the Proposed Scheme in rural areas, 500m in urban areas). In other cases, such as employment impacts, there is no defined study area. Direct impacts such as demolition of commercial and residential properties[72] occur within the boundaries of the Proposed Scheme, although the health effects may be felt by people further afield (such as employees of affected businesses). For impacts on traffic and transport, the health assessment focuses on the communities close to the Proposed Scheme where the majority of transport impacts will occur.

7.2.6 The health assessment methodology is based, in part, on a review of published evidence showing how impacts on health determinants are linked to health 'outcomes' (i.e. effects) in a large population. The evidence varies in its strength; for example, the evidence linking sound, noise and vibration to health outcomes is strong, whereas the evidence linking employment with health outcomes is moderate. The strength of evidence does not necessarily determine the importance of a health effect, but it is an indication of the level of certainty in the assessment. Additionally, there is greater reliability in the prediction of an impact on a health determinant than the consequent effect on health.

7.2.7 There is no established or widely accepted framework for assessing the ‘significant’ health effects of a development proposal. The EIA SMR sets out a methodology for describing the impacts on health determinants in terms of the magnitude and duration of the change to health determinants and the extent of the population exposed to this change. It also draws attention to the strength of evidence that links a change in health determinant with health effects. This framework permits the assessment to describe the impacts on determinants in a largely qualitative manner, with some structure to the relative scale of these impacts to give a sense of the importance of the potential health effects. However, this does not provide a clear basis for drawing conclusions as to whether a health effect is likely to be ‘significant’.

[72] In Volume 3, Route-wide effects, demolitions are categorised by: residential properties; commercial, retail and miscellaneous buildings (including outbuildings associated with residential properties, wind farms, telecommunication masts etc.); and community facilities.

7.3 Environmental baseline

Existing baseline

7.3.1 A review of publicly available health and demographic information has been undertaken to inform the health assessment. The information gathered describes the populations that could be affected by the Proposed Scheme in terms of their key characteristics such as size, distribution, age structure, socio-economic status and health. It enables consideration of the nature of the populations affected and their sensitivity to potential health effects, as well as indicating the prevalence of specific vulnerable groups (see SMR Section 12.6 for definition of vulnerable groups).

7.3.2 Public health indicators have been benchmarked by Public Health England to show how a local authority compares to England for each specific indicator[73]. The English Indices of Deprivation[74] rank neighbourhoods from most to least deprived, according to a range of criteria and an overall (combined) ranking. The benchmark is presented on a three-point scale: worse than, similar to and better than (the English average). The available data provides detail down to local authority, ward and lower super output area (LSOA) level. The description of the whole population, and the populations within these areas, does not preclude the possibility that there will be individuals or groups of people who do not conform to the overall profile.

7.3.3 The route of the Proposed Scheme will pass close to a number of large villages on the southern outskirts of Crewe, before passing beneath the town of Crewe in tunnel. After emerging from the Crewe tunnel north portal, the southern section of the route will cross sparsely populated rural land, passing through and close to a number of small settlements. Data provided by Public Health England show that, as a whole, the population along the southern part of the route has a similar health status compared with the national (England) averages, with slightly better than average health status in the areas around Crewe. The neighbourhoods along the southern part of the route are generally less deprived than the national average, falling mainly within the 10% to 50% least deprived deciles. There is a high degree of variation close to Crewe, with neighbourhoods falling within all bands from 10% most to 10% least deprived. As a whole, the population along the southern part of the route is considered to be slightly more resilient than the national average with regard to changes in the relevant health determinants, with some vulnerabilities in terms of the health status of the population.

7.3.4 To the north of the point where the Manchester spur deviates from the HS2 WCML connection, the Proposed Scheme will cross mainly agricultural land, passing through and

[73] Public Health England (2019), *Local Authority Health Profiles*. Available online at: https://fingertips.phe.org.uk/profile/health-profiles/data#page/1/gid/1938132701/pat/6/par/E12000003/ati/102/are/E08000035/iid/90366/age/1/sex/1.

[74] Ministry of Housing, Communities and Local Government (2019), *English Indices of Deprivation 2019*. Available online at: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019.

close to settlements including large villages, towns and suburbs on the outskirts of Salford, to connect with the West Coast Main Line (WCML) near Bamfurlong. As a whole, the population along the northern part of the route has a slightly worse health status compared with the national (England) averages. The neighbourhoods in this area have a high degree of variation in levels of deprivation, falling within all bands from 10% most to 10% least deprived. This area as a whole is considered to be slightly less resilient than the national average with regard to changes in the relevant health determinants and with some vulnerabilities in terms of the health status of the population.

7.3.5 The Manchester spur will diverge from the HS2 WCML connection near Hoo Green, running through the rural area to the south of Manchester and passing through and close to small rural settlements. As a whole, the population in this area has a slightly better health status compared with the national (England) averages. The neighbourhoods along this part of the Manchester spur are generally less deprived than the national average, falling mainly within the 10% to 50% least deprived deciles. This area is considered to be slightly more resilient than the national average with regard to changes in the relevant health determinants and with some vulnerabilities in terms of the health status of the population.

7.3.6 The route of the Proposed Scheme will then run in tunnel beneath suburban residential areas in south Manchester and industrial and mixed-use areas in Manchester city centre. It will run on viaduct through industrial and commercial land in Manchester city centre, passing close to residential areas and terminating at the new Manchester Piccadilly High Speed Station adjacent to the existing Manchester Piccadilly Station. As a whole, the population in this area has a worse health status compared with the national (England) averages. The neighbourhoods along this part of the Manchester spur are generally more deprived than the national average, falling mainly within the 10% to 50% most deprived deciles. This area is considered to be less resilient than the national average with regard to changes in the relevant health determinants and with some vulnerabilities in terms of the health status of the population.

7.3.7 The communities along the route of the Proposed Scheme are described in more detail in Volume 2, Community Area reports, Section 8. The baseline sections describe the general character of each area (rural or urban), the size and location of settlements and community facilities, and the demographic and health profile of the community.

Future baseline

Construction (2025)

7.3.8 Data in Volume 5: Appendix CT-004-00000 provides details of the committed developments close to the route of the Proposed Scheme that are assumed to have been implemented by 2025.

Operation (2038)

7.3.9 Data in Volume 5: Appendix CT-004-00000 provides details of the committed developments on or close to the route of the Proposed Scheme that are assumed to have been implemented by 2038.

7.4 Avoidance and mitigation measures

7.4.1 Consideration of potential health issues is an integral part of the planning and design of the Proposed Scheme, alongside other environmental, community and economic issues. Adverse effects on health determinants have been limited as far as reasonably practicable through mitigation measures, which have been incorporated into the design of the Proposed Scheme. The mitigation measures for other significant adverse effects that are most relevant to this route-wide health assessment include:

- limiting the loss of properties and community assets, as far as reasonably practicable;
- design of the track and track bed to avoid or reduce ground-borne noise and vibration; and
- provision of noise fence barriers and bunds to provide acoustic screening.

7.4.2 The design of the Proposed Scheme has also limited as far as reasonably practicable the impacts of construction on the road network and public transport through the following incorporated mitigation measures:

- site haul routes will be created adjacent to the route of the Proposed Scheme, and construction materials and equipment will be transported along the site haul routes where reasonably practicable to reduce heavy goods vehicle (HGV) movements on the public highway;
- borrow pits have been included to reduce HGV movements on the local road network;
- worker accommodation sites will be provided, which will reduce the traffic impact of daily worker trips; and
- disruption to rail users will be reduced by limiting possessions, where reasonably practicable, to existing maintenance periods. Rail blockades will be managed through a combination of measures, which could include diversions and replacement bus services, which will reduce the disruption to the travelling public.

7.4.3 Contractors will be required to comply with the Environmental Minimum Requirements for the Proposed Scheme, which will include the Code of Construction Practice (CoCP)[1].

7.4.4 The CoCP will be the means of controlling the construction works associated with the Proposed Scheme to ensure that the effects of the works upon people and the natural environment are reduced or avoided so far as reasonably practicable.

7.4.5 The CoCP will include mitigation measures to reduce transport impacts during construction of the Proposed Scheme. These include, but are not limited to, the following measures:

- engagement, where appropriate, with vulnerable road users (pedestrians, motorcyclists, cyclists, equestrians), to inform road safety measures for users of all modes of transport during traffic management works and temporary traffic control measures;
- contractor implementation of driver training programmes relevant to their specific environment (e.g. to protect pedestrians and non-motorised traffic);
- vehicle safety measures including signage, mirrors, prevention of underrunning and use of technology to remove blind spots according to vehicle size;
- a list of roads that may be used by construction traffic in the vicinity of the site, including any restrictions to construction traffic on these routes, such as the avoidance of large goods vehicles operating adjacent to schools during drop off and pick-up periods;
- regular operation of traffic liaison groups with key stakeholders to ensure that programmes of HS2 works are shared and which will assist the highways authorities to carry out their network management duties. Traffic liaison groups will consider appropriate engagement with local communities directly affected by site specific traffic management plans on a case-by-case basis;
- installation of appropriate signage indicating all temporary and permanent diversions of public rights of way (PRoW); and
- retaining access for cyclists and pedestrians, where safe and appropriate.

7.4.6 The CoCP will require contractors to produce a Community Engagement Framework and provide appropriately experienced community relations personnel to implement the framework, provide information to local communities and be the first point of contact to resolve issues. The HS2 Community Engagement Strategy[75] provides details of HS2's approach to community engagement. The HS2 Residents' Charter[76] sets out HS2's commitments to residents, and the roles of the Residents' Commissioner and Construction Commissioner in holding HS2 accountable to these commitments and monitoring responses to construction complaints.

7.4.7 The CoCP will require contractors to produce traffic management plans including measures to address road safety and reduce the risks to non-motorised users from construction vehicles on the roads. Contractors will be required to gain accreditation from the Fleet Operator Recognition Scheme, or equivalent, in order to demonstrate that all drivers have appropriate training in pedestrian, equestrian and cycle awareness and specific issues relating to driving on rural roads.

7.4.8 HS2 Ltd has adopted a series of strategic aims, which include skills, employment and education (SEE). These aims will extend through the supply chain using procurement and

[75] High Speed Two Ltd (2021), *Community Engagement Strategy*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/773683/HS2_Community_Engagement_Strategy_FULL_HiRes_WEB.pdf.

[76] High Speed Two Ltd (2017), *Community Engagement Residents Charter*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/704895/CS959_Community_Engagement_Residents_Charter_26_4.pdf.

contractual requirements. All major contracts will contain contractual requirements to provide SEE outputs, including apprenticeships, workless job starts and schools engagement.

7.4.9 HS2 Ltd has committed to providing a minimum of 2,000 apprenticeships over the lifetime of the entire project (which includes Phase One and Phase Two). The majority of these apprenticeships will be delivered through the supply chain across a wide range of trades and professions from construction to accountancy, quantity surveying to business administration.

7.4.10 Businesses required to relocate due to the construction of the Proposed Scheme will be eligible to claim compensation in accordance with the Compensation Code. HS2 Ltd recognises the importance of businesses being able to relocate to alternative premises and, therefore, offers additional support over and above statutory requirements to facilitate this process and to reduce and/or offset the effects of the Proposed Scheme.

7.4.11 As described in Volume 1, Section 9, HS2 Ltd is committed to providing trains that are quieter than the relevant current European Union specifications. Noise barriers in the form of landscape earthworks and noise fence barriers will avoid or reduce significant airborne noise effects. Significant ground-borne noise and vibration effects will be avoided or limited through the design and maintenance of the track and track bed.

7.5 Assessment of effects during construction

Employment and income

7.5.1 There is strong evidence for links between employment and income, and physical and mental health. The benefits of work are linked to increased opportunities for participation in society and increased access to healthier lifestyle choices, which are associated with improved mental and physical health. Employment also has direct health benefits such as social and psychological wellbeing, with work being an important aspect of individual identity and social status. The WHO identifies 'income and social status' as one of the six key determinants of health. A review of published research evidence linking employment, income and education with health and wellbeing can be found in the Route-wide commentary on health evidence base in Volume 5: Appendix HA-002-00000.

Construction employment and training

7.5.2 The Proposed Scheme will increase opportunities for employment and training during the construction phase. The socio-economic assessment (Section 12 of this report) estimates that the construction phase will generate 87,800 person years of construction jobs (the equivalent of 8,800 permanent full-time construction jobs). Of these, an estimated 60,600 person years of construction employment (equivalent to 6,060 permanent full time construction jobs) will be based at construction work sites along the route of the Proposed Scheme. Depending on skill levels required, and the skills of local people, communities within commuting distance of the Proposed Scheme will potentially benefit from these new

employment opportunities, as well as from the training opportunities provided by HS2 Ltd's apprenticeship scheme.

7.5.3 A further estimated 32,900 person years of employment (the equivalent of 3,300 full time jobs) could be created as a result of additional demand for goods and services through the business supply chain and expenditure effects of workers.

7.5.4 Contractors generally appoint the majority of skilled and managerial staff from their existing workforce or recruit nationally, and therefore, uptake of construction jobs from within local communities is likely to be predominantly in lower skilled roles. However, depending on skill levels required, and the skills of local people, construction employment will be accessible to residents within the communities along the route of the Proposed Scheme. These may include a range of occupations, such as skilled construction workers, labourers, tunnelling specialists, mechanical fitters, steel fixers, electricians, engineering professionals, and management and planning professionals. The local jobs created will last for the duration of the works, after which the training, skills and experience gained may continue to benefit people through improved future employment prospects in the construction sector.

7.5.5 The extent of beneficial health effects within the local communities arising from construction employment will depend on the number of people who are able to, and choose to, take up opportunities for employment and training. For those who do, this may result in improved income and employment status, with potential health and wellbeing benefits ranging from improved self-esteem to physical health benefits associated with increased access to healthy lifestyle choices.

7.5.6 Beneficial effects are likely to be greatest in the more urban areas such as Crewe and Manchester, as these areas contain a higher proportion of people of working age and with skills in the construction sector. All of these areas include communities with above regional average levels of unemployment and deprivation. Subject to uptake of employment opportunities and apprenticeships, areas of economic and social deprivation would have the most to gain from the employment and training opportunities and associated beneficial effects on health and wellbeing.

Direct and indirect business impacts and associated income and employment impacts

7.5.7 As described in the socio-economic assessment, Section 12, due to the land required for the Proposed Scheme there will be direct impacts on some local businesses. These will include the displacement of some businesses and loss of land with the potential to impact on business activities at others. The majority of businesses affected are assumed to be able to relocate to alternative premises, facilitated by payment of compensation for acquisition of the whole or part of the land. It is estimated that approximately 6,500 jobs will be displaced as a result of the requirement for land to construct the Proposed Scheme. Of these, it is assumed that approximately 780 jobs may be lost. In addition, the permanent loss of agricultural land is predicted to lead to the loss of a further 20 agricultural jobs. The direct loss of businesses and employment will also affect the business supply chain and

expenditure leading to a further 300 indirect job losses. As well as direct impacts, businesses will be affected by in-combination and isolation effects, which is predicted to lead to the loss or displacement of a further 400 jobs, plus 150 jobs lost due to impacts on business supply chains and expenditure.

7.5.8 Job losses will directly impact on incomes, and the extent to which these are recovered will depend on the type of alternative employment secured by the individuals affected. The level of job losses and reductions in income resulting from the construction of the Proposed Scheme will be very small in the context of the local and regional labour markets and will not affect health at the population level. However, some individuals may be adversely affected, particularly those who are less able to adapt due to personal circumstances. For example, workers on low incomes or with impaired mobility may face difficulties commuting to a new location. Such impacts could result in long-term effects on employment status, leading to potential adverse health and wellbeing effects.

7.5.9 In terms of overall employment and income, the construction of the Proposed Scheme will result in a net health and wellbeing benefit as a result of construction employment opportunities.

Transport

Traveller stress

7.5.10 Government guidance has identified traveller stress as an outcome of transport delays and disruption, affecting both drivers and public transport users. This comprises feelings of discomfort, annoyance, frustration or fear, culminating in physical and emotional tension that detracts from the quality and safety of a journey. Factors influencing traveller stress include fear of potential accidents, increased journey time and route uncertainty.

7.5.11 Section 14 of the Volume 2, Community Area reports, describe the impacts on the local road network and existing bus and rail infrastructure and services during the construction of the Proposed Scheme. Delays on the road network will be caused by increased traffic flows, temporary road or lane closures and associated diversions, temporary signals and speed restrictions. This will lead to temporary increases in journey times on some routes, which may cause frustration for drivers. Additionally, temporary road closures and diversions will increase route uncertainty, and temporary large increases in the proportion of HGV movements on some roads may increase fear of accidents.

7.5.12 Construction of the Proposed Scheme will require bus route diversions, with consequential increases in journey times and the need to relocate bus stops. This will result in impacts on public transport as described in Section 14 of the Volume 2, Community Area reports.

7.5.13 The construction of the Proposed Scheme is expected to require a number of rail possessions of up to 54 hours and blockades of up to nine days, affecting the WCML, the Sandbach to Northwich Line and the Mid Cheshire Line, which will occur periodically throughout the construction period. While individually these possessions and blockades are

not considered significant in the transport assessment, their cumulative impact is considered to have adverse effects on public transport.

7.5.14 It is considered that these effects will lead to temporary increases in the levels of stress experienced by drivers and public transport users. Stress experienced during journeys is not expected to lead to an increase in levels of stress more generally. However, concerns about traveller stress may deter some people from travelling on the affected routes and services.

Road safety

7.5.15 Overall traffic flows affect the likelihood of accidents occurring, and the HGV content of traffic can affect road safety, particularly for pedestrians, cyclists and equestrians. The national rate of fatal or serious accidents involving HGVs is reducing due to improved awareness and safety measures, with fatal or serious accidents involving HGVs falling by 6% between 2015 and 2018[77].

7.5.16 The construction of the Proposed Scheme will increase the amount of traffic, including HGVs, on local roads. Impacts on road safety during the construction of the Proposed Scheme are assessed in the Volume 2, Community Area reports, Section 14. These assessments identify locations where construction traffic is predicted to change the average daily traffic flows by 30% or more, consider the baseline accident rate on the affected link or junction and apply professional judgement to evaluate the accident risk. There are no locations where elevated baseline accident rates coincide with changes of greater than 30% in average daily traffic flows. Therefore, no specific locations have been identified as having a quantifiable increase in the risk of accidents.

7.5.17 However, feedback from community consultation indicates that road safety, particularly associated with HGV movements, is a key issue of concern to local communities. Concerns about road safety have the potential to affect wellbeing adversely through increased anxiety and behavioural changes, such as a reduction in levels of cycling or walking children to school.

Housing

7.5.18 There is moderate to strong evidence on the links between housing and health, relating to the quality and security of housing and the effects of involuntary relocation. Relocation of people from their homes has been shown to influence health outcomes, as disturbance to people's living and social environment and routine may precipitate stress and related symptoms. Moving house involves disruption, uncertainty and changes to social networks and familiar environments and routines.

[77] Department for Transport (2019), *Reported road casualties in Great Britain: 2018 annual report*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/864873/rrcgb-2018-print-ready-version.pdf.

7.5.19 The number of demolitions of residential properties, and subsequent relocation of residents, has been limited as far as reasonably practicable through the design of the Proposed Scheme. However, the Proposed Scheme will result in the demolition of a total of 87 residential properties across the route as a whole, as described in the Volume 2, Community Area reports.

7.5.20 The majority of residents whose properties are required as a result of construction the Proposed Scheme are likely to experience some degree of adverse effect on their wellbeing resulting from the requirement to move, such as an increase in stress. The degree of health effect associated with moving will depend on the vulnerability or resilience of the individuals affected. Older people are likely to find it more difficult to adapt following involuntary relocation, as are disabled people, and those with existing mental or physical health conditions. Parents and carers may need to move their children to different schools, or face longer journeys to school, particularly in rural areas. Children may be particularly affected if the move results in a change of school.

7.5.21 Owners of properties acquired for the construction of the Proposed Scheme are eligible for compensation in accordance with the Compensation Code. Homeowners within the land which is safeguarded for the Proposed Scheme can sell their property at its unblighted open market value to the Secretary of State through the Express Purchase Scheme, or alternatively apply for a cash offer of 10% of this value. These options are also available through the Voluntary Purchase Scheme, to homeowners whose properties are within the 'rural support zone' (outside the safeguarding zone and up to 120m from the centre line of the Proposed Scheme in rural areas). Homeowners outside of this area may be entitled to sell their property at its unblighted open market value to the Secretary of State through the Need to Sell Scheme, if they have a 'compelling reason' to sell, such as relocation for a job or ill health, and are unable to sell other than at a substantially reduced value because the location of the property and the effect of the Proposed Scheme. These schemes are designed to assist residential owners/occupiers in safeguarded areas to sell their homes to avoid prolonged uncertainty and related stress.

7.5.22 Further information about the property compensation schemes in place for HS2 Phase 2b can be found online[78]. Where appropriate, HS2 Ltd has arranged property advice surgeries for communities to answer questions and provide advice to people who are affected by HS2 and may wish to consider applying to one of the property compensation schemes.

Uncertainty and stress

7.5.23 HS2 Ltd recognises that communities close to the route of the Proposed Scheme have been and will continue to be affected by the Proposed Scheme. This includes effects on mental health, defined in the EIA SMR as including 'an overall sense of how a person feels about their life and how well they function in life'.

[78] High Speed Two Ltd (2017), *Claim compensation if your property is affected by HS2*. Available online at: https://www.gov.uk/claim-compensation-if-affected-by-hs2.

7.5.24 The health assessments in Volume 2, Community Area reports, Section 8, and this route-wide assessment, have assessed mental health effects arising from effects on a range of health determinants. This is supported by the health evidence base presented in the Route-wide commentary on health evidence base in Volume 5: Appendix HA-002-00000.

7.5.25 The health effects due to the Proposed Scheme reported in the Volume 2 health assessment chapters that include mental health outcomes are:

- effects on mental health and quality of life resulting from a reduction in people's levels of satisfaction with their living environment, identified in the neighbourhood quality assessment;
- effects on mental health resulting from reductions in access to the natural environment, opportunities to take part in physical activity and the social connections gained through formal and informal recreation, identified in the assessment of access to green space, recreation and physical activity; and
- effects on mental health resulting from reduced access to social networks and changes in levels of trust and community cohesion, identified in the assessment of social capital.

7.5.26 The health effects due to the Proposed Scheme reported in this route-wide assessment that include mental health outcomes are:

- health effects associated with changes in income and employment status;
- effects on traveller stress associated with transport delays and disruption;
- anxiety and behavioural changes relating to concerns about road safety associated with increased HGV movements;
- stress and loss of social connections caused by involuntary relocation of residents along the route; and
- effects of operational train noise on mental health.

7.5.27 In addition to the effects reported in Volume 2 and this route-wide assessment listed above, concern and uncertainty about the potential effects of the Proposed Scheme may adversely affect mental wellbeing during the planning stages.

7.5.28 Feedback from the 2017 route and property consultation, 2018 working draft Environmental Statement consultation and 2020 Design Refinement Consultation suggests adverse effects on mental wellbeing, indicated by the use of words such as stressed, upset or worried within the responses. Mental wellbeing was mentioned in association with the perceived environmental, social and economic impacts of the Proposed Scheme. The key issues identified in consultation feedback included:

- planning blight and a reduction in property values. Some residents reported feelings of anxiety associated with the value of their properties. Others stated that financial uncertainty had led to changes in their lifestyle, or that concerns about property values had deterred them from moving, affecting their quality of life. Residents also reported stress relating to difficulties in understanding their entitlements under the compensation scheme;

- loss of access to greenspace, tranquil areas and woodland. Respondents expressed negative feelings about direct and indirect impacts on their local areas of greenspace and highlighted the value of these places to their physical and mental wellbeing;
- construction noise and air emissions. People indicated that they were worried about noise and air emissions affecting their quality of life and health. Health effects from air emissions were a particular source of concern. Issues affecting particular groups of people such as children, older people and people with health conditions were raised frequently;
- construction traffic. People expressed anxiety about road safety, particularly in relation to HGVs, and were concerned about the stress and frustration that may be caused by traffic congestion. Some people described being worried about getting to work, or about the viability of their businesses; and
- severance and social isolation. Respondents expressed negative feelings about the severance of villages by the Proposed Scheme and impacts on amenity potentially deterring visitors. Some people were worried that traffic congestion would increase social isolation.

7.5.29 The issue of mental health was raised both in terms of effects on others in the community and people reporting adverse effects on their own mental wellbeing which they attribute to the Proposed Scheme. Some respondents had existing mental or physical health conditions, or cared for those with these conditions, and some said they were concerned that vulnerable people could be disproportionately affected.

7.5.30 HS2 Ltd has worked to reduce uncertainty by engaging directly with local communities along the route of the Proposed Scheme, and consulting through the working draft Environmental Statement and Design Refinement Consultations. Consultation responses have been taken into account in the process of environmental assessment and design refinement.

Other mitigation

7.5.31 HS2 Ltd will engage with local authorities and communities on road safety during construction works.

7.5.32 Businesses displaced by the Proposed Scheme will be compensated in accordance with the Compensation Code. HS2 Ltd recognises the importance of businesses, displaced from their existing premises, being able to relocate to suitable alternative premises and will, therefore, offer additional support over and above statutory requirements to facilitate this process.

7.5.33 The construction of the Proposed Scheme offers considerable opportunities to businesses and residents along the route of the Proposed Scheme in terms of supplying goods and services and obtaining employment. HS2 Ltd is committed to working with its suppliers to build a skilled workforce that promotes further economic growth across the UK.

7.5.34 HS2 Ltd is continuing to engage with local businesses, including farmers and growers, affected by the Proposed Scheme to identify reasonably practicable measures to avoid or reduce the loss of business resulting from impacts such as severance.

7.5.35 HS2 will provide a support service to assist vulnerable people along the route of the Proposed Scheme in understanding and responding to documentation. Training will be provided for staff whose role includes engaging with communities, to help them to identify vulnerable people and to ensure they receive appropriate support.

7.6 Assessment of effects during operation

Airborne noise

7.6.1 There is a strong link between transport noise and health, with long-term exposure to higher levels of transport noise being associated with adverse health outcomes. At the population level, it is possible to quantify the effects on health resulting from long term exposure to transport noise using established exposure-response relationships for specific health outcomes. A Defra-led group of Government analysts[79] published three reports between 2008 and 2010 detailing current understanding of the links between transport noise and various effects including sleep disturbance, annoyance, hypertension and ischemic heart disease. These reports provided expert advice to Defra, which in 2014 published a report and appraisal tool for the valuation of transport noise[80]. More information on the published research, including more recent evidence, can be found in Sound, noise and vibration methodology, assumptions and assessment in Volume 5: Appendix SV-001-00000.

7.6.2 The Defra report presents recommended methods to assess the impacts of noise on health to support project appraisal. This includes guidance on how to both quantify the expected number of people affected and then value this impact in terms of Disability-Adjusted Life Years (DALYs)[81]. These recommended methods have been adopted by the Department for Transport and incorporated into the environmental impact appraisal unit of the Government's Transport Appraisal Guidance (TAG). The following assessment of the Proposed Scheme has been carried out using these methods to calculate the number of DALYs lost over a 60 year appraisal period.

Health burden of noise within the study area

7.6.3 By comparison to existing ambient sound levels, exposure to noise from the Proposed Scheme will be comparatively small. This reflects the amount of mitigation that has been incorporated into the Proposed Scheme. An assessment of existing ambient sound levels documented in Volume 2, Community Area reports, Section 13, identified that residential

[79] The Interdepartmental Group on Costs and Benefits - Noise Subject Group.

[80] Department for Environment, Food and Rural Affairs (2014). *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet.* Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/380852/environmental-noise-valuing-imapcts-PB14227.pdf.

[81] DALYs indicate the estimated number of healthy life years lost in a population from premature mortality or morbidity, i.e. the health burden. For the Proposed Scheme, this is calculated using the central disability weighting values from WHO and 2.3 people per residential dwelling.

properties within the airborne sound study area (defined as 1km either side of the route of the Proposed Scheme in rural areas and 500m either side in urban areas) are currently exposed to a health impact due to noise resulting in a loss of approximately 5,142 DALYs over a 60 year appraisal period. The sources of sound that result in this existing health effect primarily consist of road traffic noise as described in the Volume 2, Community Area reports. The Proposed Scheme is estimated to result in an additional 64 DALYs, or a 1% increase in DALYs lost due to noise within the airborne sound study area. The noise-induced health effects from the Proposed Scheme can be presented based on the distance from the route of the Proposed Scheme. Figure 13 presents the DALYs in days per person for each health pathway in 50m distance bands from the route of the Proposed Scheme. Increases in DALYs resulting from adverse increases in noise have been separated from decreases in DALYs resulting from beneficial noise reductions. The overall resultant change in DALYs with distance is also shown. The figure includes several dwellings that are likely to qualify for an offer of noise insulation. If accepted, this could help reduce the estimated health effect due to noise from both the Proposed Scheme and existing sources of sound. It can be seen that a combination of adverse and beneficial noise changes contribute to a varying relationship between the risk of a noise induced health effect and distance from the Proposed Scheme. The majority of beneficial impacts are associated with the introduction of noise barriers along the western side of the existing and realigned WCML at Leighton, Crewe, the realignment of the A556 at Lostock Green and road network changes at Ashley, Mossbrow, Hollins Green, Store Street and Union Street in Manchester. At some distances from the Proposed Scheme these beneficial health effects will be greater than the adverse health effects. Overall, the change in DALYs tends to reduce with distance from the Proposed Scheme.

7.6.4 Figure 14 presents the number of residential dwellings within the airborne noise study area in 50m distance bands from the route of the Proposed Scheme. As a result of designing the route to avoid residential properties, where reasonably practicable, it can be seen that the majority of dwellings are located between 250m and 1km of the route of the Proposed Scheme.

Figure 13: Health burden due to operational noise from the Proposed Scheme as changes in DALYs lost (days per person)

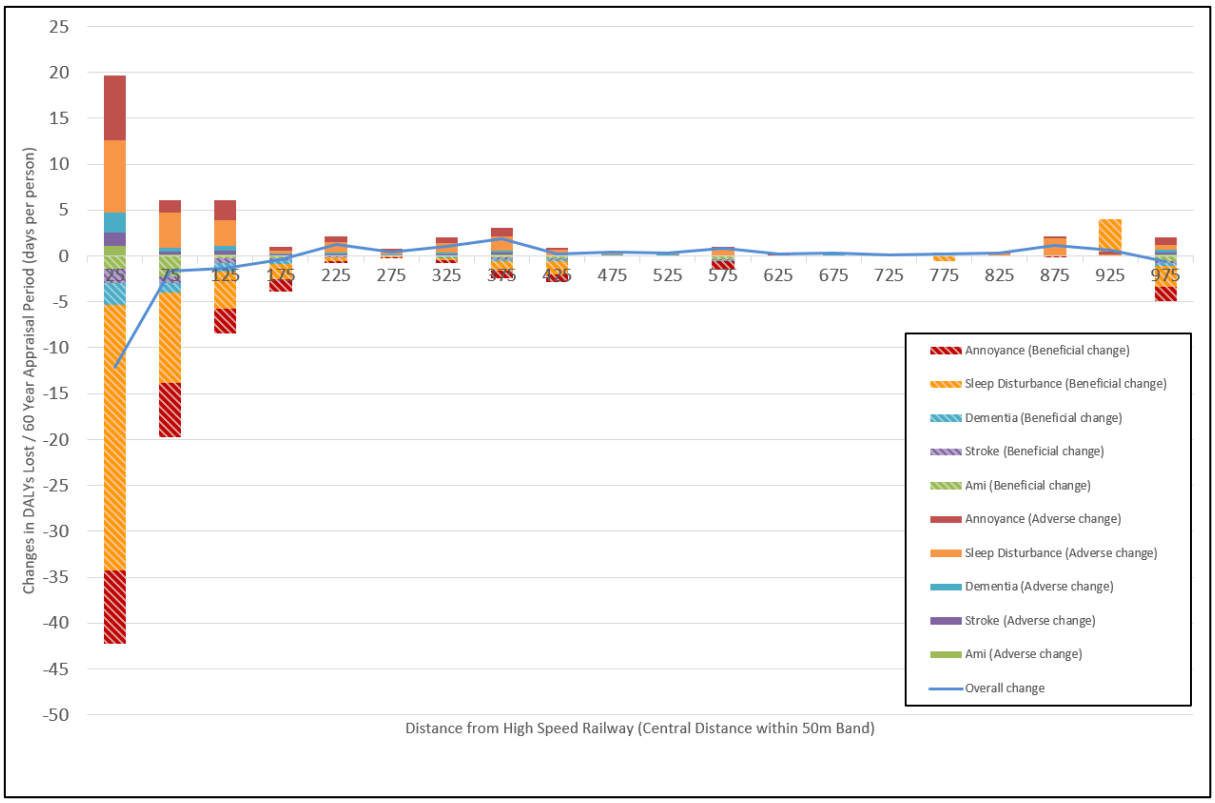
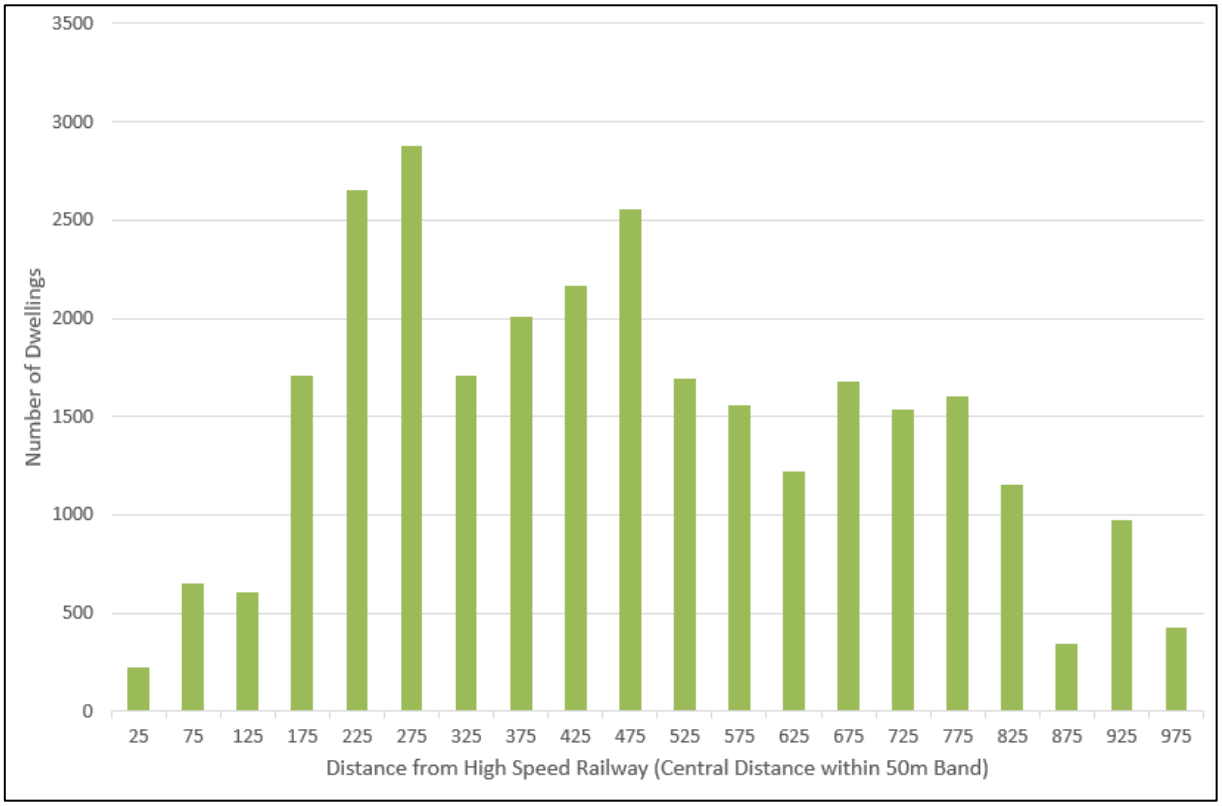


Figure 14: Number of residential properties within the operational airborne noise study area



7.6.5 The following sections present the breakdown of the total health burden due to operational noise from the Proposed Scheme into each individual health effect presented in the Defra reports.

Sleep disturbance

7.6.6 The WHO Night Noise Guidelines for Europe[82] cites numerous studies that detail the effects of transport noise on sleep. Studies have shown that noise can affect sleep in terms of immediate effects (e.g. arousal responses, sleep state changes, awakenings, body movements, total wake time, autonomic responses), after-effects (e.g. sleepiness, daytime performance, cognitive function) and long-term effects (e.g. self-reported chronic sleep disturbance). The health impact of sleep disturbance due to noise from the Proposed Scheme, in changes in DALYs lost, is estimated from: the direct assessment of outdoor night-time noise levels (L_{night}) at residential properties; the recommended exposure-response functions; and the weighting factor from WHO reflecting the severity of sleep disturbance on health.

7.6.7 The direct assessment of night-time noise at residential properties has identified approximately 1,900 dwellings where the Proposed Scheme has the potential to decrease sleep disturbance and approximately 1,500 dwellings where the Proposed Scheme has the potential to increase sleep disturbance[83]. However, only a small proportion (in the region of 2-8%) of the total number of people living in these dwellings would be expected to report a change in noise-induced sleep disturbance. The health impact of sleep disturbance due to noise at these dwellings is a loss of approximately 30 DALYs over a 60 year appraisal period.

Annoyance

7.6.8 It is well established that transport noise can cause annoyance to local residents. Whilst annoyance is not a disease in itself, it affects wellbeing and could act as a gateway to more serious health impacts. Therefore, using the broader definition of health, it is possible to estimate the changes in DALYs due to noise from the Proposed Scheme, valuing high annoyance as a distinct health endpoint. The health impact of annoyance due to the Proposed Scheme, in changes in DALYs lost, can be estimated using: the direct assessment of daytime noise LAeq,16h at residential properties; the recommended dose-response functions; and the weighting factor from WHO reflecting the severity of annoyance on health.

7.6.9 The direct assessment of daytime noise at residential properties has identified approximately 1,350 dwellings where the Proposed Scheme has the potential to reduce

[82] World Health Organisation (2010), *Night noise guidelines for Europe*.

[83] The numbers of dwellings are calculated using the predicted sound levels within the airborne sound study area and the 3dB banding within the WebTAG Noise Workbook. Available online at: www.gov.uk/government/publications/webtag-environmental-impacts-worksheets. The beneficial effects occur in locations where existing noise sources have been reduced, for example a realigned road.

noise annoyance and approximately 2,600 dwellings where the Proposed Scheme has the potential to cause or increase noise annoyance. However, only a small proportion (in the region of 5-20%) of the total number of people living in these dwellings would be expected to become annoyed or experience an increase in annoyance. The health impact of annoyance due to noise at these dwellings is a loss of approximately 23 DALYs over a 60 year appraisal period.

Noise and cardiovascular effects

Hypertension

7.6.10 A link between transport noise and hypertension is relatively well-established in the relevant academic literature. A leading hypothesis for this association is that exposure to noise could lead to arousals of the autonomic nervous system and endocrine system, including increases in systolic and diastolic blood pressure, changes in heart rate, and the release of stress hormones. Dependent upon the level of exposure, the duration of the exposure and certain attributes of the person exposed, this may make a person hypertensive. Hypertension is a medical condition of the cardiovascular system characterised by a consistently high blood pressure.

7.6.11 It is important to note that hypertension is considered a risk factor for disease rather than a disease state itself[84]. However, Defra has recommended steps which have been incorporated into the Government's TAG to value the expected incidents of hypertension by quantifying and valuing consequential changes in incidence of both dementia and stroke. The health impact of hypertension, in changes in DALYs lost, is estimated using the direct assessment of daytime noise LAeq,16h at residential properties, the odds ratio for the marginal probability of hypertension from railway noise, and the weighting factors from WHO reflecting the severity of strokes and dementia on health.

7.6.12 The direct assessment of daytime noise at residential properties has identified approximately 1,200 dwellings where the Proposed Scheme has the potential to reduce noise-induced hypertension, reducing the risk of stroke or dementia and approximately 1,150 dwellings where the Proposed Scheme has the potential to increase that risk. However, the evidence is that each decibel change in noise changes the risk of hypertension by less than 1% for people living in these dwellings, which is a very small amount. Based on this, the assessed health impact of hypertension (stroke and dementia) due to noise at these dwellings is a loss of approximately 5 DALYs over a 60 year appraisal period.

[84] Braubach, M., Jacobs, D. and Ormandy, D. (2011), *Environmental burden of disease associated with inadequate housing*. World Health Organisation Europe Report.

Acute myocardial infarctions

7.6.13 There is evidence to suggest an association between exposure to transport noise and cardiovascular effects. The recommended approach to assessing the health impact from acute myocardial infarctions (AMI) uses the dose-response relationship proposed by Babisch[85]. The Babisch model attempts to show the direct and indirect causal pathways through which noise can affect cardiovascular health. This approach is considered by Defra as the best method currently available for estimating prevalence of AMI based on sound levels[86].

7.6.14 Defra has recommended steps to estimate the change in the risk of incidences of AMI through the odds ratio estimated by the Babisch function, and value the consequential changes in incidence of AMI. The health impact of AMI, in changes in DALYs lost, is estimated using the direct assessment of daytime noise LAeq,16h at residential properties, the odds ratio for the marginal probability of AMI from transport noise, and the weighting factors from WHO reflecting the severity of AMI on health.

7.6.15 The direct assessment of daytime noise at residential properties has identified approximately 1,100 dwellings where the Proposed Scheme has the potential to reduce the risk of AMI due to noise and approximately 500 dwellings where the Proposed Scheme has the potential to increase the risk of AMI. However, the evidence suggests that each decibel change in noise would change the risk of AMI by less than 0.01% for people living in these dwellings. The health impact of AMI due to noise at these dwellings is a loss of approximately two DALY over a 60 year appraisal period. For those dwellings likely to be affected by noise from the Proposed Scheme, this amounts to an average of less than one day lost per person due to AMI. Where it occurs, the severity of effect of AMI on health is high; however, relatively high noise levels are required to change the risk of incidence of AMI and overall only a small effect on a small population has the potential to occur as a result of the Proposed Scheme.

Employment and income

7.6.16 As set out previously in this section, there is strong evidence for links between employment and income and physical and mental health. The benefits of work are linked to increased opportunities for participation in society and increased access to healthier lifestyle choices, which are associated with improved mental and physical health. Employment also has direct health benefits such as social and psychological wellbeing, with work being an important aspect of individual identity and social status. The WHO identifies 'income and social status' as one of the six key determinants of health. A review of published research evidence linking

[85] Babisch, W. (2006), *Transportation Noise and Cardiovascular Risk - Review and Synthesis of Epidemiological Studies*, Federal Environmental Agency, Germany. Available online at: http://www.bruit.fr/images/stories/pdf/babisch_transportation_noise_cardiovascular_risk.pdf.

[86] Berry, B and Flindell I (2009), *Estimating Dose-Response Relationships between Noise Exposure and Human Health Impacts in the UK: Technical Report.*

employment, income and education with health and wellbeing can be found in the Route-wide commentary on health evidence base in Volume 5: Appendix HA-002-00000.

7.6.17 The socio-economic assessment, Section 12, estimates that the Proposed Scheme will create 4,180 direct operational jobs at locations along the route including stations and maintenance depots. An estimated 1,670 indirect jobs will be created by expenditure on supplies and services needed for the operation of the Proposed Scheme, and expenditure by those directly employed on the Proposed Scheme and its suppliers. In addition, increased footfall and investment in areas around new stations is likely to support economic growth and regeneration in these areas.

7.6.18 As described in the socio-economic assessment, Section 12, the business case for HS2 estimates the wider economic benefits of the Proposed Scheme at £3.75 billion (present value 2015 prices), which will translate into increased employment and average household incomes.

7.6.19 Based on these assessments, it is likely that some communities will experience a small increase in the availability and choice of employment opportunities and an increase in wages during the operation of the Proposed Scheme, resulting in a positive effect on mental and physical health for some individuals. These effects will occur mainly in areas benefitting from investment in stations and improved transport connectivity. The extent to which these effects will benefit people who are currently unemployed or on low incomes has not been quantified.

7.7 Other mitigation

7.7.1 HS2's Skills, Employment and Education Strategy[87] sets out its commitments to work with local authorities and agencies to use the HS2 Programme as a catalyst for growth and to encourage disadvantaged or under-represented groups to enter the labour market.

[87] High Speed Two Ltd (2018), *Skills, Employment and Education Strategy.* Available online at: https://assets.hs2.org.uk/wp-content/uploads/2018/09/26114402/CS962-HS2-Skills-Education-Employment-Strategy-210x2101.pdf.

8 Historic environment

8.1 Introduction

8.1.1 This section of the report describes the direct effects of the Proposed Scheme at a route-wide level on designated heritage assets. Designated heritage assets include World Heritage Sites, listed buildings, scheduled monuments, registered parks and gardens (inventory gardens and designed landscapes in Scotland), conservation areas and registered battlefields (inventory battlefields in Scotland).

8.1.2 It also describes any significant direct effects of the Proposed Scheme at a route-wide level on non-designated heritage assets, particularly linear heritage assets that are located across more than one community area.

8.1.3 Heritage assets can be affected through physical removal or through changes to their setting due to development, where setting makes a positive contribution to the value of the asset.

8.1.4 The loss of individual heritage assets and changes to their setting are most appropriately assessed on an individual basis within the relevant Volume 2, Community Area reports, Section 9, and where appropriate, Volume 4, Off-route effects.

8.2 Scope, assumptions and limitations

8.2.1 The scope, assumptions and limitations for the historic environment assessment are described in Volume 1, Section 8 and the EIA Scope and Methodology Report (SMR)[2].

8.3 Environmental baseline

8.3.1 The study areas used to determine existing environmental baseline conditions for the historic environment comprised the entire land requirement of the Proposed Scheme plus a 500m study area (250m in urban areas) for all designated and non-designated heritage assets, and up to a 2km study area for all designated heritage assets. The 2km study area was used to determine potential effects arising from development within the settings of heritage assets. In relation to bored or mined tunnels, these study areas were reduced to 100m either side of the extent of tunnelling to allow for an assessment of the potential effects of ground movement (settlement) on heritage assets.

8.3.2 There are no World Heritage Sites, scheduled monuments, Grade I listed buildings, Category A, B or C listed buildings, inventory gardens and designed landscapes, registered battlefields or inventory battlefields within the land required for the construction of the Proposed Scheme. Designated heritage assets within the land required for the construction of the Proposed Scheme comprise:

- two Grade II* listed buildings;
- 16 Grade II listed buildings;

- 13 conservation areas; and
- one registered park and garden.

8.3.3 Also within the land required for the construction of the Proposed Scheme are two burial grounds: St Andrew's Church and disused graveyard (site of), and St Silas' Church and disused graveyard (site of), both in Manchester, and both non-designated heritage assets of high value.

8.4 Assessment of effects during construction

8.4.1 The Proposed Scheme will not have any direct physical effect on any World Heritage Site, Grade I listed building, Category A, B or C listed building in Scotland, registered park and garden (inventory garden and designed landscape in Scotland) or registered battlefield (inventory battlefield in Scotland). Effects on ancient woodland are assessed in Section 6, Ecology and biodiversity, of this report.

8.4.2 Across the Proposed Scheme, a number of designated heritage assets will be affected through direct physical impact. These comprise:

- one Grade II listed building which will be demolished: Buckhall, The Four Seasons Hotel, Manchester (MA06_0015);
- four listed buildings which are within the land required for construction and will be altered but not demolished: Train shed and undercroft at Manchester Piccadilly Station (Grade II) (MA08_0476); Citadel Station (Grade II*) (OR002_0079), Carlisle; Preston Railway Station (Grade II) (OR001_0040); and Railway Viaduct over River Ribble (Grade II) (OR001_0013);
- permanent construction and operation phase effects are predicted in relation to direct impacts on the character and appearance of the Trent and Mersey Canal conservation area – Middlewich to Preston Brook (MA02_0114). A permanent construction phase effect is also predicted in relation to Bostock conservation area (MA02_0113) as a result of landscape planting proposed within the conservation area;
- works are proposed within Tatton Park, a Grade II* registered park and garden, although the works relate to re-stringing an existing overhead line and are not predicted to have any permanent effect on this asset; and
- two Grade II listed mileposts will be removed during the construction phase and then will be reinstated in, or as close as possible to their original location (Milepost, Bostock Road (east) (MA02_0083) and Milestone adjacent to Withington Fire Station (MA07_0146)).

Cumulative effects

8.4.3 The following heritage assets cross between different community areas and this is recorded in the ES reports (Volume 5, summary gazetteer). The assets have been allocated Unique gazetteer Identifier (UID) references within each community area, these are provided below for reference:

- Non-designated Roman Road - Whitchurch to Middlewich (Margary 700) is within the Hough to Walley's Green area (recorded as MA01_0168) and the Wimboldsey to Lostock Gralam area (recorded as MA02_0001);
- Non-designated Grand Junction Railway is within the Hough to Walley's Green area (recorded as MA01_0179) and the Wimboldsey to Lostock Gralam area (recorded as MA02_0238);
- Non-designated Shropshire Union Canal, Middlewich Branch is within the Hough to Walley Green area (recorded as MA01_0181) and the Wimboldsey to Lostock Gralam area (recorded as MA02_0037);
- Dunham Massey, a Grade II* registered park and garden is within the Pickmere to Agden and Hulseheath area (recorded as MA03_0068), Broomedge to Glazebrook area (recorded as MA04_0251) and Hulseheath to Manchester Airport area (recorded as MA06_0225);
- Non-designated Roman Road - Chester to Manchester (Margary no. 7a) is within the Wimboldsey to Lostock Gralam area (recorded as MA02_0191), Pickmere to Agden and Hulseheath area (recorded as MA03_0119) and Hulseheath to Manchester Airport area (recorded as MA06_0145);
- Non-designated Bridgewater Canal is within the Pickmere to Agden and Hulseheath area (recorded as MA03_0168) and Broomedge to Glazebrook area (recorded as MA04_0082);
- The Devisdale Conservation Area is within the Pickmere to Agden and Hulseheath area (recorded as MA03_0169) and Hulseheath to Manchester Airport area (recorded as MA06_0323);
- Non-designated Cheshire Midland Railway Manchester to Chester Line is within the Wimboldsey to Lostock Green area (recorded as MA02_0183) and Hulseheath to Manchester Airport area (recorded as MA06_0146);
- Non-designated Roman Road - Manchester to Buxton Roman (Margary 71b) is within the Davenport Green to Ardwick area (recorded as MA07_0234) and the Manchester Piccadilly area (recorded as MA08_0792);
- Non-designated Ashton Canal is within the Davenport Green to Ardwick area (recorded as MA07_0385) and the Manchester Piccadilly area (recorded as MA08_0611); and
- Non-designated Roman Road - Manchester to Castleshaw (Margary 712) is within the Davenport Green to Ardwick area (recorded as MA07_0386) and the Manchester Piccadilly area (recorded as MA08_0647).

8.4.4 While these assets are located within more than one community area, no additional significant effects are predicted in relation to these assets, other than those reported in the Volume 2 Community Area reports.

9 Land quality

9.1 Introduction

9.1.1 This section of the report presents the route-wide assessment of the likely significant land quality effects identified arising from the construction and operation of the Proposed Scheme. Land quality encompasses issues relating to potential and existing land contamination associated with past and current industrial, mining and waste disposal land uses, as well as possible impacts on mineral and geological conservation resources.

9.1.2 Significant effects arising from the construction and operation of the Proposed Scheme interacting with individual areas of potential land contamination, mineral resources and geological conservation resources are reported within the Volume 2, Community Area reports, Section 10, and where appropriate, Volume 4, Off-route effects. This section of this report considers where wider, regional scale effects could occur as a result of the interaction of the Proposed Scheme with areas of land contamination, mineral or geological resources, when they are considered either individually or in combination with each other.

9.2 Scope, assumptions and limitations

9.2.1 The scope, assumptions and limitations for the land quality assessment are set out in Volume 1, the Volume 2, Community Area reports and Volume 5: Map Books and the EIA Scope and Methodology Report (SMR)[2].

9.2.2 Existing contamination has been assessed by screening to identify relevant sites, taking into account the potential for contamination to be present, the nature of works proposed in the area and the proximity of sensitive land uses. Sites identified as being of potential concern as a result of the screening exercise have then been further assessed to identify the probability and consequence of pollution or harm occurring, in order to identify potentially significant effects during both construction and operational phases.

9.2.3 Mineral and geological resources have been assessed by considering their sensitivity or value and the potential magnitude of the impact on them as a result of the Proposed Scheme in order to identify potentially significant effects. Mineral resources include, but are not limited to, sand, gravel, salt, clay, building stone, shale gas, coal, coal bed methane and hydrocarbons.

9.2.4 Although ground gases, leachate and contaminated groundwater arising from contaminated sites and landfills can, in some circumstances, migrate some distance from their source, such migration is usually over a relatively limited area. Such local effects are unlikely to lead to regional effects. Where either ground gases, leachate or contaminated groundwater migration is encountered, measures will be put in place to control contaminant migration as necessary to avoid the occurrence of adverse effects at a local level. Controls to deal with the effects of encountering land contamination are set out in the draft Code of Construction Practice (CoCP)[1] and may also, where appropriate, be enhanced by further site-specific

remediation measures. Route-wide effects from existing contamination have been assessed for sites (either individually or in combination) for which residual effects are considered to have the potential to present a significant effect at a regional level.

9.2.5 Route-wide effects in relation to mineral and geological resources have been considered where the Proposed Scheme may have a significant effect on a regionally or nationally important mineral resource, or on a nationally or internationally important geological resource.

9.2.6 In accordance with the EIA SMR, the assessment considers soils, water and geological resources from a perspective of land contamination, mineral resources and geological conservation. Other aspects associated with these resources are dealt with elsewhere within this report, such as the agricultural value of soils (Section 2), effects on heritage assets (Section 8), issues around major accident and disaster control (Section 11), waste issues associated with disposal of contaminated soils (Section 15), and groundwater and surface water (Section 16).

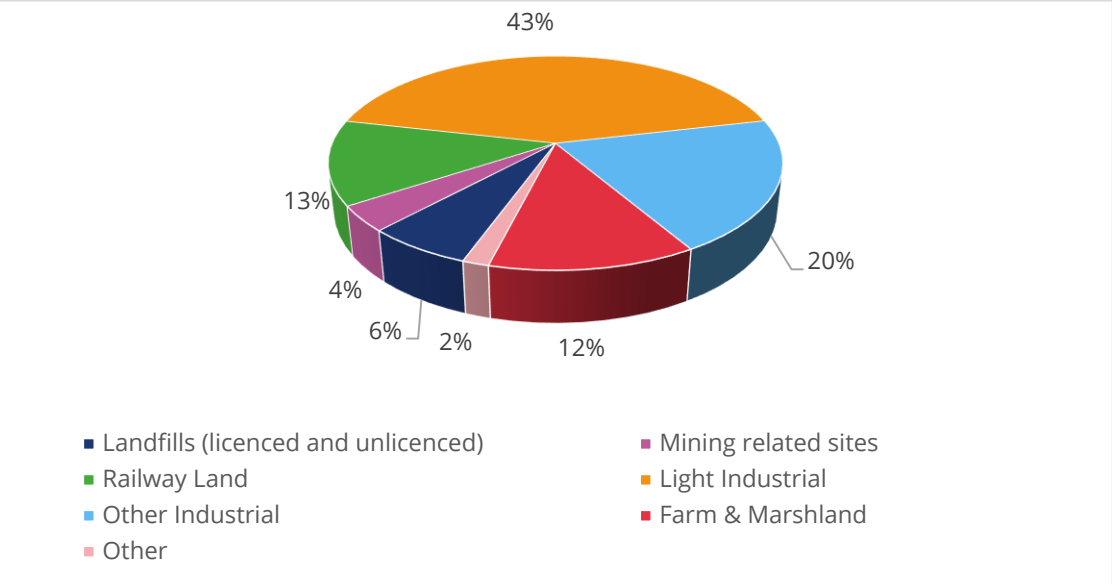
9.3 Environmental baseline

Contaminative land uses

9.3.1 Along the Proposed Scheme potentially contaminative land uses have been found in 1,422 locations[88]. Of these, 313 sites were found to require more detailed assessment based on the process outlined in the EIA SMR. These comprise a combination of historical and current sites being used for landfills, industry, mining, railways and farms. Figure 15 shows the proportion of sites fitting these classifications that are present within the study area, which shows that the majority of sites fall into the light industrial category.

[88] Excluding the off-route sites of Preston Station and Carlisle Station which have been excluded from the land quality assessment. For the avoidance of doubt, the off-route site at Annandale is included in the land quality assessment.

Figure 15: Site groupings within the study area (excluding MML and off-route sites)



9.3.2 Table 23 shows a summary of these sites that are within the land required for construction of the Proposed Scheme and that are present within the study area.

Table 23: Number of potentially contaminative land uses identified within the study area that required detailed assessment

Feature	Number of potentially contaminative land uses on-site[A]	Number of potentially contaminative land uses off-site[B]	Total number of sites within the study area
Landfills (licenced and unlicensed)	12	7	19
Mining related sites	8	1	9
Railway land	24	16	40
Light industrial	56	82	138
Other industrial	23	41	64
Farm and marshland	17	22	39

Notes:

[A] Includes one infilled reservoir (regarded as a landfill for the purpose of this table), one railway site and one light industrial site identified at the proposed Annandale depot.

[B] Includes one light industrial site identified near to the proposed Annandale depot.

- *On-site is defined as being within the land required for construction of the Proposed Scheme;*
- *Off-site is defined as being outside the land required for construction of the Proposed Scheme but within the study area;*
- *Number of landfills does not include waste transfer sites;*
- *Landfill category includes Holford Brinefield landfill site and Winsford Rock Salt Mine Waste Disposal Facility, which are underground waste storage facilities situated within salt caverns;*
- *Mining related sites include coal mining, quarries, sand and gravel pits, brickworks/fields, shale pits and limestone works;*
- *Railway land includes disused and active railways, goods yards, engine sheds and workshops;*
- *Light industrial sites include industrial estates, business parks, retail parks, garages, sewage works, depots, coal wharfs, warehouses, petrol filling stations, scrapyards, smithies, abattoirs and Manchester Airport; and*
- *'Other industrial' sites include large electrical substations, textile and dye works, power stations, chemical works, gas works and timber treatment works.*

9.3.3 It should be noted that whilst the Holford Brinefield landfill site and Winsford Rock Salt Mine Waste Disposal Facility are designated as landfills by the Environment Agency, they are actually underground waste storage facilities that makes use of salt caverns. The Holford Brinefield site also includes a gas storage facility and is a Control of Major Accident Hazards (COMAH) site of national importance.

Coal mining

9.3.4 The Proposed Scheme is unlikely to be affected by historical coal mining as coal seams, abandoned works, colliery spoil and infilled open cast pits (potential sources of contamination) and adits, shafts and fractures that have the potential to form pathways for gas and groundwater migration are largely absent.

9.3.5 Coal workings are present at depth (greater than 30m in depth) in the Risley to Bamfurlong area (MA05) where two mine entries are located within the land required for construction of the Proposed Scheme (near Wigan), with a further 28 mine entries and three pit heads present within the study area. Coal workings are also present in the Davenport Green to Ardwick area (MA07) where shallow and deep workings are present with five mine entries recorded within the land required for construction of the Proposed Scheme (associated with highways improvements and utilities) and a further 37 mine entries within the wider study area. Due to the depth of the workings drilling and grouting of mine works will not be necessary, although mitigation measures may be required to deal with mine entries.

Mineral resources

9.3.6 The assessment has identified potential regional or route-wide effects associated with areas of mineral resources. Table 24 shows the length of the Proposed Scheme that will pass through the different mineral resources present along the Proposed Scheme where there may be some potential for limited sterilisation of resource.

Table 24: Length of route of the Proposed Scheme that passes through different mineral resource areas

Mineral resource	Length of route that passes through mineral resource areas (km)[89]	Percentage of total route that passes through mineral resource areas	Comments
Mineral Safeguarding Areas (MSA) – sand and gravel	3.72	4%	Within the Wimboldsley to Lostock Gralam area (MA02) and the Broomedge to Glazebrook area (MA04). Also present at Preston Station and Carlisle Station.
MSA – building stone (including limestone)	0	0	Absent in all areas.

[89] This includes the off-route sites at Preston Station, Carlisle Station and Annandale depot.

Mineral resource	Length of route that passes through mineral resource areas (km)[89]	Percentage of total route that passes through mineral resource areas	Comments
MSA – clay	1.1	1%	MSA for clay minerals present near Wigan in the Risley to Bamfurlong area (MA05).
MSA - coal	1.1	1%	For shallow coal near Wigan in the Risley to Bamfurlong area (MA05).
Salt	12.42	14%	Focussed within Cheshire in the Hough to Walley's Green area (MA01) and Wimboldsley to Lostock Gralam area (MA02). Note that these sites comprise active and historical salt mining sites, preferred and consented extensions. No MSA for salt are present. There is also a planned gas storage facility situated within an existing salt cavern close to the route of the Proposed Scheme at Holford Brinefield.
Coal bed methane	0	0	Absent in all areas.
Petroleum Exploration Development Licence (PEDL)	66.9	74%	Absent in the Davenport Green to Ardwick area (MA07), Manchester Piccadilly Station area (MA08), and the off-route sites at Annandale depot and Carlisle Station.
Shale Prospective Areas	81.1	89%	Absent at off-route sites.

Geological resources

9.3.7 Two sites of geological conservation have been identified within the vicinity of the route of the Proposed Scheme, one of which is a Site of Special Scientific Interest of regional importance (Rostherne Mere, located within the Hulseheath to Manchester Airport area), the other being identified as a geodiversity site by the Cheshire RIGS[90] Geoconservation Group, Billinge Flashes, within the Wimboldsley to Lostock Gralam area.

9.4 Avoidance and mitigation measures

9.4.1 Avoidance and mitigation measures to address local effects, as described in Volume 1, and Volume 2, Community Area reports are detailed in the draft CoCP. If site specific remedial measures are required, these will be developed in accordance with the draft CoCP.

9.4.2 Based upon the findings of the assessment, it is considered that no further avoidance or mitigation measures are required in order to address route wide effects.

[90] Regionally Important Geological and geomorphological Sites.

9.5 Assessment of the effects of construction

9.5.1 In rural areas, remediation of these sites (if necessary) at the construction stage will give rise to local beneficial effects. In more urban areas, where the incidence of potentially contaminative land uses is more frequent/widespread, the effects of remediation (if necessary) will be local in nature due to the limited area over which contamination can spread.

9.5.2 It is intended to deal with contaminated soils by treating and reusing suitable materials on site wherever safe, practicable and appropriate. Any material that cannot be made suitable for use will be taken off-site for further treatment or disposal. The likely incidence of such materials that cannot be treated and made suitable for re-use on site is considered to be low, and therefore, the route wide disposal of contaminated soils is not considered to be a significant issue (see Section 15 Waste and material resources, of this report).

9.5.3 It is anticipated that, with the application of the measures set out in the draft CoCP (which includes site-specific remediation), there will be no significant adverse route-wide effects from contamination during construction.

9.5.4 It should be noted that the Holford Brinefield landfill site and Winsford Rock Salt Mine Waste Disposal Facility are of national importance, but as the facilities are located at depth and the Proposed Scheme is at surface level at these locations the impact on these 'landfills' is expected to be negligible.

9.5.5 Where appropriate, combined effects on a local scale between areas of nearby contamination are assessed in the relevant Volume 2, Community Area reports, Section 10.

9.5.6 For mineral resources, route-wide effects have been assessed in relation to the proportion of a resource being affected by sterilisation or isolation and its relative importance in terms of local and national scale. MSA for identified deposits of sand and gravel occur regularly along the route of the Proposed Scheme. In the southern part of the Proposed Scheme there are extensive areas of salt deposits. There are a number of PEDL areas such as the Bowland Shale Prospective Area, in addition to localised deposits of shallow and deep coal.

9.5.7 Where it is necessary to pre-extract minerals for engineering purposes this will be discussed with the landowner, the local mineral planning authority, the Coal Authority (if appropriate) and other relevant stakeholders to assist in achieving effective management of minerals. Consent from the relevant authorities may also be required. It should be noted that the hydrocarbon deposits could potentially be exploited by lateral drilling. With this mitigation available, it is considered that on a regional or route-wide basis the effects on mineral resources during construction would not be significant.

9.5.8 There are a number of salt mines, brinefields and extensions to brinefields planned in the Wimboldsley to Lostock Gralam area. Where the Proposed Scheme will pass through the Springbank Farm extension to Holford Brinefield the impact has been assessed in the Volume 2 Community Area report for this area as moderate adverse and therefore significant. Where the mineral sites are located outside of the land required for the

Proposed Scheme, such as at Warmingham Brinefield, Holford Brinefield and Winsford Rock Salt Mine, the effect has been assessed in the Volume 2 Community Area report for this area as negligible to minor adverse and therefore not significant. As these are localised effects there are unlikely to be any further regional or route-wide effects due to the Proposed Scheme passing through these brinefield extensions.

9.5.9 For geological conservation resources, route-wide effects have been assessed based upon the degree of local or national importance and the proportion of the resources impacted. The SSSI site (Rostherne Mere) is located within the Hulseheath to Manchester Airport area outside the land required for construction of the Proposed Scheme and the impacts at a local scale are assessed in the Volume 2 Community Area report for this area as negligible and therefore not significant. A RIGS, Billinge Flashes, is located within the Wimboldsley to Lostock Gralam area within the land required for construction of the Proposed Scheme but the impacts at a local scale have been assessed in the Volume 2 Community Area report for this area as being negligible and therefore not significant. These are not considered to constitute regional or route-wide effects on geological conservation areas.

9.6 Assessment of the effects of operation

9.6.1 It is anticipated that there will be no significant route-wide effects for land quality during operation.

9.6.2 Route-wide permanent adverse impacts on land quality arising during operation will be avoided or mitigated through measures included in the design.

10 Landscape and visual

10.1 Introduction

10.1.1 This section of the report provides an assessment of the route-wide impacts and likely significant effects on landscape arising from the construction and operation of the Proposed Scheme. Within the Volume 2, Community Area reports, Section 11, and where appropriate, Volume 4, Off-route effects significant landscape effects are reported by landscape character areas and significant visual effects on receptors are reported by reference to identified viewpoints.

10.2 Scope, assumptions and limitations

10.2.1 The scope, assumptions and limitations for the landscape and visual assessment are set out in Volume 1, Section 8, and in the EIA Scope and Methodology Report[2].

10.2.2 The route of the Proposed Scheme will not cross any national landscape designations, such as Areas of Outstanding Natural Beauty and National Parks, designations that occur at a geographical scale greater than the community areas described in Volume 2 and Volume 5. Therefore, effects on such sensitive landscape receptors at a route-wide level do not have the potential to occur and are scoped out of this assessment.

10.3 Assessment of the effects of construction

10.3.1 Landscape and visual effects from construction activities will be confined to local areas. Construction landscape and visual effects have been assessed on a local basis and are described for each area within the Volume 2, Community Area reports, Section 11.

10.3.2 It is considered that there will be no significant landscape and visual effects on a route-wide basis associated with the construction of the Proposed Scheme.

10.4 Assessment of the effects of operation

10.4.1 Landscape and visual effects from the operation of the Proposed Scheme will occur locally. Operational landscape and visual effects have been assessed on a local basis and are described for each area within the Volume 2, Community Area reports, Section 11.

10.4.2 It is considered that there will be no significant landscape and visual effects on a route-wide basis associated with the operation of the Proposed Scheme.

11 Major accidents and disasters

11.1 Introduction

11.1.1 This section of the report presents the route-wide assessment of the likely significant environmental effects arising directly from the Proposed Scheme if it were to be affected by a major accident and/or natural disaster.

11.1.2 The Environmental Impact Assessment (EIA) Directive (2014/52/EU) requires an assessment of the expected significant adverse effects of a project on the environment deriving from the vulnerability of a project to major accidents and/or natural disasters. When the Town and Country Planning (EIA) Regulations 2017[91] transposed the Directive into UK law the word 'natural' was dropped to ensure that both manmade and natural disasters are considered.

11.1.3 The underlying objective of the assessment is to ensure that appropriate precautionary actions are taken for those projects, which 'because of their vulnerability to major accidents and/or natural disasters (such as flooding, sea level rise, or earthquakes), are likely to have significant adverse effects on the environment (2014 EIA Directive)[92].

11.1.4 Based on the requirements of the EIA Directive, this section of the report deals with the following issues:

- the legal, contractual, and management frameworks that are in place to ensure safety of the Proposed Scheme;
- the vulnerability of the Proposed Scheme to major accidents and disasters;
- the likelihood of significant adverse environmental effect(s) arising from these major accidents and disasters; and
- the measures required to prevent or mitigate the likely significant adverse effects of such events on the environment.

11.2 Legal and regulatory framework

EIA requirement

11.2.1 Part 1 of the Town and Country Planning (EIA) Regulations 2017 requires that the EIA shall identify, describe, and assess in the appropriate manner, the direct and indirect significant effects of the Proposed Scheme on population and human health, biodiversity, land, soil, water, air and climate, material assets, cultural heritage and landscape and the interaction

[91] *The Town and Country Planning (Environmental Impact Assessment) Regulations 2017.* (S.I 2017 No. 571), Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/uksi/2017/571/pdfs/uksi_20170571_en.pdf.

[92] *Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.*

between these factors, arising from the vulnerability of the Proposed Scheme to major accidents or disasters that are relevant to the Proposed Scheme.

11.2.2 The EIA Directive states that to ensure a higher level of protection of the environment, precautionary actions need to be taken for certain projects that have a high vulnerability to major accidents and/or disasters. Due to the scale of the Proposed Scheme, and its potential vulnerability to major accidents and/or disasters, it has been considered appropriate to undertake an assessment. The assessment will be used to determine how the Proposed Scheme will manage its vulnerability to potential major accidents and disasters during construction and operation to be as low as reasonably practicable (ALARP)[93].

Other relevant legislation and regulation

11.2.3 The design, management, operation, and maintenance of the Proposed Scheme must comply with the following UK legislation and EU regulations, which are therefore intrinsic to this assessment (further detail around the specific context to this assessment is available in Major accidents and disasters risk screening in Volume 5: Appendix MA-001-00000):

- Civil Contingencies Act 2004[94];
- Construction (Design and Management) (CDM) Regulations 2015[95];
- Control of Asbestos Regulations 2012[96];
- Control of Major Accident Hazards (COMAH) Regulations 2015[97];
- Control of Substances Hazardous to Health Regulations 2002[98] (COSHH);

[93] ALARP is the preferred term used by the Health and Safety Executive when discussing risk management, as noted at https://www.hse.gov.uk/managing/theory/index.htm. So far as is reasonably practicable (SFAIRP), used within the HS2 Development Agreement as noted in Section 11.2.10, is an alternative term that can be used interchangeably with ALARP when discussing risk management. At their core is the concept of "reasonably practicable"; this involves weighing a risk against the trouble, time, and money needed to control it. For the purposes of this assessment ALARP has been used when specific risk management is discussed. However, it should be noted that the term 'so far as is reasonably practicable' is still used in some instances of this section when the discussion is not specific to the management of risk.

[94] *Civil Contingencies Act 2004* (c.36). Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/ukpga/2004/36/contents.

[95] *The Construction (Design and Management) Regulations 2015.* (SI 2015 No. 51). Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/uksi/2015/51/pdfs/uksi_20150051_en.pdf.

[96] *The Control of Asbestos Regulations 2012*. No. 632. Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/uksi/2012/632/contents/made.

[97] *The Control of Major Accident Hazards Regulations 2015*. (SI 2015 No. 483). Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/2015/483/contents/made.

[98] *The Control of Substances Hazardous to Health Regulations* 2002. (No. 2677). Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/uksi/2002/2677/regulation/7/made.

- EU Regulation 402/2013 on the Common Safety Method on Risk Evaluation and Assessment[99] (CSM-RA); Health and Safety at Work etc. Act 1974[100] (HSWA);
- Pipeline Safety Regulations 1996[101];
- Planning (Hazardous Substances) Regulations 2015[102];
- Railway Group Standards[103];
- The Management of Health and Safety at Work Regulations 1999[104];
- The Rail Safety (Amendment etc.) (EU Exit) Regulations 2019[105];
- The Railways (Interoperability) Regulations 2011[106] (as amended) (RIR); and
- The Railways and Other Guided Transport Systems (Safety) Regulations 2006[107] (as amended) (ROGS). The Railways and Other Guided Transport Systems (Safety) Regulations 2006) which applies to both the Proposed Scheme and the existing conventional rail network.

11.2.4 In broad terms, risks associated with major accidents and disasters will be identified, assessed, and mitigated during the design, construction, operation, and maintenance of the Proposed Scheme. The legislation described above sets out the requirements, duties, and in some cases establishes the mechanisms for doing this.

[99] Official Journal of the European Union (2013), *Commission Implementing Regulation (EU) No 402/2013 of 30 April 2013 on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No 352/2009*. Available online at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0402.

[100] *Health and Safety at Work etc. Act 1974. SI 1974 c.37.* Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/ukpga/1974/37/contents/enacted.

[101] *The Pipelines Safety Regulations 1996*. No. 825. Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/uksi/1996/825/contents/made.

[102] *The Planning (Hazardous Substances) Regulations 2015*. No. 627. Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/2015/627/contents/made.

[103] Rail Safety and Standards Board (undated), *Standards and the rail industry*. Available online at https://www.rssb.co.uk/standards-and-the-rail-industry.

[104] *The Management of Health and Safety at Work Regulations 1999.* SI 1999 No. 3242. Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/1999/3242/contents/made.

[105] *The Rail Safety (Amendment etc.) (EU Exit) Regulations 2019.* SI 2015 No. 837. Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/2019/837/contents/made.

[106] *The Railways (Interoperability) Regulations 2011.* SI 2011 No. 3066. Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/2011/3066/contents/made.

[107] *The Railways and Other Guided Transport Systems (Safety) Regulations 2006.* No. 599. Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/2006/599/contents/made.

11.2.5 As suggested in recital 15 of the EIA Directive[108], safety assessments undertaken for the Proposed Scheme have been used to inform the identification and assessment of major accidents and disasters to which the Proposed Scheme may be vulnerable.

11.2.6 In addition to the regulations described above, the Proposed Scheme is being designed, and its implementation will be guided by, other industry standards and codes, many of which are mandatory. These require infrastructure and systems to be designed so that risks to people and the environment are either eliminated or reduced to levels that are considered acceptable.

HS2 Ltd safety and risk management strategy

11.2.7 The Proposed Scheme will be designed, constructed, operated, and maintained to reduce so far as is reasonably practicable[93], the risk of harm (including major accidents) occurring. This section briefly describes how HS2 Ltd will meet its legal and contractual obligations and deliver an exemplary project in terms of health, safety and the environment, since this provides the framework within which the risk of major accidents and/or disasters impacting the environment will be managed. All measures to manage and reduce risk described in this section are defined as 'embedded' measures for the purposes of this assessment.

Development agreement

11.2.8 The HS2 Development Agreement[109] between the Government and HS2 Ltd sets out HS2 Ltd's role in developing, building, and operating the new railway. This includes outlining the application of HS2 Ltd's legal obligations with respect to health and safety, risk and liability. Annex 2 of the Development Agreement states that the railway shall be designed, constructed and operated so that safety risks are as low as reasonably practicable. Furthermore, the Proposed Scheme shall be designed and delivered to avoid, reduce and if possible, remedy adverse impacts on the environment, insofar as reasonably practicable.

[108] Recital 15 of the Directive states in its second part: '*In order to avoid duplications, it should be possible to use any relevant information available and obtained through risk assessments carried out pursuant to Union legislation, such as Directive 2012/18/EU of the European Parliament and the Council (4) and Council Directive 2009/71/Euratom (5), or through relevant assessments carried out pursuant to national legislation provided that the requirements of this Directive are met.*' The specific Directives referred to in recital 15 are not applicable to the Proposed Scheme as they relate to operating sites containing large quantities of hazardous substances (for example oil refineries, oil storage depots and nuclear facilities). However, the principle of using relevant information obtained through risk assessments undertaken as part of the Proposed Scheme development is adopted here.

[109] Department for Transport and High Speed Two Ltd (2018), *HS2 Development agreement*. Available online at: https://www.gov.uk/government/publications/hs2-development-agreement.

11.2.9 Annex 3 of the Development Agreement[110] identifies the commitments that HS2 Ltd will deliver to meet the requirements of the agreement set by the sponsor. Specifically, Annex 3, Section 2.7 includes a commitment that: 'The selection and application of mitigations will be evaluated on a 'so far as reasonably practical' basis and further informed by HS2 Ltd's 'Design Vision' objectives (FR.250).'

11.2.10 HS2 Ltd's commitments in terms of both physical and cyber-security are set out in Annex 3, Section 16 of the Development Agreement. Key to the assessment presented in this report is that: 'Measures to prevent unauthorised access to the Railway (primarily consisting of the physical separation of the Railway from the external environment) will be implemented (FR.275)' and 'HS2 Ltd shall develop and implement a robust Information and Cyber Security (ICS) policy to enable it to meet its statutory, regulatory and contractual obligations and reduce risk to its information and assets (FR.278)'.

System safety strategy

11.2.11 HS2 Ltd's Railway System Safety Strategy explains HS2 Ltd's approach to demonstrating, through the whole lifecycle of the railway system, that the new HS2 High Speed Railway (HSR) system will be safe to operate and maintain through:

- compliance with the CSM-RA[111] to support the application for HS2 Ltd to achieve authorisation to put into use and place into service the Proposed Scheme infrastructure; and
- the provision of suitable and sufficient information that allows future infrastructure managers and transport undertakings to meet the requirements of their safety management systems in respect of the ROGS Regulations 2006 (as amended)[112] including the assessments of the operational procedures through the application of CSM-RA.

11.2.12 Ultimately, the HS2 Ltd Railway System Safety Strategy and the activities it defines are required to achieve the authority to place HS2 into service. Failure to achieve this approval will mean that the Proposed Scheme could not be put into operation.

11.2.13 The HS2 Ltd Railway System Safety Strategy sets out the hierarchy of documentation, governance, accountability, and scope of the system safety, and specifically how HS2 Ltd will apply CSM-RA.

[110] Reference is to the July 2017 version of the Development Agreement as the Annex 3 Functional Response within the November 2018 version is currently being updated by HS2 Ltd. Available online at: https://webarchive.nationalarchives.gov.uk/20180806215940/https://www.gov.uk/government/publications/hs2-development-agreement-july-2017.

[111] The Rail Safety (Amendment etc.) (EU Exit) Regulations 2019. No. 837. Her Majesty's Stationary Office, London. Available online at: https://www.legislation.gov.uk/uksi/2019/837/contents/made.

[112] *The Railways and Other Guided Transport Systems (Safety) Regulations 2006.* No. 599. Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/2006/599/contents/made.

11.2.14 Sections of the HS2 Ltd Railway System Safety Strategy of particular relevance to this section include:

- safety principles;
- legislation, standards, and guidance;
- definitions and abbreviations;
- responsibilities (including roles and responsibilities, process and organisation for acceptance, safety aspects of organisation and contractual strategy, competency);
- approach (including system definition, hazard identification, risk analyses and evaluation, safety requirements and demonstration of compliance); and
- the CSM-RA compliance matrix presented in Appendix A of the strategy.

Health and safety management system

11.2.15 The HS2 Ltd Health and Safety Policy[113] presents HS2 Ltd's high-level health and safety principles, which will be delivered by HS2 Ltd's health and safety management system. It highlights HS2 Ltd's principles of health and safety, and sets out its areas of focus for eliminating, reducing and controlling risk, which are further defined by the HS2 Health and Safety Strategy.

11.2.16 HS2 Ltd's health and safety management system is founded on the principles of the Health and Safety Executive's guidance HSG65[114] and is certified to Occupational Health and Safety Assessment ISO 45001[115]. It defines the responsibilities at each level in the business, and establishes the organisational framework, the processes and tools to continually identify, prevent, and manage health and safety risks, to comply with, or exceed legislative requirements and to monitor and review health and safety performance.

HS2 Ltd approach to risk management

11.2.17 Risk management is embedded as a fundamental tenet for the management of all aspects of HS2 and is undertaken to constrain threats within acceptable limits. HS2 Ltd's approach to risk management is based on several guiding principles, including that:

- risk management applies to all aspects of HS2;
- clear accountability for risk will be ensured; and
- risk management will be based on continuous improvement.

[113] High Speed Two Ltd (2019), *Health and Safety Policy*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871759/Health__Safety_Policy_v2.pdf.

[114] Health and Safety Executive (2013), *Managing for Health and Safety (HSG65).* Available online at: https://www.hse.gov.uk/pubns/priced/hsg65.pdf.

[115] ISO 45001, *Occupational Health and Safety Management Certification.*

HS2 Ltd supply chain health and safety standards

11.2.18 Contractors and suppliers working on behalf of HS2 Ltd are expected to comply with HS2 Ltd's supply chain health and safety approach[116]. This sets out HS2 Ltd's expectations in terms of the health and safety commitments of its suppliers, HS2 Ltd's health and safety principles, and its strategic commitments. Contractors appointed by HS2 Ltd to design, assess, and construct the railway (and undertake the enabling works) are required to further identify and mitigate risk during the detailed design stage and identify and mitigate construction risks. HS2 Ltd evaluates the competence of contractors to be able to do this as part of the procurement process. These strategic commitments cover:

- workforce safety;
- public and neighbour health and safety;
- workforce health and wellbeing;
- safe design;
- safe supply chain management;
- safe operations (including those that interface with Network Rail); and
- SMART[117] assurance.

11.2.19 Further requirements upon contractors will be detailed in Works Information, which will be contract specific.

11.2.20 The draft Code of Construction Practice (CoCP)[1] describes the control measures and standards to be implemented to protect communities and the environment during construction works. It sets out the principles that form the basis of the environmental management system (EMS), and measures to be defined within the Local Environmental Management Plans (LEMPs)[118].

11.2.21 Particularly relevant to this topic assessment, the draft CoCP includes the requirement for construction contractors and suppliers to have:

- a comprehensive community emergency plan, where relevant. This will ensure that in the case of a major emergency, when working in partnership with the relevant emergency service, the community can be kept fully informed and that adequate arrangements are in place for the evacuation of an affected area if necessary;
- site-specific assessments of security and trespass risk, and appropriate control measures;

[116] High Speed Two Ltd (2018), *Supply chain health and safety approach.* Available online at: https://www.hs2.org.uk/documents/hs2-supply-chain-health-and-safety-approach/.

[117] Specific, measurable, achievable, realistic, and timebound.

[118] The LEMPs will set out how the Proposed Scheme will adapt and deliver the required environmental and community protection measures within each local authority area, through a series of topic-specific measures that reflect the general requirements of the CoCP.

- a procedure for assessing risks and putting response measures in place related to unexploded ordnance;
- pollution incident control, including pollution response plans and arrangements with spill response companies;
- emergency planning and emergency response procedures;
- appropriate plans and management controls to prevent fires; and
- due consideration to the impacts of extreme weather events and related conditions during construction.

11.2.22 The draft CoCP also presents requirements for measures to reduce the impacts of construction activities on specific categories of environmental receptors along the route of the Proposed Scheme, including: agriculture, forestry and soils; air quality; historic environment; ecology and biodiversity; ground settlement; land quality; landscape and visual; noise and vibration; traffic and transport; waste and materials; and water resources and flood risk.

11.3 Scope, assumptions and limitations

11.3.1 The scope of this assessment topic follows that set out in Volume 1, Section 8, and the EIA Scope and Methodology Report (SMR)[2]. It addresses those unplanned events or situations, that have been determined as being relevant to the Proposed Scheme, considered to be major in scale and have been identified as having the potential to result in a significant adverse environmental effect. Key terms used in this assessment topic are defined in Table 25. A full review of terminology and selected definitions is presented in the EIA SMR.

Table 25: Key definitions relevant to this assessment topic

Term	Definition
ALARP	As low as reasonably practicable. Involves weighing a risk against the trouble, time and money needed to control it. Thus, ALARP describes the level to which risks are expected to be controlled.
CSM-RA	Common Safety Method for Risk Evaluation and Assessment
Environmental receptor	Features of the environment that are subject to assessment under Article 3 of the EIA Directive, namely population and human health, biodiversity, land, soil, water, air, climate, material assets, cultural heritage and landscape. These are categorised consistently within the EIA structure.
Major accident	A major accident, in the context of the Proposed Scheme, is an unplanned event or situation that threatens immediate or delayed serious damage (defined below) to human health, welfare and/or the environment and requires the use of resources beyond those of HS2 Ltd or its contractors to manage it.
Disaster	An external occurrence leading to an event or situation that meets the definition of a major accident. It may result from natural sources, such as extreme weather (storm, flood, temperature) and ground-related hazard events (subsidence, landslide, earthquake), or from man-made sources such as large-scale fire, structural collapse, explosion, or transport accident.

Term	Definition
Reasonable worst case environmental effect	A challenging manifestation of the consequence(s) of a risk event occurring, after highly implausible or less significant consequences are excluded.
Risk	The likelihood of an impact occurring, combined with effect or consequence(s) of the impact on a receptor if it does occur.
Risk event	An identified, unplanned event which is considered relevant to the Proposed Scheme and has the potential to be a major accident or disaster subject to assessment of its potential to result in a significant adverse effect on an environmental receptor.
Serious damage	Serious damage includes the loss of life or permanent injury and/or permanent or long-lasting damage to an environmental receptor that cannot be restored through minor clean-up and restoration efforts.
Vulnerability	In the context of the EIA Directive, the term refers to the '*exposure* and *resilience*' of the Proposed Scheme to the risk of a major accident and/or natural disaster.

11.3.2 Environmental effects associated with unplanned events that do not meet the definition of major accidents and/or disasters (e.g. leaks and spills that may be contained within construction sites and the operational railway infrastructure) are addressed in the draft CoCP and relevant sections of this report (for example Section 16, Water resources and flood risk).

11.3.3 Receptors addressed in the assessment are those relevant to the scope of the ES and include:

- members of the public and local communities;
- infrastructure and the built environment;
- the natural environment, including ecosystems, land and soil, air, surface and groundwater resources and landscape; and
- the historic environment, including archaeology and built heritage.

Exclusions

11.3.4 Effects of the Proposed Scheme on employees of HS2 Ltd and/or its contractors and suppliers (e.g. construction and maintenance staff) and HS2 passengers will be managed via other health and safety legislation, as described previously in this section, and are not addressed in the scope of this assessment. Effects on members of the public who wilfully trespass are also considered to be outside the scope of this assessment, recognising that HS2 Ltd would take appropriate measures to provide a secure boundary to reduce the likelihood of trespass. Finally, risk events that only present risks to HS2 Ltd as an organisation (e.g. cost and programme) are outside the scope of this assessment.

11.3.5 Further details on the exclusions and the scope of this assessment are set out in the EIA SMR.

Risk event identification

11.3.6 Major accident and disaster 'risk events', to which the Proposed Scheme is considered vulnerable, have been identified by referring to risk assessments (including CDM) undertaken for the Proposed Scheme and determining whether there is potential for impact to an in-scope receptor. These risk assessments are part of other processes, many of which are required by law.

11.3.7 The identification of relevant risk events focuses on high-level major accident and/or disaster events that have the potential to cause significant harm. Many of the risk events to which the Proposed Scheme may be vulnerable have multiple causes; for example, a train derailment may be caused by infrastructure condition, a natural disaster event, malicious intent or human error, amongst other causes. Unless the risk event is identified as having the potential to result in a likely significant effect, the underlying causes of the risk event are not the subject of assessment.

11.3.8 No additional risk assessments have been undertaken specifically for this section of the report. Accidents on the railway, including those initiated by natural events, are controlled through the rail regulatory framework previously mentioned. The requirement to satisfy that framework has led to the identification of many safety-relevant hazards, which include those that might have an environmental effect. This section presents a review of risk assessments carried out for the Proposed Scheme to determine whether significant effects on the environment could occur, and whether such risks have been managed and mitigated to be ALARP.

11.3.9 System safety activities, through the application of the CSM-RA, are required to be assessed by an independent body before being approved by HS2 Ltd's System Review Panel and then the Health and Safety Executive (HSE). Authorisation to place the Proposed Scheme into service must then be given by the Office of Road and Rail (the Regulator). This section does not seek to reproduce this extensive process, rather to summarise the current state of risk identification and assessment, in order to specifically assess whether any additional mitigation measures may be required to prevent any likely significant effects to the environment.

11.3.10 Safety risk assessments would remain live documents throughout the design, construction, and operation of the Proposed Scheme.

11.3.11 The guiding principle of both the CSM-RA and the CDM risk assessment is that all foreseeable risks should be controlled to an acceptable level. In the case of the CDM risk assessment this is defined as ALARP.

Assessment methodology

11.3.12 The major accidents and disasters assessment has been undertaken in accordance with the methodology described in the EIA SMR.

11.3.13 A full record of risk identification, risk screening and final risk assessment is provided in Major accidents and disasters risk screening in Volume 5: Appendix MA-001-00000.

11.4 Environmental baseline

11.4.1 The baseline relevant to this topic comprises:

- features external to the Proposed Scheme that contribute a potential source of hazard to the Proposed Scheme;
- sensitive environmental receptors at risk of experiencing significant effects; and
- current (without the Proposed Scheme) major accident and disaster risks.

Baseline features that contribute a potential source of hazard

11.4.2 So far as is reasonably practicable, the route of the Proposed Scheme avoids existing features that have the potential to present a hazard to the construction or operation of the Proposed Scheme.

11.4.3 Features external to the Proposed Scheme that lie within the land required for the construction and operation of the Proposed Scheme and/or cross the route of the Proposed Scheme, and which present a potential source of hazard, either during construction or operation include, but are not limited to:

- oil, gas and electricity transmission, including major accident hazard pipelines registered with the HSE;
- existing operational airports;
- proximity of hazardous facility sites;
- potential presence of unexploded ordnance;
- former landfill sites and the potential presence of landfill gas;
- below ground hazards such as salt mining, and the underground storage of gas;
- existing operational railway lines; and
- adjacent highways, both local roads and motorways.

11.4.4 These features, where present, have been considered and addressed as appropriate throughout the design development.

Potential interaction with hazardous facilities

11.4.5 As noted above, the proximity of hazardous facilities present a potential source of hazard to the Proposed Scheme, and vice versa. These sites have 'consultation zones' which have been

set by the HSE, determined by a detailed assessment of the risks created by the site[119]. The consultation zone acts as a trigger for the HSE as a statutory consultee to be consulted where any encroachment upon this zone may be caused by a project.

11.4.6 In order to identify potential hazards to the Proposed Scheme arising from the presence and proximity of existing major hazard sites and determine any required mitigation, and or instances where the Proposed Scheme has the potential to impact existing sites, the following process is undertaken:

- using data sourced from the HSE, identify any intersections between the consultation zones of existing hazardous sites and the land required for the construction of the Proposed Scheme. Where there are intersections, instances where there are potential hazards to the Proposed Scheme are identified;
- in parallel to the previous point, identify at a high level the potential for the construction and/or operation of the Proposed Scheme to impact existing major hazard sites, such as interference with emergency access and egress due to, for example, road re-alignments. The responsibility to ensure emergency response plans remain appropriate in such circumstances will sit with the operator of the site; and
- for any existing major hazard sites identified by either of the previous two points, where sufficient information is not publicly available, HS2 Ltd will initiate direct engagement with site operators to discuss potential hazards and or impacts. If there are likely to be impacts where a major accident or disaster could directly impact the Proposed Scheme, or such an event at a major hazard site could be made worse by the Proposed Scheme (either by increasing the impact, or by reducing the ability to respond to an incident) appropriate remedial measures to manage the risk ALARP will be implemented. These measures will be integrated into the HS2 design, construction plans, or owned by the site operator, as appropriate.

11.4.7 Through the process outlined it has been identified that there are several sites registered with hazardous substance consent[120], and in some instances under the Control of Major Accident Hazards (COMAH) Regulations[121], whose consultation zone interacts with the land required for the Proposed Scheme. As this could present a source of hazard to the Proposed Scheme, this interaction triggers the need to consider what is required to manage the risk ALARP.

11.4.8 Direct stakeholder engagement between HS2 Ltd and site operators of potentially affected hazardous facilities is ongoing and will continue as the design of the Proposed Scheme

[119] Health and Safety Executive, HSE's Land Use Planning Methodology. Available online at: https://www.hse.gov.uk/landuseplanning/methodology.htm.

[120] Sites which hold certain quantities of hazardous substances at or above defined limits must obtain hazardous substance consent, in accordance with the Planning (Hazardous Substances) Regulations 2015.

[121] *The Control of Major Accident Hazards (COMAH) Regulations 2015*. (SI 2015 No. 483). Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/uksi/2015/483/contents/made.

evolves. Further information on sites identified by the HSE can be found in External sources of hazard, Background Information and Data report BID MA-002-00000[122].

Environmental receptors

11.4.9 Environmental receptors that may be at risk in the event of a major accident and/or disaster include those close enough to be impacted by a major accident and/or disaster in the Proposed Scheme construction and operational areas. The receptors included and excluded under this definition are detailed within the EIA SMR.

Baseline accidents and disaster risks

11.4.10 Major accident and/or disaster risks relevant to the baseline in the absence of the Proposed Scheme include extreme weather events, associated flooding, and road traffic collisions. Baseline 'without project' conditions are described in:

- Volume 2, Community Area reports;
- Volume 2, Section 14, Traffic and transport;
- Volume 2, Section 15, Water resources and flood risk;
- Volume 4, Off-route effects; and
- Volume 3, Section 4, Climate change.

11.4.11 As outlined in Volume 1, Section 3, engagement to date has informed the design and environmental assessment process, including the identification and consideration of baseline features which contribute a potential source of hazard. This includes engagement with:

- expert, technical and specialist groups, such as Network Rail, National Grid, the Oil and Pipelines Agency, British Geological Survey, emergency services, Highways England and Canal & River Trust;
- local authorities; and
- and major asset owners and businesses, such as Manchester Airport and utility providers.

11.4.12 Potential source of hazard features, where present, have been considered and addressed as appropriate throughout the design development.

11.4.13 The presence of hazardous facilities which have risks associated with them regardless of the presence of the Proposed Scheme are as previously discussed.

[122] High Speed Two (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, External sources of hazard, BID MA-002-00000*. Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.

11.5 Assessment of the effects of construction

11.5.1 Major accidents and disasters to which the Proposed Scheme may be vulnerable during the construction phase and the outcomes of the assessment are summarised in Table 26.

11.5.2 Table 26 describes those risk events for which impact on an environmental receptor (including members of the public who are not employees or passengers of HS2) has the potential to be a major accident, as defined in Table 25. Key management and mitigation measures are described in Table 26.

11.5.3 In all cases, compliance with the legal and regulatory requirements to reduce risks to be ALARP must be demonstrated. In particular, compliance with the CDM regulations and HS2 Ltd safety and risk management strategy and approach will ensure health and safety is at the heart of design, planning and construction work. In addition, the presence of a draft CoCP, and LEMPs, will provide effective planning, management, and control during construction to control potential impacts upon people, businesses, and the natural and historic environment.

11.5.4 An assessment of the interface with hazardous facilities during construction has been undertaken and incorporated within Table 26.

Table 26: Assessment of potential major accident and/or disaster events during construction

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures present to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously described.
C1	Tunnel collapse	Structural damage to or collapse of buildings and/or infrastructure.	Locations of below ground risk/hazard identified and fed into the design and construction. Risk assessment, monitoring and management measures as appropriate of overlying structures/infrastructure. Stakeholder engagement and grievance mechanism.
C2	Ground collapse (including ground instability/slope failure)	Network Rail train derails causing fatality/injury to member(s) of public and/or damage to buildings/infrastructure. Severe disruption to rail transportation, major accident causing injury/fatality to Network Rail staff/passenger(s) and/or harm to adjacent receptors. Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	Locations of below ground risk/hazard identified and fed into the design and construction. Consultation with relevant agencies and owners/operators of caverns and review of their records. The Proposed Scheme will avoid passing through known areas of ground instability as far as reasonably practicable. Modelling and settlement calculations to be undertaken at detailed design. Risk assessment, monitoring and management measures as appropriate of overlying structures/infrastructure.

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures present to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously described.
			Stakeholder engagement and grievance mechanism. Use of industry standard construction methods, including stepped excavations.
C3	Offline train derailment/collision on Network Rail mainline due to construction activities on or adjacent to the existing mainline.	Collision on Network Rail mainline, or Network Rail train derails off-track and outside the boundary causing fatality/injury to member(s) of public, including secondary impact as a result of structural damage to buildings and/or infrastructure. Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	Consultation with Network Rail, and other rail service providers, to manage interfaces and define appropriate control measures. Potential damage assessments to be undertaken at detailed design. Draft CoCP states emergency procedures for works on the existing rail network will be produced in accordance with established industry procedures.
C4	Major road traffic incident due to construction work over or adjacent to existing highways, work on existing road infrastructure, and movement of construction vehicles along public roads/adjacent to public rights of way (PRoW).	Fatality/injury to motorist(s)/non-motorised user(s) or other member(s) of the public. Debris striking traffic/member(s) of public, resulting in fatality/injury.	Volume 2, Community Area reports, Section 14, Volume 3, Route-wide effects, Section 14 and Volume 5, Traffic and transport Route-wide effects, Section 14, describe the baseline environment – accident clusters are identified. There will be no significant effects on accidents and safety risk as there are no locations where there are both existing accident clusters and substantial changes in traffic due to the construction of the Proposed Scheme. Consultation with Highways England, local authorities, and other asset owners to manage interfaces and define appropriate control measures. All diversions and realignments would be subject to detailed design and safety audit processes to seek to minimise the risk of accidents. Priority will be given to the use of the main road network and site haul routes for construction traffic, and transportation via rail to minimise the impact on local road network and local communities. Planning of delivery routes and timing of deliveries will be undertaken. Draft CoCP requires route-wide, local area and site-specific traffic management measures to be implemented during the construction of the Proposed Scheme on or adjacent to public roads, bridleways, footpaths and other PRoW affected by the Proposed Scheme as necessary.

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures present to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously described.
			The management of risks to public road users as a result of the Proposed Scheme is assessed and considered within Volume 2, Community Area reports, Section 14.
C5	Physical damage or contamination of aquifer or water abstraction point due to construction activities (e.g. disturbance of contaminated ground).	Pollution of groundwater/surface water receptors due to release of contaminants.	Locations of below ground assets identified and fed into the design and construction. Consultation with utility providers, local authorities, and the Environment Agency to manage interfaces and define appropriate control measures.
C6	Spillage or longer-term seepage of pollutants into groundwater or surface water.	Pollution of groundwater/surface water receptors. Irreversible damage to environmental receptor (watercourse). Contamination and/or loss of drinking water supply.	Locations of below ground conditions identified and fed into the design and construction. Consultation with the Environment Agency, local authorities, landfill owners and operators to manage interfaces and define appropriate control measures, to be undertaken in accordance with Environment Agency procedures. Draft CoCP sets out pollution prevention measures and measures to reduce potential impacts to water resources. The management of risk related to leaks and spills impacting upon water features is considered within Volume 2, Community Area reports, Section 14 and Volume 3, Section 16.
C7	Fire, explosion, release or exposure to harmful gas/materials. Sources may include, for example, presence of former landfill sites, mine workings, brine caverns, ethylene storage/gas transmission pipelines, presence of unexploded ordnance (UXO), underground utilities/services.	Fire and/or explosion/release of harmful materials/gas leading to fatality/injury to member(s) of public and/or structural damage to buildings and/or infrastructure.	Locations of below ground hazard/risk (e.g. UXO) identified and fed into the design and construction. All major utilities that interface with the Proposed Scheme infrastructure to be diverted away from the Proposed Scheme prior to commencing early works, where possible and appropriate to do so. Consultation with appropriate stakeholders such as cavern owners/operators, utility providers, and Environment Agency to manage interfaces and define appropriate control measures. The draft CoCP includes specific requirements to prevent fire, and to carry out risk assessments for the possibility of UXO being encountered.

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures present to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously described.
C8	Release of asbestos during demolition of buildings, structures and infrastructure.	Demolition results in uncontrolled release of asbestos containing material. Short term exposure of members of public to asbestos containing material.	Risk managed via legislation governing the handling and disposal of asbestos containing materials, CDM and resulting construction planning associated with demolition of buildings, structures and infrastructure, and disturbance of land, with potential asbestos containing materials. Measures relevant to control risks associated with asbestos dust outlined in draft CoCP.
C9	Extreme weather impact caused or exacerbated by the construction of the Proposed Scheme.	Irreversible damage to property/infrastructure. Worsened extreme weather impact leads to fatality/injury to member(s) of public. Irreversible damage to environmental receptor.	Hydraulic modelling undertaken and floodplain extent taken into account during construction planning. Early construction of permanent replacement floodplain storage areas and other temporary measures to reduce flood risk to be implemented where required. Flood risk modelling undertaken and presented in Volume 5, Water Resources and Flood Risk WR-005 Flood risk assessment and shown in the Map series WR-05 and WR-06. The draft CoCP includes measures for contractors to manage risks of pollution due to severe weather events, to inform themselves of the potential for severe weather and put in place contingency plans to ensure the resilience of other mitigation required in draft CoCP in the event of severe weather. It further advises on location of stockpiles considering predominant wind direction relative to sensitive receptors, away from flood zones and sensitive watercourses where practicable, and covered where necessary. Protection, monitoring and aftercare management of reinstated areas and created habitats, including remedial works as required. Resilience measures to be implemented through the design process and/or during the construction and operational stages of the Proposed Scheme address potential climate change impacts identified so that all climate change risks assessed low or medium with no additional resilience measures recommended.

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures present to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously described.
C10	Collapse/damage to structures/infrastructure resulting from construction activities adjacent, above or below existing structures/infrastructure.	Collapse of structure/infrastructure affects a public area causing fatality/injury to member(s) of public. Falling debris affecting a public area causing fatality/injury to member(s) of public. Release of harmful contaminants onto land or surface water receptors leads to irreversible damage to environmental receptor. Tunnelling activity results in structural damage to or collapse of buildings and/or infrastructure.	Locations of below ground risk/hazard and crossing structures identified and fed into the design and construction. Relevant stakeholder consultation, risk assessment and monitoring and management measures of overlying structures/infrastructure. Adequate separation between construction works and public areas. Stakeholder engagement and grievance mechanism. Application of the measures as set out in the draft CoCP and necessary management plans, including measures for the use of best practicable means for vibration prevention and reduction, crane operation and lifting procedures.
C11	Member(s) of public using an existing station that is being modified. Construction activities interface with member(s) of public.	Fatality/injury to member(s) of public.	Consultation with Network Rail and other rail service providers to manage interfaces and define appropriate control measures. Appropriate construction planning, sequencing and site controls. Adequate separation between construction works and public areas. Use of hoarding/barriers to prevent interfaces with members of public. Application of the measures as set out in the draft CoCP and necessary management plans, including requirements for traffic management.
C12	Fatality/injury to member of public i.e. pedestrians, equestrians, Network Rail train occupants and operatives on Network Rail mainline due to interfaces with construction activities.	Fatality/injury to member(s) of public.	Consultation with Network Rail and other rail service providers, local authorities, utility providers etc. to manage interfaces and define appropriate control measures. Implementation of HS2 Ltd Supply Chain Health and Safety standard. Appropriate construction planning, sequencing and site controls. Network Rail level crossings to be manned during possession of Network Rail lines when operations are affected by the construction of the Proposed Scheme. Use of hoarding/barriers to prevent interfaces with members of public. Application of the measures set out in the draft CoCP and necessary management plans, including how community relations

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures present to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously described.
			will be managed and requirements for traffic management. Stakeholder engagement and grievance mechanism.
C13	Increased risk associated with neighbouring hazardous facilities, including impact upon emergency response/evacuation procedures due to closure/diversion/congestion of emergency response routes.	Fatality/injury to member(s) of public. Delay to emergency response leading to fatality/injury to member(s) of public. Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	Consultation with the HSE, local authorities, and utility providers to manage interfaces and define appropriate control measures. Early engagement with the emergency services and operators of affected facilities. Appropriate diversions/alternative routes and access points to be identified and agreed. All major utilities that interface with the Proposed Scheme infrastructure to be diverted away from the Proposed Scheme as part of early works, where possible and appropriate to do so. As outlined in the draft CoCP route-wide, local area and site-specific traffic management measures will be implemented during the construction of the Proposed Scheme on or adjacent to public roads, bridleways, footpaths and other PRoW affected by the Proposed Scheme as necessary.
C14	Damage to designated environmental receptor.	Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	So far as is reasonably practicable, the route of the Proposed Scheme avoids existing designated environmental features. Incident management plans are developed and communicated sufficiently early enough to influence construction phase plans regarding locations of evacuation/emergency refuge areas which avoid designated environmental receptors.
C15	Airport related incident due to construction activity interference with airport-related operations.	Aircraft incident results in fatality/injury to member(s) of public. Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	Consultation with Manchester Airport to manage interfaces and define appropriate control measures. Aerodrome safeguarding assessment to be undertaken at detailed design. An assessment including obstacle limitation surface of cranes and plant to be used within the land required for construction of the Proposed Scheme to be undertaken at detailed design. A Bird Hazard Area surrounding the airport has been determined. A Wildlife Hazard Management Assessment, following the Civil

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures present to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously described.
			Aviation Authority CAP 772 guidance[123], has been undertaken for Manchester Airport. The findings have been shared with Manchester Airport Group. Appropriate actions will be agreed with relevant stakeholders to ensure any identified risks are managed to be as low as reasonably practicable.
C16	Release of and/or exposure to harmful materials during excavation.	Uncontrolled release and exposure of members of the public to harmful material.	Consultation with the Environment Agency, local authorities, and owners/operators of landfills to understand locations, nature of the waste deposited and the integrity/construction design of landfills to feed into the design and construction. Locations of risk/hazard e.g. asbestos, carcass burial sites to be identified and managed in line with the draft CoCP. Stakeholder engagement and grievance mechanism.

11.6 Assessment of the effects of operation

11.6.1 Risk events to which the Proposed Scheme may be vulnerable during the operational phase and the results of the assessment are summarised in Table 27. Table 27 describes those risk events for which impact on an environmental receptor (including members of the public who are not employees or passengers of HS2) has the potential to be a major accident, as defined in Table 25. Key management and mitigation measures are described in Table 27.

11.6.2 In all cases, compliance with the legal and regulatory requirements described in this section to manage risks to be ALARP must be demonstrated, including requirement to:

- manage all train accident risks in accordance with the CSM-RA. Measures must be accepted by the regulator as being adequate to manage risks to be ALARP in order for a licence to be granted;
- comply with design standards (including HS2 Ltd Technical Standards). This would include designing to appropriate environmental parameters (flood, wind, lightning) including climate change. Design standards apply to rolling stock, controls and systems, civil infrastructure, and electrical infrastructure;

[123] CAP 772 is guidance from the Civil Aviation Authority which covers wildlife hazard management at aerodromes. Further detail available is available at: https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=2726.

- comply with the National Technical Specification Notices (NTSNs); and
- co-ordinate between HS2 and the conventional rail network.

11.6.3 An assessment of impacts upon emergency response/evacuation procedures for hazardous facilities during operation has been undertaken, where interaction with a consultation zone is present, and incorporated within Table 27.

Table 27: Assessment of potential major accident and/or disaster events during operation

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously summarised in this section and all legislation outlined previously.
OM1A	Train derailment or collision (on HS2 mainline). There are multiple potential causes of this event including: electrical infrastructure and safety equipment failure; EMI from airport air traffic control equipment and radar causing interference to HS2 signalling and train control systems; human factors (drivers, signal control points etc.); infrastructure failure (structure, ground, drainage and/or track); rolling stock failure; objects on the line (unauthorised third party access, animals, vehicle incursion, falling trees, debris); system/equipment failure; and vandalism and terrorism (including cyber-attacks).	Off-track and outside boundary derailment causing severe disruption to rail transportation, major accident causing injury/fatality to Network Rail staff, passengers and adjacent receptors. Severe disruption to rail transportation, major accident causing injury/fatality to member(s) of public, Network Rail staff/ passengers and adjacent receptors. Spillage of pollutants resulting in irreversible damage to an environmental receptor Off-track and outside boundary derailment involving maintenance train travelling at low speed, but potentially carrying flammable fuel.	In addition to the legislative measures outlined in Section 11.2, a summary of specific measures is listed below (not exhaustive). Consultation with Network Rail, and other rail service providers, to manage interfaces and define appropriate control measures. Compliance with industry design and safety standards. Detailed design and safety audit processes to seek to minimise the risk of derailment. Staff training for the operation and maintenance of the Proposed Scheme. Operation and maintenance manuals to be robust, complete, communicated early and maintained. To ensure these consider cyber-crime and viruses. Safe system of working implemented. Monitoring and control of electrical infrastructure/systems. Appropriate rolling stock design standards employed. Minimisation of switches and crossings, use of a single, unified and modern signalling system. Use of derailment containment measures, and provision of a secure boundary to protect the Proposed Scheme from incursion by objects or vehicles. HS2 signalling and train control systems will comply with relevant electromagnetic compatibility (EMC) standards, and will be designed and installed applying good EMC engineering practice. Engagement with Manchester Airport Group ongoing to understand the transmission power and

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously summarised in this section and all legislation outlined previously.
			operating frequency of Air Traffic Control (ATC) and radar equipment used, and to identify whether additional, specific, design and/or installation measures will be required.
OM2	Train derailment or collision (on Network Rail main line). As per OM1A, there are a number of potential causes of this event related to the interface between the Proposed Scheme and the existing railway, and shared use of tracks/interface between the Proposed Scheme and existing railway.	Off-track and outside boundary derailment of a non-HS2 train (including freight), or a HS2 train using the conventional rail network. Severe disruption to rail transportation, major accident causing injury/fatality to Network Rail staff/ passengers and adjacent receptors. Spillage of pollutants.	Mitigation measures listed for risk OM1A are relevant, additionally the Proposed Scheme must comply with Network Rail. Standards to be allowed onto the conventional network. Compatibility must be ensured.
OM3	Major road traffic incident	Fatality/injury to motorist(s)/non-motorised user(s) or other member(s) of public.	Volume 2, Community Area reports, Section 14, Volume 3, Section 14 and Volume 5, Traffic and transport, describe the baseline environment – accident clusters are identified. There will be no significant effects on accidents and safety risk as there are no locations where there are both existing accident clusters and substantial changes in traffic due to the operation of the Proposed Scheme. Amendments and additions to the road network designed in accordance with design and safety standards, and in consultation with Highways England and local authorities. All new infrastructure designed would be subject to detailed design and safety audit processes to seek to minimise the risk of accidents. Errant vehicle protection and barriers to minimise risk associated with visual distraction to drivers. During maintenance, traffic management to be implemented.
OM4	Collapse of structures leading to non-train incident with potential causes including: bridge	Fatality/injury to member(s) of public (pedestrians, cyclists or	Structures designed and maintained in accordance with industry standards, including resilience to flood risk, climate change and seismic events, and in

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously summarised in this section and all legislation outlined previously.
	strike; inadequate design; material quality.	road users etc.) using crossing or over/understructure. Damage to property/infrastructure.	response to identified below ground risks/hazards. The Proposed Scheme will be designed to mitigate for bridge strike. Incident response procedures will in place in the eventuality of bridge strike.
OM6	Fire and/or explosion, either direct or indirect harm	Drift of fire to/from facility (e.g. depot) associated with the Proposed Scheme. Damage to property. Irreversible damage to environmental receptor (listed building, ecological site etc.). Fatality/injury to members of the public.	Tunnels/buildings have been designed to relevant industry standards, and in accordance with HS2's fire strategy. A tunnel fire risk assessment must be carried out under legislation, to ensure the safety of the occupants of the tunnel and those in the immediate vicinity who are at risk. A fire management strategy for tunnels will be drawn up during detailed design in line with the National Technical Specification Notices (NTSNs) for Interoperability. HS2 rolling stock is electric -no flammable fuels. Maintenance trains are diesel fuelled, but will not carry other flammable materials. The Proposed Scheme shall not carry hazardous (combustible/explosive) freight. However, it is expected that off-route sections associated with the Proposed Scheme will carry freight (which could carry hazardous materials), alongside HS2 services. However, in these instances freight will be carried on Network Rail owned and operated infrastructure, and as such falls under Network Rails operating licence and safety plans. The fire safety objectives of the Proposed Scheme include the protection of the environment. Any drainage contaminated by firefighting operations will be discharged into a balancing pond and discharged safely in agreement with the Environment Agency, avoiding sensitive environmental receptors. Mitigation measures to be defined in accordance with CDM for hazard storage near HS2 alignment. Consultation to be undertaken to manage interfaces and define appropriate control measures.

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously summarised in this section and all legislation outlined previously.
OM7	Extreme weather impact which is caused or exacerbated by the operation of the Proposed Scheme.	Worsened extreme weather impact leads to fatality/injury to member(s) of public Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.). Damage to property/infrastructure. Pollution of groundwater/surface water.	Rivers and watercourse crossings i.e. viaducts, bridges and culverts are designed to accommodate 1 in 100 (1%) annual probability flood plus climate change for the 2080s as defined by Environment Agency guidance on Flood risk assessments: climate change allowances. The drainage infrastructure is designed to ensure that no increases in surface water runoff occur from the footprint of the Proposed Scheme, including an allowance for increases in peak rainfall intensity predicted to occur due to climate change for the 2080s. All river, watercourse crossings and drainage infrastructure will be operated and maintained in accordance with the procedures outlined in the Water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-007-00000). The plan will be further developed as the design of the Proposed Scheme advances and specific measures will be incorporated through Drainage Management Plans etc. to address this principle. Proposed Scheme infrastructure located outside of floodplains, where practicable. Appropriate floodplain compensation and defences identified and provided where necessary. Design structures for high winds, including provision of barriers where necessary. Protection, monitoring and aftercare management of reinstated areas and created habitats, including remedial works as required. Resilience measures to be implemented through the design process and/or during the construction and operational stages of the Proposed Scheme address potential climate change impacts identified so that all climate change risks assessed low or medium with no additional resilience measures recommended (See Section 4 Climate change).

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously summarised in this section and all legislation outlined previously.
OM13	Fatality/injury to member(s) of public i.e. pedestrians, equestrians, Network Rail staff. Possible cause includes flooding and object falling from infrastructure.	Fatality/injury to member(s) of public.	Proposed Scheme design has taken into consideration extreme weather events, including climate change. Appropriate planning of maintenance work, including the implementation of a safe system of working.
OM14	Fatality/injury to member(s) of public associated with use of level crossings on Network Rail infrastructure.	Fatality/injury to member(s) of public.	There are no level crossings included as part of the Proposed Scheme design. However, it is expected that off-route sections associated with the Proposed Scheme will pass level crossings. As these crossings exist on Network Rail owned and operated infrastructure these will continue to be managed under Network Rail's operating licence and safety plans. Risk Assessments will be undertaken by Network Rail to ensure that risks to level crossing users are minimised.
OM15	Emergency response impacts on designated environmental receptors (due to the application of incident management plan response which focuses on the safe evacuation of passengers and staff and has the potential to have an adverse effect on local receptors).	Irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.).	Incident management plans should be developed and communicated sufficiently early enough to influence design. These should include consideration of the local environment and community. Relevant stakeholders to be involved in developing and have awareness of incident response plans. Incident management plans are maintained and audited. Integrity of communications and processes in event of incident.
OM16	Exposure to live conductor/arcing	Fatality/injury to member(s) of public or Network Rail staff.	Earthing and bonding will be undertaken in line with relevant industry standards. Isolation and earthing procedures in place. Provision of a secure boundary and other appropriate measures to reduce likelihood of contact with overhead lines. Overhead lines designed to appropriate parameters, including adverse weather and climate change.
OM17	Impact upon emergency response/evacuation procedures, including for hazardous facilities due to permanent	Delay to emergency response leading to fatality/injury to member(s) of public. Irreversible damage to environmental receptor (listed	Consultation with emergency services, Greater Manchester Fire and Rescue Service, Transport for Greater Manchester, owners/operators of hazardous facilities, the HSE, local authorities and utility

ID	Risk event	Reasonable worst case if event did occur	Summary of key risk management and mitigation measures to demonstrate risks to be ALARP (refer to Volume 5 MA-001-00000 for full details). These are in addition to those previously summarised in this section and all legislation outlined previously.
	closure/diversion/ congestion of emergency response routes.	building, ecological site, watercourse etc.).	providers to manage interfaces and define appropriate control measures. Early engagement with the emergency services and affected sites so that emergency response strategies can be revised, if required. Permanent diversions/alternative routes to be identified and agreed.
OM18	Airport related incident due to presence of the Proposed Scheme, including balancing ponds increasing risk of bird strike and interference with airport operations.	Aircraft incident results in fatality/injury to member(s) of public and/or irreversible damage to environmental receptor (listed building, ecological site, watercourse etc.). Pollution of groundwater/surface water receptors.	Consultation with Manchester Airport and NATS to manage interfaces and define appropriate control measures. A Bird Hazard Area surrounding the airport has been determined. A Wildlife Hazard Management Assessment, following the Civil Aviation Authority CAP 772 guidance, has been undertaken for Manchester Airport. The findings have been shared with Manchester Airport Group. Appropriate actions will be agreed with relevant stakeholders to ensure any identified risks are managed to be as low as reasonably practicable. Balancing ponds and water treatment areas designed to minimise the risk of / the presence of large flock forming birds.
OM19	Electromagnetic interference – failure of safety critical functions and systems. Possible causes include cyber terrorism leading to train failure, signal failure, runaway train, failure in controlling the train service, high winds.	Severe disruption to rail transportation. Major accident causing injury/fatality to Network Rail staff, and adjacent receptors, Spillage of pollutants.	Signalling and telecommunications designs have and will continue to follow appropriate standards to mitigate the risk of failure of safety critical functions and systems.

11.7 Conclusions

11.7.1 Given the processes that are in place, and the resulting measures that will be introduced to avoid and/or reduce the vulnerability of the Proposed Scheme to major accidents and/or disasters, it is considered that the risks of any such event occurring will be managed ALARP. The application of the ALARP principle for the management of railway safety risks has been accepted by the regulator (Office of Rail and Road) and the HSE.

11.7.2 As a result, it is considered that there will not be any likely significant environmental effects arising from the vulnerability of the Proposed Scheme to major accidents and disasters.

11.7.3 The Office of Rail and Road (ORR) will only authorise the Proposed Scheme to be placed into service on the basis of an accepted and independently assessed application of the CSM-RA (which therefore must ensure that all risks are mitigated to be ALARP). Without this authorisation, the Proposed Scheme will not be granted a licence to operate.

11.7.4 The measures in place to avoid and/or reduce the vulnerability of the Proposed Scheme to major accidents and disasters will be considered and controlled under other legislative processes, as identified within this section above, in addition to those put in place by the hybrid Bill.

12 Socio-economics

12.1 Introduction

12.1.1 This section of the report provides an assessment of the route-wide socio-economic impacts and likely socio-economic significant effects arising from the construction and operation of the Proposed Scheme. Direct socio-economic effects of the Proposed Scheme are reported at both route-wide and community area levels. The potential overall changes to employment levels (i.e. both the wider socio-economic benefits and those that will arise from the construction and operation of the Proposed Scheme) are reported in this section of the report at a route-wide level. Significant localised effects on employment are reported at a local level in the Volume 2, Community Area reports, Section 12, and where appropriate Volume 4, Off-route effects.

12.2 Scope, assumptions and limitations

12.2.1 The scope, assumptions and limitations for the socio-economics assessment are set out in Volume 1, Section 8 (which also includes those relating to the economic impact of Covid-19); and in the EIA Scope and Methodology Report (SMR)[2].

12.3 National policy and guidance

12.3.1 The key points from national policy and guidance, which have informed the planning and development context for the socio-economic assessment, are as follows:

- the January 2012 Command Paper – 'Investing in Britain's Future'[124], which articulates a national strategy for high speed rail placing the Proposed Scheme as part of a wider network supporting the continuing growth of rail services in the UK to support ongoing economic growth;
- the National Infrastructure Plan, which provides a strategic framework for the identification and prioritisation of infrastructure development within the UK and establishes a series of objectives for infrastructure investment. The original 2011 plan[125] identified HS2 as a priority project with the potential to deliver the essential capacity and connectivity, attract investment and secure long-term economic prosperity, and therefore, generate employment. An update was undertaken in 2012 in which the Government announced its decision to proceed with HS2, and a further update

[124] HM Treasury (2013), *Investing in Britain's future*. HM Treasury, London.

[125] Infrastructure UK (2011), *National Infrastructure Plan 2011.* HM Treasury, London.

published in 2016[126], which set out the progress made on priority infrastructure investments; and

- The 2020 'National Infrastructure Strategy'[57] and HM Treasury's 'Build Back Better: our plan for growth'[127] both refer to HS2 as the government's flagship national transport project delivering essential North-South connectivity between some of the UK's biggest cities.

12.4 Key themes of the assessment

12.4.1 This section presents the three types of impacts considered in the route-wide socio-economic assessment, using the methodology described in the EIA SMR. It also describes how socio-economic effects are presented.

Impacts on employment associated with construction

12.4.2 Two types of impact are defined:

- direct employment opportunities: the number of jobs that the Proposed Scheme is expected to directly generate throughout the construction phase; and
- indirect employment opportunities: the number of jobs that the Proposed Scheme is expected to generate indirectly throughout the construction phase through multiplier effects[128].

Impacts on existing businesses and organisations

12.4.3 Three types of impact are defined:

- businesses and organisations (socio-economic resources) that will be displaced due to land being acquired for the construction and/or operation of the Proposed Scheme. Socio-economic resources are defined as a property used by one business or organisation, or by a group of businesses and/or organisations;

[126] Infrastructure and Projects Authority (2016), *National Infrastructure Delivery Plan 2016–2021*. HM Treasury and Cabinet Office, London.

[127] HM Treasury (2021), *Build Back Better our plan for growth*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/968403/PfG_Final_Web_Accessible_Version.pdf.

[128] The additional impacts of construction employment creation on the business supply chain and their expenditure effects can be calculated using four economic adjustment factors: leakage, displacement, substitution and multiplier effects. These factors and their rates are explained in Homes and Communities Agency (2014), *Additionality Guide: A standard approach to assessing the impact of interventions* (4th Edition). Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf.

- socio-economic resources affected by a change in key environmental conditions as a result of construction and operation of the Proposed Scheme. A combination of factors such as: sound, noise and vibration; air quality; heavy goods vehicle (HGV) traffic flows; and visual impacts may adversely affect the ability of a business unit to attract trade; and
- socio-economic resources affected by isolation[129] from customers/users as a result of the construction and operation of the Proposed Scheme. This analysis considered the consequence of these isolation effects on business operations.

Impacts on employment associated with operation

12.4.4 Two types of impact are defined:

- direct employment opportunities: the number of jobs that the Proposed Scheme is expected to directly generate throughout the operational phase; and
- indirect employment opportunities: the number of jobs that the Proposed Scheme is expected to generate indirectly throughout the operational phase through multiplier effects.

Socio-economic effects

12.4.5 Socio-economic effects are presented as either gross or net employment effects. Gross effects refer to the total effect of the Proposed Scheme. This includes:

- direct effects (such as jobs required to lay the track in the construction phase or operatives employed at HS2 stations and depots in the operational phase); and
- indirect effects (or knock-on effects, such as supply chain and expenditure effects, which are collectively referred to as multiplier effects).

12.4.6 In calculating net effects, economic adjustments such as leakage, displacement and substitution[130] are applied to reflect the interrelated nature of the economy. These effects can be beneficial or adverse.

[129] The term isolation refers to the physical islanding or isolation of a resource which results in a change to businesses' and organisations' environments as defined in the EIA SMR.

[130] Economic adjustments: Leakage – The proportion of outputs that benefit those outside of the intervention's target area or group; Displacement - The proportion of outputs/outcomes elsewhere in the target area; and Substitution - This effect arises where a firm substitutes one activity for a similar one (such as recruiting a jobless person while another loses a job) to take advantage of public sector assistance. It can be thought of as 'within firm' displacement.

12.5 Wider socio-economic benefits

12.5.1 The Proposed Scheme will enable the realisation of wider socio-economic benefits for businesses, communities and local authorities including:

- wider economic benefits identified in the business case for HS2 comprising better linkages between firms resulting in improvements in productivity (agglomeration impacts), extending labour markets and allowing businesses to attract more skilled employees (labour market impacts), and the additional value to customers of goods and services (imperfect competition). These wider economic benefits total £3.75bn (present value, 2015 prices). These benefits will translate into increased employment and average household incomes on a scale substantially greater than the other immediate direct and indirect socioeconomic impacts;
- generating demand for property development around the Proposed Scheme stations (Manchester Piccadilly and Manchester Airport) which will provide substantial new employment space and new homes. The Strategic Regeneration Framework for Manchester Piccadilly[131] proposes approximately 8 million square feet of development of which around 55% will be for residential use equating to over 5,000 residential units; and
- freeing up capacity on the conventional rail network as a consequence of passengers transferring from the conventional rail network to long-distance services provided by the Proposed Scheme.

12.6 Socio-economic baseline

12.6.1 This section summarises key economic indicators for Great Britain and the regional economy of the North West, on which the Proposed Scheme will principally impact. The Proposed Scheme will impact on parts of Scotland. These impacts are limited in nature, occur in only a few locations and do not alter the impact on a route-wide level.

12.6.2 Gross domestic product (GDP) measures the size of the economy over a period of time. Great Britain's GDP in 2019 was £2,147billion, of which the North West region contributed £213 billion[132]. GDP per person in 2019 was £33,100 in Great Britain and £29,000 in the North West. The long-term trend has been for both total GDP and GDP per person to increase[133].

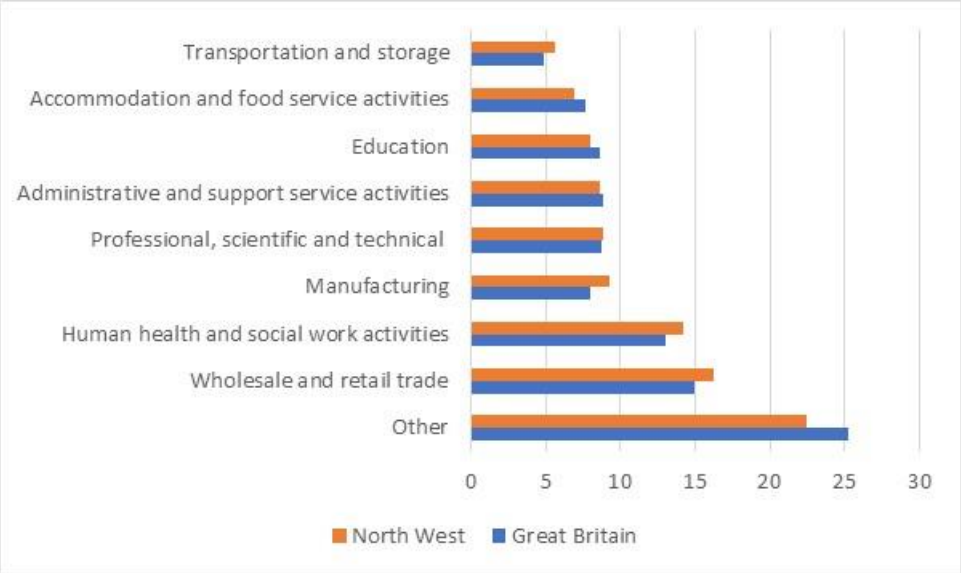
[131] Bennetts Associates (2018), *Manchester Piccadilly Strategic Regeneration Framework*. Manchester, Bennetts Associates, March 2018. Available online at: https://www.manchester.gov.uk/downloads/download/6868/manchester_piccadilly_srf_march_2018.

[132] Office for National Statistics (2019), *Regional economic activity by gross domestic product, UK: 1998 to 2019*. Available online at: https://www.ons.gov.uk/releases/regionaleconomicactivitybygrossdomesticproductuk1998to2018.

[133] Between 2000 and 2019 Great Britain's average annual rate of change in GDP per person is 3.1% in nominal terms (unadjusted for inflation).

12.6.3 In 2019, 30.1 million people were employed in Great Britain, of whom 3.4 million were in the North West[134]. A sectoral breakdown of employment in the North West benchmarked against Great Britain, is shown in Figure 16.

Figure 16: Proportion of employment by industry in the regional economies of North West and Great Britain[134]



Note: 'Other' includes construction, public administration and defence, arts, entertainment, recreation and other services, information and communication, financial and insurance, mining and quarrying and utilities and agriculture, forestry and fishing.

12.6.4 Figure 16 shows some minor differences between the employment profile of the North West compared to Great Britain. There is a slightly higher proportion of employment in manufacturing, health and transportation and storage and a slightly lower proportion of employment in education and accommodation and food services.

12.6.5 In the period January 2020 to December 2020 the average employment rate for those aged 16-64 was 74% in the North West compared with 75% for Great Britain as a whole. The average unemployment rate in the same period for those aged 16-64 was 4.3% in the North West compared with 4.6% for Great Britain as a whole[135].

12.7 Assessment of the effects of construction

12.7.1 There are two types of impacts considered for the construction phase of the Proposed Scheme on a route-wide basis: employment associated with construction of the Proposed Scheme; and employment associated with businesses affected by construction of the Proposed Scheme.

[134]Office for National Statistics (2019), *Business Register and Employment Survey*. Available online at: http://www.nomisweb.co.uk/datasets/newbres6pub.

[135] Office for National Statistics (2020), *Annual Population Survey*, NOMIS. Available online at: https://www.nomisweb.co.uk/datasets/apsnew.

Construction employment

12.7.2 The Proposed Scheme will support employment in the construction industry over the construction period. Overall, it is estimated that the construction phase will generate 87,800 person years of construction employment opportunities[136] (equivalent to 8,800 full time construction jobs[137]), which will be a major beneficial effect and is, therefore, considered to be significant.

12.7.3 Of these, an estimated 60,600 person years of construction employment opportunities (equivalent to 6,060 permanent full-time construction jobs)[137] will be based at worksites along the Proposed Scheme, as described in Volume 2, Community Area reports, Section 12. Depending on skill levels required, and the skills of local people, these jobs will be accessible to local residents and to others living within the relevant travel to work area. Travel to Work Areas (TTWAs) are a geography created to approximate labour market areas in which most people both live and work. The current criteria for defining TTWAs are that at least 75% of the area's resident workforce work in the area and at least 75% of the people who work in the area also live in the area[138].

12.7.4 It is anticipated that direct construction jobs will potentially offer a range of occupations and skillsets, such as: skilled construction workers, labourers, tunnelling specialists, mechanical fitters, steel fixers, electricians, engineering professionals, and management and planning professionals.

12.7.5 HS2 Ltd has committed to providing a minimum of 2,000 apprenticeships over the lifetime of the entire project (which includes Phase One and Phase Two[139]). HS2 Ltd is committed to using the Proposed Scheme to maximise the creation of new apprenticeships, as well as affording existing apprentices employed in the supply chain the unique opportunity to experience working on the Proposed Scheme. Across the supply chain, apprentices will be employed in a wide range of trades and professions from construction to accountancy, quantity surveying to business administration.

12.7.6 The construction works will generate additional indirect demand for goods and services through the business supply chain and expenditure effects of workers, which can stimulate

[136] Construction labour is reported in construction person years, where one construction person year represents the work done by one person in a year composed of a standard number of working days.

[137] Based on the total construction person years generated by the Proposed Scheme and a ratio of 10 construction person years to one full time permanent job.

[138] Office of National Statistics (2016), *Travel to work area analysis in Great Britain: 2016.* Available online at: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/traveltoworkareaanalysisingreatbritain/2016.

[139] Department for Transport (2017), *High Speed Two, Phase Two Strategic Case.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629393/high-speed-two-phase-two-strategic-case.pdf.

business growth and opportunities to generate further employment[140]. The additional impacts of construction employment creation on the business supply chain and their expenditure effects can be calculated using four economic adjustment factors: leakage, displacement, substitution and multiplier effects. As a consequence, a further 32,900 person years of employment can be created (equivalent to 3,300 full-time jobs), which is a moderate beneficial significant effect.

Businesses affected

12.7.7 The construction phase will result in the displacement of some existing businesses through land required for the construction and/or operation of the Proposed Scheme. These effects have been assessed and reported within the relevant Volume 2, Community area reports, Section 12.

12.7.8 Businesses displaced by the Proposed Scheme will be eligible for compensation in accordance with the Compensation Code. HS2 Ltd recognises the importance of displaced businesses being able to relocate to alternative premises and will, therefore, offer additional support to facilitate this.

12.7.9 In most cases, it is assumed that the majority of displaced businesses will be able to relocate, given the availability of alternative premises and the payment of compensation, and thereby continue to operate.

12.7.10 It is also assumed that a large proportion of the employees who may lose their jobs as a consequence of their employer closing or relocating will be able to secure new employment relatively quickly given the current size and strength of the relevant local labour markets (if these conditions were to be sustained). There is predicted to be a total relocation of 6,500 jobs from businesses as a result of land required for construction of the Proposed Scheme. Discussions with a number of businesses are ongoing, with the aim to limit the impact of the Proposed Scheme on their operations.

12.7.11 Whilst it is not possible to predict accurately the numbers of jobs that are at risk of being lost route-wide (as a result of businesses failing to relocate and closing, or relocating and contracting, and employees being unable to find work in the short term), an assumption can be made by drawing on previous research. The London Development Agency (LDA) carried out research into the relocation of companies and jobs on account of the London 2012 Olympic Games. This research[141] indicated that the majority of businesses (88%) relocated while 12% of businesses did not continue to trade. Therefore, for the purpose of this

[140] Economic adjustment factors and their rates are explained in Homes and Communities Agency (2014), Additionality Guide (4th Edition). Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf.

[141] See London Development Agency (LDA) (30th June 2008), Request for Information/Freedom of Information Act by Mr Julian Cheyne, FOI291.

assessment, the indicative rate of successful relocation is judged to be 88% and employment at these businesses will not be lost[142].

12.7.12 If an assumption is made that 12% of all jobs associated with businesses directly affected by the Proposed Scheme could be lost route-wide, then approximately 780 jobs may be lost. In addition, there is the loss of 20 agricultural jobs (full time equivalents) as a consequence of the permanent loss of agricultural land required for the Proposed Scheme.

12.7.13 The direct loss of businesses and employment will have knock-on effects through the business supply chain and expenditure effects alongside other economic adjustment factors[140]. As a consequence, it is estimated that approximately 300 additional jobs may be lost through indirect effects, route-wide.

12.7.14 In total, approximately 1,100 jobs may be lost route-wide from businesses directly and indirectly affected during the construction phase. It is considered that the route-wide impact will be of medium magnitude. The route-wide sensitivity of businesses is assumed to be medium. As such, there will be a moderate adverse significant effect.

12.7.15 This impact will diminish over time as the UK and regional economies grow and new opportunities for employment for people who have lost their jobs, and have been unable to find work, come forward. As outlined in the Economic Case for HS2 in the longer term, the Proposed Scheme will enhance these opportunities through increased investment and economic activity above the baseline. Table 28 provides a summary of this assessment of construction effects.

12.7.16 The construction phase will also result in some proposed developments not being implemented as a consequence of land required for the construction and/or operation of the Proposed Scheme. It is assumed that, in the majority of cases, these or similar developments will instead come forward elsewhere in the relevant region.

12.7.17 The construction phase will also require the use of land that has been allocated for employment purposes. It is assumed that either the same quantity of development can still be accommodated on the site by its reconfiguration, increasing density of development or on other sites elsewhere in the relevant region.

12.7.18 Business in-combination and isolation effects have been assessed and reported within the relevant Volume 2, Community Area reports, Section 12. Route-wide, there are approximately 80 businesses along the length of the route that may experience significant in-combination or isolation effects as a result of construction of the Proposed Scheme. As a consequence, the trade of these businesses will potentially be affected. Businesses significantly affected are in the hospitality, leisure and recreation sectors, retail sector and industrial and manufacturing sectors. In total, it is estimated that approximately 400 jobs

[142] Of the businesses which closed (or may close), these businesses represent only 2% of total employment within businesses displaced by London 2012. Given the potential complexities associated with relocating some of the affected businesses, for the purposes of the route-wide assessment, it is assumed that a worst-case figure of 12% to represent total employment lost as a result of the Proposed Scheme.

could potentially be lost or displaced at these businesses. As a result of knock on effects through the business supply chain and expenditure effects, an additional 150 jobs could be lost or displaced. It is considered that the route-wide impact will be of high magnitude. The route-wide sensitivity of businesses is assumed to be low. As such, there will be a moderate adverse significant effect.

12.7.19 In total, approximately 1,650 jobs could be lost route-wide from businesses directly and indirectly affected during the construction phase. This impact will be mitigated over time as the UK and regional economies grow and new opportunities for employment for people that have lost their jobs, and have been unable to find work, come forward. As outlined in the Economic Case for HS2, in the longer term, the Proposed Scheme will enhance these opportunities through increased investment and economic activity above the baseline. In the context of the economy of the North West which provides over 3.3 million jobs, the potential level of job loss is a relatively small proportion of total employment.

Table 28: Summary of the construction socio-economic assessment

Construction employment created (direct)	
Magnitude	Medium
Sensitivity	High
Overall significance	Major beneficial
Construction employment created (indirect)	
Magnitude	Low
Sensitivity	High
Overall significance	Moderate beneficial
Employment in businesses directly and indirectly affected	
Magnitude	Medium
Sensitivity	Moderate
Overall significance	Moderate adverse
Employment in businesses with in-combination or isolation effects	
Magnitude	High
Sensitivity	Low
Overall significance	Moderate adverse

12.8 Assessment of the effects of operation

12.8.1 There are two types of impacts considered for the operational phase of the Proposed Scheme: employment associated with the operation of the service and employment associated with businesses affected by operation of the service.

Operational employment

12.8.2 The Proposed Scheme will create direct operational employment at locations along the route including stations and maintenance depots, as well as employment associated with train

crew facilities. The key locations of employment will be the two new railway stations of the Proposed Scheme (Manchester Airport High Speed station and Manchester Piccadilly High Speed station) and at its associated depots at Crewe North and Annandale. The Proposed Scheme will also create employment at other railway stations served by HS2 including Carlisle Station and Preston Station and provide additional employment at locations on earlier phases on HS2.

12.8.3 Along the HS2 network there will be an estimated 4,180 direct operational jobs created. Table 29 presents the number of operational jobs by location.

Table 29: Proposed Scheme: direct operational employment

Location of operational employment	Total employment (estimated)
Manchester Airport High Speed station	160
Manchester Piccadilly High Speed station	230
Crewe North rolling stock depot	330
Annandale depot	160
Carlisle Station (traincrew)	400
Preston Station (traincrew)	750
Crewe Station	320
Birmingham Curzon Street	420
London Euston	340
Edinburgh Waverley	140
Glasgow Central	190
Liverpool Lime Street	100
Manchester Piccadilly (traincrew)	430
Manchester Airport (retail employment)	60
Manchester Piccadilly (retail employment)	150
Total	**4,180**

12.8.4 The route-wide impact will be of medium magnitude while the sensitivity is considered to be high given the benefit that individuals will derive from employment. Route-wide the 4,180 direct operational jobs will be a major beneficial effect and is therefore considered to be significant.

12.8.5 The Proposed Scheme will create indirect employment opportunities at locations along the route associated with stations and maintenance depots, as well as employment associated with train crew facilities. These indirect jobs will result from expenditure on supplies and services necessary for the operation of the Proposed Scheme. Indirect jobs will also result from expenditure by those directly employed as part of operations on the Proposed Scheme and by workers employed by suppliers contracted to the Proposed Scheme. It is estimated that 1,670 jobs will be created route-wide through indirect effects as a result of the operational phase. Route-wide, the indirect employment impact will be a major beneficial effect and is therefore considered to be significant.

12.8.6 In addition, the anticipated increased footfall at and around stations is likely to generate demand for new retail and office floorspace, and generate wider employment opportunities during the operational phase. The new development at stations is also likely to encourage investment in their surrounding areas as businesses seek to capture transport user benefits and footfall.

Businesses directly affected

12.8.7 The socio-economic assessment has not identified any businesses that may be directly affected (either negatively or beneficially) by the operations of the Proposed Scheme beyond those already covered in the construction phase analysis.

Total operational employment

12.8.8 In total, 5,850 direct and indirect permanent jobs are estimated to be created during the operational phase. Table 30 provides a summary of this assessment of operational effects.

Table 30: Summary of the operational phase assessment

Direct operational employment created	
Magnitude	Medium
Sensitivity	High
Overall significance	Major beneficial
Indirect operational employment created	
Magnitude	Medium
Sensitivity	High
Overall significance	Major beneficial

13 Sound, noise and vibration

13.1 Introduction

13.1.1 This section presents the route-wide assessment of the likely significant sound, noise or vibration effects arising from the Proposed Scheme.

13.2 Scope, assumptions and limitations

13.2.1 The scope, assumptions and limitations for the sound, noise and vibration assessment are set out in Volume 1, Section 8, and in the EIA Scope and Methodology Report (SMR)[2].

13.3 Assessment of the effects of construction

13.3.1 Noise and vibration effects from construction activities will be confined to local areas in the vicinity of construction sites. Construction noise and vibration effects have been assessed on a local basis and are described for each area within the Volume 2, Community Area reports, Section 13, and where appropriate, Volume 4, Off-route effects.

13.3.2 It is considered that there will be no significant noise or vibration effects on a route-wide basis associated with the construction of the Proposed Scheme.

13.4 Assessment of the effects of operation

13.4.1 Noise and vibration effects from the operation of the Proposed Scheme will occur locally, affecting people and other sensitive receptors (including schools, churches, hospitals and offices). Operational noise and vibration effects have been assessed on a local basis and are described for each area within the Volume 2, Community Area reports, Section 13, and where appropriate Volume 4, Off-route effects. A summary of any route-wide health effects arising from noise and vibration generated during the operation of the Proposed Scheme is presented in Section 7 of this report.

13.4.2 It is considered that there will be no significant noise or vibration effects on a route-wide basis associated with the operation of the Proposed Scheme.

14 Traffic and transport

14.1 Introduction

14.1.1 This section of the report provides an assessment of the route-wide impacts and likely significant effects on traffic and transport arising from the construction and operation of the Proposed Scheme. The geographical extent of the Proposed Scheme is such that there is the potential for traffic and transport effects at a route-wide level due to construction activities or changes in travel patterns. This assessment considers those impacts. Traffic and transport effects at a local scale are assessed in the relevant Volume 2, Community Area reports, and where appropriate, Volume 4, Off-route effects

14.1.2 The construction assessment in relation to rail users has been based on analyses to identify works to the national rail network and includes consideration of the likely number, location, duration and nature of works. For impacts and effects at a route-wide level on highway users, consideration has been given to the expected overall scale of increase in use of the national Strategic Road Network (SRN) by HS2 construction traffic.

14.1.3 The operational assessment of traffic and transport impacts and effects at regional and route-wide levels is primarily based upon the output from the PLANET Framework Model (PFM)[143], which forms the basis for the economic assessment.

14.1.4 Continued growth in demand is forecast for long-distance rail travel to 2038 when the Proposed Scheme opens and beyond. However, the forecasts used in the assessment have been produced prior to the development of a full understanding of the likely impact of COVID-19 on economic growth and travel behaviour. The full impact of COVID-19 is not yet known but is considered likely to result in lower travel demand in the medium term than the forecasts used in the assessment for background traffic and rail, including HS2.

14.1.5 Without the Proposed Scheme, the West Coast Main Line (WCML) and other routes would become increasingly congested. The Proposed Scheme is expected to bring benefits to transport users across a variety of trip types including commuter, business and leisure passengers. Key impacts include:

- new additional rail capacity to accommodate future growth in demand for rail travel;
- reduced journey times between key destinations;
- increased capacity and reduced congestion on the WCML for medium distance and local services;

[143] The PFM is the Department for Transport forecasting model which has been used to develop rail demand forecasts as a result of the Proposed Scheme. PFM has been developed by HS2 Ltd from a suite of models originally developed by the Strategic Rail Authority (SRA). PFM is the most appropriate modelling tool to be used in terms of forecasting the demand for the Proposed Scheme given its strategic capability, covering all long-distance rail, car and air movements across England, Scotland and Wales. PFM provides forecasts of demand to drive the appraisal of HS2. The version used for this assessment is PFM9.6.

- increased capacity for freight services; and
- new travel opportunities.

14.1.6 The traffic and transport effects set out in the Volume 2, Community Area reports, Section 14, are structured to identify impacts by individual transport mode. The assessment of route-wide and regional effects in this report adopts the same approach and criteria for identifying impacts and assessing their effects.

14.2 Scope, assumptions and limitations

14.2.1 The scope, key assumptions and limitations for the route-wide traffic and transport assessment are set out in Volume 1, Section 8, and the EIA Scope and Methodology Report (SMR)[2].

14.2.2 The route-wide study area for traffic and transport considers all transport movements across the UK rail, highway and air networks that might be affected by the Proposed Scheme at a route-wide level. However, the particular focus of impacts comprises the corridor towards the North West (in particular Manchester, via Crewe) and connecting onto the WCML, together with parallel rail and highway routes.

14.2.3 Wherever practicable, the potential effects on traffic and transport have been assessed quantitatively, based on the Proposed Scheme design.

14.3 Environmental baseline

14.3.1 The Proposed Scheme comprises the route from Crewe to Manchester (and connections onto the WCML). Details of the traffic and transport environmental baseline are reported in the Volume 2, Community Area reports, Section 14. In transport terms, the baseline includes the WCML as well as the SRN, which includes the M6, the M56, the M62, the M60, the M602 and the A556.

14.3.2 The current fastest journey times by rail from London and Birmingham to stations on the Proposed Scheme are set out in Table 31.

Table 31: Current fastest journey times

Train origin/ destination	Train destination/origin	Current fastest standard hour journey time by conventional rail (hours:minutes)
London	Crewe	1:30
	Manchester Piccadilly	2:07
	Preston	2:08
	Liverpool Lime Street	2:14
	Glasgow Central	4:30
	Edinburgh (Waverley)	4:22
Birmingham	Liverpool Lime Street	1:34
	Manchester Piccadilly	1:28

Train origin/ destination	Train destination/origin	Current fastest standard hour journey time by conventional rail (hours:minutes)
	Glasgow Central	4:02
	Edinburgh (Waverley)	4:07

14.4 Avoidance and mitigation measures

14.4.1 Avoidance and mitigation measures to address local effects are set out in Volume 1, Section 9 and the Volume 2, Community Area reports previously listed. These will be applied as part of the draft Code of Construction Practice (CoCP)[1] and as appropriate, site-specific remedial measures, which will flow from the draft CoCP.

14.5 Assessment of the effects of construction

14.5.1 During construction, traffic and transport effects could arise from the cumulative impact of all construction works on the wider strategic road network and the impact on the wider rail network as a cumulative result of possessions or blockades.

14.5.2 The potential route-wide effects that have been identified during construction include:

- overall combined traffic impacts on SRN during construction; and
- impacts on rail passenger users and freight during possessions and blockades, although the majority of these are likely to be short term with largely local impacts.

Impacts arising on the highway network during construction

14.5.3 The use of rail access for construction, to transport bulk materials (such as excavated material, ballast, rails and sleepers), where reasonably practicable, will help to reduce wider traffic effects of such movements.

14.5.4 The impacts of construction traffic are primarily focussed on the road network close to the Proposed Scheme, which includes the principal routes for movement of excavated material. These local impacts are considered within the Volume 2, Community Area reports, Section 14. These assessments consider the effects of construction activity on roads extending from the Proposed Scheme to the SRN.

14.5.5 During construction of the Proposed Scheme, excavated material will be reused where suitable and reasonably practicable, and as a result will reduce the amount of construction traffic. Where practicable, material will be moved along the HS2 route using internal site haul routes. A number of further measures have been included within the Proposed Scheme that help to reduce construction traffic movements including the use of borrow pits, which will reduce the impact of construction traffic on the local and strategic road network. These will be used to enable construction material to be obtained locally. Following excavation of construction material, the borrow pits will be backfilled with materials generated from the

construction of the Proposed Scheme, thereby reducing the wider potential impacts on the road network of disposal of surplus excavated material. The use of borrow pits, compared to the alternative of moving materials from quarries, reduces the impact of heavy good vehicles on the road network by reducing the vehicle-kilometres travelled.

14.5.6 Traffic generated by construction on roads from the Proposed Scheme to the SRN has been assessed in Volume 2, Community Area reports, Section 14 and measures are proposed to mitigate the effect of this traffic. The use of the SRN by HS2 construction vehicles within the area of the Proposed Scheme is addressed in Volume 2. However, the combined effects across CA are not considered to represent a significant route-wide effect. In addition, the effects outside CA are not considered likely to result in any route-wide effects on the SRN.

Impacts on the railway network during construction

14.5.7 The assessment of the potential impacts of the Proposed Scheme on the railway network during construction considers impacts of both works to the railway and movement of materials by rail. The design of the Proposed Scheme aims to avoid operational disruption to the conventional rail network during construction, insofar as reasonably practicable. Where it is safe to do so, works for the Proposed Scheme will be undertaken while conventional train services are still running. Where this is not practicable, works will have to be undertaken when trains are not running, in possessions.

14.5.8 Many of these works will be undertaken in the standard night-time maintenance possessions to reduce disruption to passenger and freight services. However, for certain major works that cannot be accommodated within these maintenance periods, weekend closures of one day's duration or longer will be required. These are referred to as weekend possessions. Where the works are particularly complex and require more time than a normal or bank holiday weekend, durations longer than a weekend will be required and are referred to as blockades.

14.5.9 Possessions are a standard technique widely used for the maintenance of the existing railway network. The possessions to accommodate and deliver the construction of the Proposed Scheme will be consistent with those adopted for current Network Rail working practices. Where reasonably practicable, HS2 Ltd will work with Network Rail to co-ordinate possessions with existing planned maintenance and renewals to reduce overall disruption to the travelling public and to ensure that any disruption impact of the Proposed Scheme is not significant.

14.5.10 The potential scale of effect from these works on or near the national rail network will depend on a number of factors including the type and complexity of the works, duration of works, level of use of the rail line affected and timing of the works. For example, railheads and rail sidings will not have a direct impact on the operation of the conventional rail network as they can be implemented without the need for disruption to the railway and delay to passenger journeys. However, major track re-modelling has greater potential to

affect services. While most railway works will be undertaken overnight or during weekend possessions (and thus will have limited impacts in isolation), a long programme of such works across a route could, over a period of time, cause disruption to the travelling public and freight services.

14.5.11 Rail movements of bulk material will use spare train paths on the conventional rail network and the approach to the use of rail has been developed taking into account likely availability of train paths. As a result, the movement of materials by rail will be planned so that it can be accommodated within available capacity and not have significant transport impacts or effects.

14.5.12 The type and number of possessions required for the Proposed Scheme on existing railway lines are summarised in Table 32. These are spread over the period 2024 to 2034 with most occurring between 2024 and 2030.

Table 32: Summary of likely route-wide possession and blockade requirement

Possessions Summary (passenger and freight route-wide)	27-hour	54-hour	72-hour	100-hour	Blockades
Proposed Scheme excluding off-route stations and depot	46	79	3	0	7
Preston Station (off-route)	1	18	0	0	1
Carlisle Station (off-route)	1	14	0	2	1
Annandale depot (off-route)	2	4	6	1	0
Total Proposed Scheme including off-route and depot stations and depots	50	115	9	3	9
Of which, possessions and blockades affecting WCML passengers and freight	41	93	8	3	8

14.5.13 As most of these are works are relatively localised and short-term in duration and are generally not expected to have route-wide effects, they have been considered in the relevant Volume 2, Community Area reports, Section 14 and in Volume 4 for off-route works. However, there are a number of works proposed that are of sufficient scale that they could potentially create disruption and delay to rail passenger and freight services on the WCML. These are outlined below with further detail in the relevant Volume 2:

- blockades on the WCML Crewe North Junction to Winsford South Junction in the MA01 Hough to Walley's Green Community Area associated with the Crewe North Connection comprising three nine day blockades plus a series of associated 27 and 54-hour weekend possessions;
- weekend possessions over 27 and 54 hours on the WCML Crewe North Junction to Winsford South Junction in the MA01 Hough to Walley's Green Community Area associated with Crewe Northern Connection, WCML reception tracks, the extension of the existing Parkers Road Overbridge, Parkers Road temporary footbridge, Footpath

Crewe 29/1 accommodation overbridge and Footpath Minshull Vernon 8/1 accommodation overbridge;

- connections to the WCML south of Wigan via the Golborne link requiring possessions and blockades on the WCML Crewe to Carlisle between Golborne junction and Springs Bank junction in the MA05 Risley to Bamfurlong Community Area. These works comprise: three blockades of between four and six days duration plus a series of associated 27, 54 and 72-hour weekend possessions;
- Preston Station modifications comprising one nine day Christmas blockade, together with 27 and 54-hour weekend possessions associated with construction of Proposed Scheme elements including the extension, widening and reinstatement of platforms, the provision of a new footbridge link and track alignment/renewal works;
- Carlisle Station modifications comprising: one nine day Christmas blockade and a series of 27-hour, 54-hour and 100-hour possessions associated with the construction of platform 0, the installation of a new footbridge and the alterations of tracks; and
- Annandale depot comprising a series of 27-hour, 54-hour and 72-hour weekend possessions.

14.5.14 There may be opportunities to reduce impacts by carrying out works simultaneously, including combining longer-term blockades. These could, however, result in less convenient alternative arrangements, including rail replacement services.

14.5.15 In addition to the impacts on the WCML and services operating on it, blockades associated with the Crewe North Junction to Winsford South Junction would affect services to Liverpool and would require rail replacement services. Longer distance Anglo-Scottish services could also be diverted via Manchester and Bolton.

14.5.16 Whilst rail passenger effects can be mitigated by rail replacement services, it is more difficult to mitigate effects on freight. In the event of blockades closing the WCML in this area, and if no diversionary routes are available or suitable.

14.5.17 HS2 Ltd will continue to work with Network Rail to seek to reduce the impacts of possessions and blockades on the railway network, where reasonably practicable.

14.5.18 Although in isolation each of these have limited impacts that are addressed in the relevant Volume 2, taken together and recognising the substantial number and extended duration of the possessions and blockades that will affect users of the WCML, will lead to a major adverse effect on rail passengers and freight which is significant.

14.6 Assessment of the effects of operation

14.6.1 The introduction of the Proposed Scheme will provide improved journey times through use of HS2 services and build on the already significant beneficial effects of Phase One and Phase 2a which were reported in the Phase One and Phase 2a Environmental Statements. This section considers the incremental effects of the Proposed Scheme (where Phase One and Phase 2a are included in the future baseline) and then considers the cumulative effects

of Phase One, Phase 2a and the Proposed Scheme. The assessment also considers the impacts on the conventional rail network, the SRN and air travel.

Impacts of changes to train patterns and services during operation

14.6.2 During operation, there will be substantial changes to train patterns and frequencies on the rail network, both as a direct result of Proposed Scheme services and also to take advantage of the capacity released on the conventional rail network. This includes the potential for new services to take up conventional rail network train paths released by HS2 services taking over the role of providing for long-distance travel. Together with the new HS2 services, these changes will provide journey time and accessibility benefits and are likely to reduce crowding and congestion on the conventional rail network. These service improvements have the potential to result in substantial changes in overall use of rail services and mode shift from private car and air travel during the operation of the Proposed Scheme.

The Proposed Scheme

14.6.3 The train service specification (TSS) for the Proposed Scheme offers substantial improvements in London-Manchester and Birmingham-Manchester connectivity together with improved services to Scotland when compared to the services that would be operated for HS2 Phase One and Phase 2a and the conventional rail network. The TSS for the Proposed Scheme, including Phase One and Phase 2a, comprises 11 services per hour per direction to and from London Euston and three services per hour starting at Birmingham Curzon Street. The services can be broken into the following groups;

- London-Birmingham: three services per hour unchanged from Phase 2a (these services would not use the Proposed Scheme);
- London-Manchester: three services per hour to Manchester, with the section from Crewe to Manchester Piccadilly using the Proposed Scheme, offering higher HS2 train frequency and improved journey times when compared with Phase 2a;
- London-Scotland: two services per hour using the Proposed Scheme and then the conventional rail network, that split at Carlisle and serve Glasgow and Edinburgh, offering improved connectivity when compared with Phase 2a which comprises an hourly service to Glasgow using 200m long rolling stock (with no service to Edinburgh);
- London-North West: three services per hour comprising hourly services to Liverpool, Liverpool/Lancaster (splitter) and Macclesfield unchanged from Phase 2a (these services would not use the Proposed Scheme);
- Birmingham-Manchester: two services per hour to Manchester using the Proposed Scheme, offering improved connectivity when compared with Phase 2a, which does not provide this link; and

- Birmingham-Scotland: one service per hour using the Proposed Scheme and then the conventional rail network, alternating between Glasgow and Edinburgh & Scotland, offering improved connectivity when compared with Phase 2a.

Released capacity

14.6.4 The transfer of long-distance passengers from the conventional rail network to the Proposed Scheme will create the opportunity to provide additional services and to stop services at more locations on the conventional rail network. A released capacity timetable specification has been developed by the DfT to represent how these opportunities may be utilised. While it is too early to set the timetable and make final decisions on stopping patterns, the released capacity TSS for the Proposed Scheme sets out the assumptions regarding the train services that are likely to run, based on the best information available at the time of assessment.

14.6.5 The general principles underpinning the assumptions for the use of the released capacity have been to increase capacity in corridors with high demand and to address some of the reliability and overcrowding issues that currently exist and that are otherwise forecast to intensify as a result of increased demand for rail travel. With the introduction of the new long-distance high speed services for the Proposed Scheme, the general approach will be to reduce limited stop long distance services and replace them with enhanced services on medium distance and local commuter routes.

14.6.6 These assumptions should not be regarded as final, as it is likely that further changes will be made over the coming years in light of emerging information on demographics, demand for rail services and other relevant factors. The introduction of HS2 services will have a significant impact on the railway as a whole and will necessitate a recast of the timetable to ensure that available capacity is used in a way that maximises benefit for both passengers and freight.

14.6.7 Overall, the use of the released long-distance train paths by medium distance and local services, coupled with diversion of long-distance passengers to HS2 services from the WCML will increase capacity and reduce congestion and passenger crowding.

Impacts of journey time savings during operation

14.6.8 Substantial journey time benefits will be provided by the Proposed Scheme with the biggest proportionate benefits achieved where the service uses just the HS2 route. Journey time savings from London and Birmingham to stations on the Proposed Scheme are set out in Table 33.

14.6.9 When combined with Phase One and Phase 2a, the Proposed Scheme will reduce overall journey times between London and Manchester Piccadilly by 56 minutes (a 44% reduction), Preston by 50 minutes (39%) and Glasgow Central by 42 minutes (16%). Comparable journey time reductions to and from Birmingham will be 48 minutes to Manchester Piccadilly (30%) and 44 minutes to Glasgow Central (18%). The resultant combined travel time savings for the

Proposed Scheme with Phase One and Phase 2a represents a major beneficial effect, which is significant.

14.6.10 When compared to a baseline containing both Phase One and Phase 2a, the incremental journey time reductions of the Proposed Scheme between London Euston and Manchester Piccadilly will be 19 minutes (21%) and between London Euston and Preston will be 12 minutes (13%). Incremental journey time reductions between Birmingham Curzon Street and Manchester Piccadilly will be 48 minutes (30%), between Birmingham Curzon Street and Glasgow Central will be 44 minutes (18%) and between Birmingham Curzon Street and Edinburgh (Waverley or Haymarket) will be 51 minutes (20%). The savings from Birmingham to Manchester Piccadilly and Scotland will be the same as those for the Proposed Scheme in-combination with Phase One and Phase 2a because the majority of journey time improvements for these routes are a result of the Proposed Scheme.

14.6.11 The incremental journey time reductions of the Proposed Scheme are assessed as a minor beneficial effect, which is significant, on journey times between London and mainline stations in the north-west of the country with journey time savings between Birmingham and the north-west of England and Scotland assessed as a major beneficial effect, which is significant.

Table 33: Journey times between key destinations 'without' and 'with' the Proposed Scheme in operation

Train origin/ destination	Train destination/origin	Current fastest standard hour journey time by conventional rail (hours: minutes)	Fastest standard hour journey time with HS2 Phase One and 2a (hours: minutes)	Fastest standard hour journey time with the Proposed Scheme (including Phase One and Phase 2a) (hours: minutes)
London Euston	Crewe	1:30	0:56	0:56
	Manchester Airport	2:24 (to conventional rail station)	1:47 via Manchester Piccadilly High Speed station	1:03 (to Manchester Airport High speed station)
	Manchester Piccadilly	2:07	1:30	1:11
	Preston	2:08	1:30	1:18
	Liverpool Lime Street	2:14	1:34	1:34
	Glasgow Central	4:30	3:48	3:46
	Edinburgh Waverley	4:22	4:20	3:42
	Liverpool Lime Street	1:39	1:39	1:09
Birmingham Curzon Street	Manchester	1:28	1:28	0:41
	Glasgow Central	4:02	4:02	3:23
	Edinburgh Waverley	4:07	4.07	3:20

Impacts on travel demand during operation

14.6.12 Increased demand is forecast for long-distance rail travel. Without the Proposed Scheme, the WCML and other routes will become increasingly congested. With the Proposed Scheme,

new capacity for long-distance rail journeys will be introduced with accompanying reductions in journey times and enhanced passenger experience. This will also result in released capacity and reduced congestion and passenger crowding on the conventional rail network.

14.6.13 Daily boardings and alightings for 2038 and 2046, onto and off HS2 trains at all stations served by HS2 are shown in Table 34, which includes stations that are part of the Proposed Scheme, HS2 stations that are part of HS2 Phase One and other stations to be served by HS2. This demonstrates the substantial flows into and out of London, Birmingham and Manchester HS2 stations. Other stations with notable HS2 boarders and alighters include Glasgow, Edinburgh and Preston.

Table 34: HS2 boardings and alightings by station - all phases, 2038 and 2046

HS2 station	Total boarders 2038	Total alighters 2038	Total boarders 2046	Total alighters 2046
Manchester Airport High Speed station	8,783	8,791	9,354	9,355
Manchester Piccadilly High Speed station	17,573	17,589	18,694	18,696
Euston	53,018	54,736	55,864	57,692
Old Oak Common	33,525	32,556	35,342	34,315
Birmingham Interchange	14,865	15,124	15,689	15,950
Birmingham Curzon Street	22,614	22,175	23,932	23,466
Stafford	1,783	2,010	1,883	2,125
Stoke-On-Trent	1,058	1,060	1,121	1,122
Crewe	7,572	6,728	7,893	7,020
Macclesfield	594	618	628	653
Runcorn	3,371	3,301	3,498	3,426
Warrington Bank Quay	1,413	1,365	1,492	1,438
Liverpool Lime Street High Level	5,403	5,529	5,645	5,782
Wigan North Western	2,331	2,484	2,464	2,623
Preston	11,779	11,570	12,335	12,121
Lancaster	2,259	2,281	2,371	2,392
Oxenholme Lake District	809	817	837	843
Penrith	561	566	583	590
Carlisle	4,154	4,003	4,340	4,180
Lockerbie	419	446	429	456
Motherwell	96	80	101	84
Glasgow Central	7,335	7,505	7,756	7,933
Edinburgh Waverley	9,150	9,137	9,693	9,679
Total	**210,465**	**210,471**	**221,944**	**221,941**

Impacts on modal share

14.6.14 The increased capacity and improved journey times that will result from the Proposed Scheme and the additional services provided to take advantage of released capacity will generate increased demand for rail travel. The Proposed Scheme will provide an attractive substitute for users of the long-distance rail services that would operate in the absence of HS2. The improvements will also encourage changes in mode share from car and potentially air, as well as generating new rail trips.

14.6.15 Forecast demand for rail, car and air travel and the extent of changes in mode share for 2038 and 2046 have been considered for the future baseline cases and for the Proposed Scheme scenarios.

14.6.16 The daily and annual forecast numbers of HS2 passenger trips for 2038 and 2046, the numbers of generated new trips and, for the remainder, the mode of travel that they will have transferred from for Phase One, Phase 2a and the Proposed Scheme are set out in Table 35 and Table 36 on a daily and annual basis respectively.

Table 35: Number and mode share of HS2 passenger trips - daily (2038 and 2046)

Source of HS2 demand	2038 Phase One and Phase 2a	2038 Phase One, Phase 2a and Proposed Scheme	2046 Phase One and Phase 2a	2046 Phase One, Phase 2a and Proposed Scheme
Total HS2 trips, of which:	157,082	205,611	164,520	216,751
From conventional rail	114,242	141,119	118,574	147,074
From car	4,109	6,705	4,451	7,274
From air	1,138	2,756	1,270	3,098
Newly generated by HS2	37,594	55,031	40,224	59,306

Table 36: Number and mode share of HS2 passenger trips (millions) - annual (2038 and 2046)

Source of HS2 demand	2038 Phase One and Phase 2a	2038 Phase One, Phase 2a and Proposed Scheme	2046 Phase One and Phase 2a	2046 Phase One, Phase 2a and Proposed Scheme
Total HS2 trips, of which:	50.0	70.0	52.4	70.6
From conventional rail	36.9	46.8	38.4	48.9
From car	1.3	2.1	1.4	2.2
From air	0.4	0.9	0.4	1.0
Newly generated by HS2	11.5	17.2	12.3	18.5

14.6.17 Table 36 shows that the combined HS2 Phase One, Phase 2a and Proposed Scheme will attract 70.6 million users per annum by 2046, with the Proposed Scheme in isolation increasing use of HS2 services by 18.2 million passenger trips per annum (35%) when compared with HS2 Phase One and Phase 2a. With the Proposed Scheme in combination with Phase One and Phase 2a, 26% of the total demand is newly generated, compared to 24% for Phase One and Phase 2a, due to new journey opportunities, reduced travel times and higher frequencies. The percentage of HS2 demand abstracted from conventional rail

reduces with each phase of HS2, from 73% for Phase One and Phase 2a and to 70% for the Proposed Scheme in combination with Phase One and Phase 2a, corresponding to the increase in newly generated demand. The proportion from car and air remain constant between phases, at around 3% and 1% respectively.

14.6.18 The overall change in rail travel, with a proportion of HS2 trips being generated as new travel, demonstrates the levels of travel suppressed by capacity constraints and journey times. The overall change in rail travel shows the substantial travel opportunities and aspirations that the Proposed Scheme and the released capacity services would realise.

14.6.19 The transfer of passengers from the conventional rail network and from mode transfer from car will result in benefits through reducing forecast future congestion on both the SRN and the conventional rail network. The extent of reduction in highway vehicle kilometres as a result of the Proposed Scheme is shown in Table 37.

14.6.20 Table 37 shows that the incremental impact of the Proposed Scheme will be a reduction in annual vehicle travel by car on strategic long-distance routes of 106 million kilometres by 2046. The in-combination impact of HS2 Phase One, Phase 2a and the Proposed Scheme will be a reduction in annual vehicle travel by car on strategic long-distance routes of 239 million kilometres by 2046.

14.6.21 In incremental terms, the Proposed Scheme contributes approximately 44% of the in combination total vehicle kilometre savings of HS2 Phase One, Phase 2a and the Proposed Scheme together.

Table 37: Reduction in vehicle kilometres (millions) resulting from mode shift

	Long distance highway vehicle kilometres (millions)	Incremental reduction in highway vehicle kilometres (millions)	Total reduction in highway vehicle kilometres (millions)
2038 future baseline	115,697	-	-
2038 Phase One and Phase 2a	115,569	128	-
2038 Proposed Scheme	115,473	96	224
2046 future baseline	119,200	-	-
2046 Phase One and 2a	119,067	134	-
2046 Proposed Scheme	118,961	106	239

14.6.22 The Proposed Scheme is shown to increase demand for rail travel and provide beneficial relief to the conventional rail network as well as beneficial reductions in long distance travel by car, both of which are substantial increases compared to Phase One and Phase 2a in combination. These impacts for the Proposed Scheme in isolation are considered to provide a major beneficial effect which is significant.

15 Waste and material resources

15.1 Introduction

15.1.1 This section of the report presents a route-wide assessment of the likely significant environmental effects identified to date associated with the off-site disposal to landfill of solid waste that will be generated by the construction and operation of the Proposed Scheme. This assessment considers:

- the types and quantities of waste that will be generated;
- the quantity of waste that will require off-site disposal to landfill; and
- the availability of off-site landfill disposal capacity.

15.1.2 This assessment does not consider liquid waste, the direct and indirect effects of waste-related transport, or mineral resources located along the route of the Proposed Scheme. Liquid wastes[144], such as waste oil, are not considered as they would be immaterial in quantity compared to solid waste and have, therefore, been scoped out. Effects related to pollution risk and water quality are assessed in the Volume 2, Community area reports, Section 15, Water resources and flood risk. Waste-related transport is considered as part of the traffic and transport assessment in Volume 2, Community area reports, Section 14. This assessment, in turn, is used by other topics, such as Climate change, Section 4 of this report, to undertake their own assessments. Mineral resources are considered elsewhere within this report (Section 9, Land quality), and will be managed in accordance with the measures contained within the draft Code of Construction Practice (CoCP)[1].

15.1.3 Consideration of material resources in this assessment is limited to the beneficial reuse of materials arising from the construction of the Proposed Scheme (e.g. excavated material).

15.1.4 Only if excavated material is not required or is unsuitable for the construction of the Proposed Scheme would it be considered for use beyond the Proposed Scheme or consigned as waste.

15.1.5 The likely significant environmental effects from the use of materials (e.g. aggregate, concrete, brick and steel) for the construction or operation of the Proposed Scheme is addressed by consideration of the greenhouse gas impacts associated with the embedded carbon, which is covered in Section 8 (Climate change).

[144] *Directive 1999/31/EC of the European Parliament and of the Council 26 April 1999 on the Landfill of Waste*. Available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:NOT.

Context

Need for route-wide assessment

15.1.6 The movement of waste from source to final destination is a complex process, as waste is often transferred across waste planning authority boundaries for treatment or disposal according to the type of waste and the nature of the waste management facility required.

15.1.7 Waste planning authorities in England have a statutory duty to plan for an appropriate amount of waste infrastructure capacity to be available over a defined period according to projected waste arisings, targets for diverting waste from landfill, policies with regard to the separate collection of waste types, and the need to take account of waste that may be imported/exported from/to other areas for treatment or disposal.

15.1.8 For this reason, waste planning has traditionally been undertaken on a county-level basis and until early 2013 (when regional plans were abolished) on a regional-level basis that took account of the inter-regional movement of waste within England. Waste planning in Scotland is undertaken on a regional-basis by Strategic Development Plan (SDP) or Local Authority area[145].

15.1.9 To reflect this broader county and regional-based approach to waste planning and management, an assessment of the likely significant environmental effects associated with the off-site disposal to landfill of solid waste that will be generated by the Proposed Scheme has been undertaken on a route-wide basis.

15.1.10 This route-wide approach takes into account waste arisings and waste infrastructure capacity data available at county and regional levels. Comprehensive waste data at district level is often limited and so has not been considered for use in this assessment.

Environmental effects of waste management

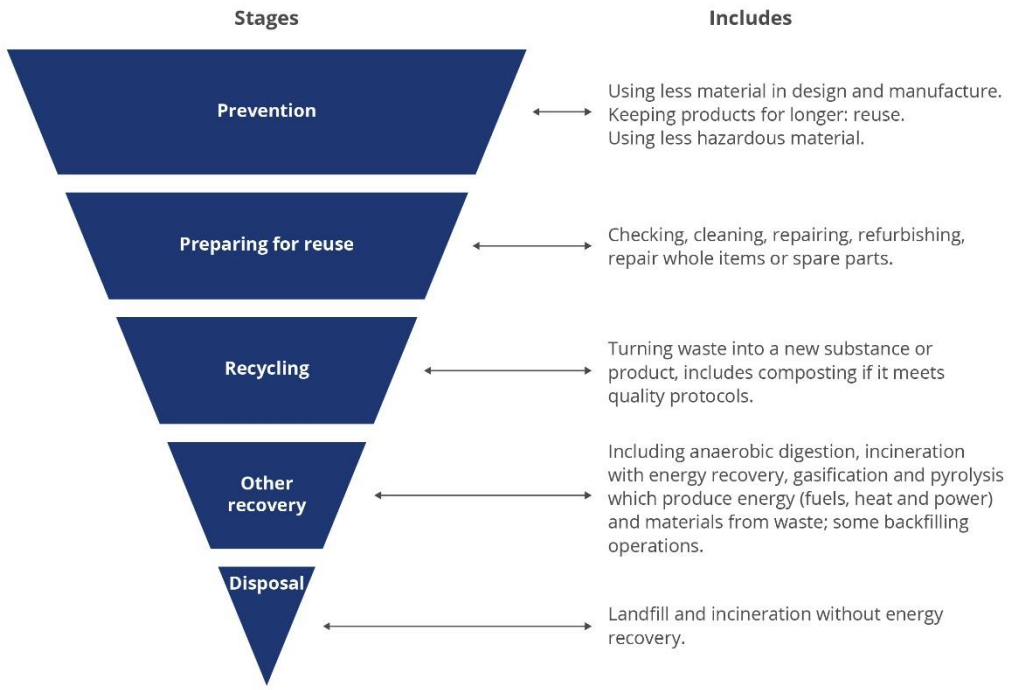
15.1.11 The waste hierarchy[146] (Figure 17) sets out the preferred approach to the management of waste from waste prevention, to preparation for reuse, recycling, other recovery and disposal to landfill as a last resort. In England, Wales and Scotland, waste producers have a

[145] Scottish Planning Policy (2014) available online at: https://www.webarchive.org.uk/wayback/archive/20150829013211/http://www.gov.scot/Publications/2014/06/5823 states that *"Planning authorities should have regard to the annual update of required capacity for source segregated and unsorted waste, mindful of the need to achieve the all-Scotland operational capacity".* It is therefore recognised that Scottish Local Authorities can work in a number of arrangements spatially and operationally to collectively deliver this capacity. Emphasis should be placed on need over proximity, and may involve waste crossing planning boundaries.

[146] Department for Environment, Food and Rural Affairs (2011), *Government Review of Waste Policy in England 2011*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69401/pb13540-waste-policy-review110614.pdf.

legal duty to apply the waste hierarchy to decisions concerning the generation and management of waste[147].

Figure 17: The waste hierarchy



15.1.12 The waste hierarchy supports the need to achieve efficient use of material resources, minimise the amount of waste produced (or otherwise increase its value as a resource) and reduce, as far as possible, the amount of waste that is disposed to landfill.

15.1.13 The waste hierarchy advocates landfill disposal only as a last resort due to a range of potential adverse effects associated with its use. This includes natural resource depletion, methane production and nuisance effects (e.g. dust and odour). There is also a need to conserve existing landfill capacity for wastes for which there are currently no alternative treatment options that can be used to recover material resources and/or energy.

15.1.14 The availability of waste management infrastructure capacity is also important considering national policy that supports the treatment and disposal of waste at one of the nearest appropriate installations[148].

[147] *Environmental Protection Act 1990.* Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/ukpga/1990/43/contents.

[148] Department for Communities and Local Government (October 2014), *National Planning Policy for Waste*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/364759/141015_National_Planning_Policy_for_Waste.pdf.

15.1.15 For this reason, this assessment sets out the likely significant environmental effects associated with the off-site disposal to landfill of solid waste that will be generated by the construction and operation of the Proposed Scheme.

Design approach and mitigation

15.1.16 An integrated design approach has been developed that seeks to reuse excavated material to satisfy the necessary engineering and environmental mitigation earthworks requirements for the Proposed Scheme, and includes the use of borrow pits where appropriate. It seeks to minimise the quantity of surplus excavated material generated and minimise off-site disposal to landfill. This includes reuse of all topsoil and agricultural subsoil as close to the point of excavation as practicable.

15.1.17 Materials Management Plans will be drafted in accordance with the CL:AIRE Code of Practice[149] in anticipation of implementing the integrated design approach. This will enable suitable excavated material to be used as a resource within the construction of the Proposed Scheme with the additional benefit of reducing the quantity of imported minerals required.

15.1.18 The nominated undertaker has an ambition to seek opportunities for beneficial reuse of excavated material that cannot be reused in the earthworks of the Proposed Scheme. Such beneficial uses might include:

- use in other construction projects where opportunities arise at the time of construction; and/or
- restoration of mineral or landfill sites.

15.1.19 Opportunities for beneficial reuse off-site will be pursued where the transportation of that material does not result in likely significant environmental effects.

15.2 Policy framework

General

15.2.1 The assessment and mitigation of the likely significant environmental effects associated with the off-site disposal to landfill of solid waste has been considered with respect to relevant waste planning and management policies in England. Those of relevance to this assessment are summarised within this section[150].

[149] Contaminated Land: Applications in Real Environments (2011), *Definition of Waste: Development Industry Code of Practice*. Available online at: http://www.claire.co.uk/projects-and-initiatives/dow-cop/28-framework-and-guidance/111-dow-cop-main-document.

[150] Some of the off-route works will be located in Scotland. This review of national and local waste planning and management policies focuses on England. This is where the majority of works associated with the Proposed Scheme will occur, and which the route of the Proposed Scheme will pass and where most of the waste will be managed. This is therefore considered the primary study area for the route-wide assessment as detailed in Section 15.4.

National policy framework

15.2.2 The Government's 25 Year Plan to Improve the Environment, published in January 2018, aims to maximise resource efficiency, minimise environmental impacts at the end of life of materials and products, and embed the 'environmental net gain' principle in all new infrastructure projects. The Government's 25 Year Plan to Improve the Environment commits to eliminating all avoidable plastic waste by the end of 2042, and achieving an overall target of zero avoidable waste by the end of 2050. It also seeks to deliver a substantial reduction in litter and littering behaviour.

15.2.3 The Resources and Waste Strategy for England[151], published in December 2018, sets out how resource use will be optimised by minimising waste, promoting resource efficiency and moving towards a circular economy in England. It gives a clear longer-term policy direction in line with the 25 Year Environment Plan. The Resources and Waste Strategy sets out how the Government will, among other measures:

- explore mandatory guarantees and extended warranties on products, to encourage manufacturers to design products that last longer and increase the levels of repair and reuse;
- transform construction using digital building design and new manufacturing technologies offering an opportunity to reduce waste and increase productivity, with an overall aim of a 50% reduction in build time;
- invoke the polluter pays principle and apply extended producer responsibility requirements for certain materials in the construction and demolition sector;
- consult on legal powers to introduce mandatory targets for food waste prevention and publish a new food surplus and waste hierarchy;
- stimulate demand for recycled plastic by introducing a tax on plastic packaging with less than 30% recycled plastic;
- ensure producers pay the full net costs of disposal or recycling of packaging they place on the market through extended producer responsibility; and
- prevent illegal national and overseas movements of waste by introducing compulsory electronic tracking of waste, and stricter penalties for waste crime (e.g. mislabelling the waste to avoid taxation requirements).

15.2.4 The National Planning Policy Framework (NPPF)[152] does not contain any specific policies on waste planning, but sets an overarching sustainable development objective of using natural

[151] HM Government (2018), *Our Waste, Our Resources: A Strategy for England*. Available online at: https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england.

[152] Ministry of Housing, Communities and Local Government (2019), *National Planning Policy Framework*. Available online at: https://www.gov.uk/government/collections/revised-national-planning-policy-framework.

resources prudently and minimising waste. The National Planning Policy for Waste[153], published in October 2014, sets out waste planning policies that all local planning authorities in England must follow when discharging their responsibilities associated with waste management. The policy aims to:

- deliver sustainable development including through the provision of modern infrastructure that drives waste management up the waste hierarchy;
- ensure that waste management is considered alongside other spatial planning concerns, recognising the positive contribution that waste management can make to the development of sustainable communities;
- provide a framework for communities to take more responsibility for their waste;
- secure the reuse, recovery or disposal of waste without endangering human health or the environment; and
- ensure that the design and layout of new development supports sustainable waste management.

15.2.5 The Waste Management Plan for England[154] provides an analysis of the waste management situation in England, as at the end of 2013, and a framework to support a more sustainable and efficient approach to resource use and management. Its purpose is to consolidate several existing policies within the context of a single national waste management plan.

15.2.6 Construction 2025: industrial strategy for construction (Construction 2025)[155] is a joint Government and industry initiative that aims to promote the concept of sustainability within the construction industry by setting out a long-term strategic action plan to be followed by both parties. Despite being more than eight years old, the document remains as current national policy and there are continued efforts to meet the ambitions and targets set within it. Construction 2025 recognises that outputs from the construction industry have a major effect on both the economy and the environment, and that a significant volume of construction, demolition and excavation waste (CDEW) is generated and not reused due, in large part, to the approach to risk across the supply chain. In addition, many procurement processes are bureaucratic and consequently wasteful. Construction 2025 predicts that the practice of off-site construction could halve CDEW generation.

[153] Department for Communities and Local Government (2014), *National Planning Policy for Waste*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/364759/141015_National_Planning_Policy_for_Waste.pdf.

[154] Department for Environment, Food & Rural Affairs (2013), *National Waste Management Plan for England*. Her Majesty's Stationery Office. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/265810/pb14100-waste-management-plan-20131213.pdf.

[155] HM Government (2013), *Construction 2025: Industrial Strategy: government and industry in partnership.* Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf.

15.2.7 The National Policy Statement for Hazardous Waste: A Framework Document for Planning Decisions on Nationally Significant Hazardous Waste Infrastructure 2013[156] sets out the need for large-scale hazardous waste infrastructure, and the framework for decision-making on relevant development consent applications within England.

Local policy framework

15.2.8 Local development plan documents for minerals and waste provide the local policy framework of relevance to this assessment. Local plans, produced in accordance with the requirements of the NPPF and section 20 of the Planning and Compulsory Purchase Act 2004 (as amended)[157], set out the strategic vision and overall spatial strategy applicable to waste and material resources. This is in relation both to the development of waste infrastructure and to waste generation and management associated with non-waste development.

15.2.9 A summary of the local policy framework applicable to this assessment is set out within the Route-wide waste and material resources policy review and benchmarks (BID WM-002-00000)[158,159].

15.2.10 Given the route-wide nature of this assessment, district and borough-level policy provisions applicable to waste planning and non-waste development (where relevant to the generation and management of waste) have not been considered further in this assessment.

15.3 Scope, assumptions and limitations

15.3.1 The scope of this assessment includes waste generated during construction and operation of the Proposed Scheme. It does not include material inputs to construction, i.e. waste associated with the manufacture of material inputs. The scope is set out in further detail within Volume 1, Section 8, and the EIA Scope and Methodology Report (SMR)[2].

15.3.2 Assumptions and limitations relevant to this assessment are set out in Volume 1, Section 8.

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[156] Department for Environment, Food & Rural Affairs (2013), *National Policy Statement for Hazardous Waste: A Framework Document for Planning Decisions on Nationally Significant Hazardous Waste Infrastructure.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/205568/pb13927-hazardous-waste-policy-20130606.pdf.

[157] *Planning and Compulsory Purchase Act 2004* (as amended). Her Majesty's Stationery Office, London. Available online at: https://www.legislation.gov.uk/ukpga/2004/5/contents.

[158] This includes the local policy framework applicable to the Dumfries and Galloway Council area to account for the construction of the off-route works at Annandale depot.

[159] High Speed Two (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Route-wide waste and material resources policy review and benchmarks*, *BID WM-002-00000*. Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.

15.4 Environmental baseline

General

15.4.1 The baseline comprises environmental conditions with respect to the types, quantities and management routes of waste generated in England and Scotland, within each of the counties and former regional planning areas through which the route of the Proposed Scheme will pass, and within each of the counties and former regional planning areas in which the off-route works associated with the Proposed Scheme will be located.

15.4.2 The types of waste described in this context are:

- CDEW that will be generated during the construction phase of the Proposed Scheme (2025 to 2038);
- commercial and industrial (C&I) waste that will be generated from worker accommodation sites during the construction phase of the Proposed Scheme (2025 to 2038); and
- C&I waste that will be generated during the first complete year of operation of the Proposed Scheme (2039).

15.4.3 The baseline also comprises the availability (types and capacity) of waste infrastructure within each of the county and former regional planning areas through which the route of the Proposed Scheme will pass.

15.4.4 Baseline conditions are presented as existing environmental conditions (based on latest available published data), and then as predicted future baseline conditions for the period 2025 to 2038 (construction period) and 2039 (first full year of operation).

15.4.5 The primary study area for this assessment is defined as the North West region shown in Table 38. This comprises the waste planning authorities of (in alphabetical order) Cheshire East, Cheshire West and Chester and Greater Manchester Combined Authority (and its constituent authorities) through which the route of the Proposed Scheme will pass, but also Cumbria County Council, Lancashire County Council and Merseyside. The North West region also represents the administrative area within which the various waste streams are likely to be managed, and the area for which waste arisings and waste infrastructure data is available[160].

15.4.6 Reference is also made in the assessment to specific local areas (see Table 38) within the North West region. These local areas comprise of local authority administration areas through which the route of the Proposed Scheme will pass.

[160] Comprehensive data for waste arisings and waste infrastructure capacity is not available on a community area basis.

Table 38: Study area for route-wide assessment

Regional area	Waste planning authority	Local area
North West Authorities through which the Proposed Scheme will pass are highlighted in bold text	**Cheshire East Council** **Cheshire West and Chester Council** **Warrington Borough Council** **Greater Manchester Combined Authority** Cumbria County Council, Lancashire County Council, Merseyside	**Crewe, Nantwich, Macclesfield** **Vale Royal, City of Chester** **Manchester City Council**, **Salford District, Trafford District, and Wigan District**, Halton Council, Knowsley Council, Liverpool City Council, Sefton Council, St. Helens Council and Wirral Council

15.4.7 Baseline and future baseline information is presented by both local and waste planning authority area, as there is often a need to manage waste outside of the immediate administrative area in which it is generated. This is dependent upon the type of waste infrastructure required, and the available capacity of such facilities to receive and manage the type(s) of waste generated.

15.4.8 In addition to the primary study area, baseline conditions in further regional and local areas are considered in the assessment of off-route works, see Table 39.

Table 39: Study area for assessment of off-route works

Regional area	Waste planning authority
North West	Preston City Council, Cumbria County Council
Scotland	Dumfries and Galloway Council

15.5 Waste arisings and management

Construction, demolition and excavation

National construction, demolition and excavation waste

15.5.1 Latest available data shows that a total of 120,297,807 tonnes of CDEW[161] was generated in England in 2016[162]. Of this amount, 59,649,648 tonnes comprised of non-hazardous waste from construction and demolition activities, of which 54,958,052 tonnes (approximately 92%) were recovered. In 2012, Defra ceased publication of national estimates for the recycling and recovery of CDEW. However, based on the estimated proportion of CDEW sent to landfill in

[161] European Competition Commission (2010), *CDEW is defined as NACE Code F (Construction category)*. Available online at: http://ec.europa.eu/competition/mergers/cases/index/nace_all.html. The UK Government report to the EU using the NACE classification system (NACE: Nomenclature générale des activités économiques dans les Communautés Européennes; equivalent in English is General Industrial Classification of Economic Activities within the European Communities).

[162] Department for Environment, Food & Rural Affairs (2020), *ENV23 - UK statistics on waste*. Available online at: https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management.

2010[163], the last year for which data is available, it has been forecast that of the 120,297,807 tonnes of CDEW generated in England in 2016, 30,843,629 tonnes (approximately 26%) were sent to landfill.

15.5.2 Comprehensive information on the likely future growth of CDEW arisings across England is limited. However, Eurostat data[164] shows that CDEW generation across the UK has been on an upward trend since 2004, (the first year for which data is available), with UK CDEW arisings increasing 39% between 2004 and 2018, as shown in Table 40.

Table 40: UK CDEW generation trend data, 2004 to 2018

Year	United Kingdom
2004	99,234,124
2006	109,545,987
2008	100,999,493
2010	118,910,602
2012	115,059,137
2014	131,229,457
2016	136,196,492
2018	137,798,233

15.5.3 The Eurostat data shows an average annual CDEW growth trend of approximately 2.5%. Based on this growth, the projected quantity of CDEW in England during the construction phase of the Proposed Scheme (2025 to 2038) has been calculated (see Table 41) to develop the baseline and future baseline. The proportion of the projected quantity of CDEW disposed of in landfill, and the quantity diverted, is based on the 2012 Defra estimates[163].

Table 41: Baseline and future baseline national CDEW arisings

Year	Landfill (tonnes)	Diverted from landfill (tonnes)	Total (tonnes)
2021	34,828,189	101,010,392	135,838,581
2025 - 2038	632,335,895	1,833,931,008	2,466,266,904

Regional construction, demolition and excavation waste

15.5.4 Regional CDEW arisings and management data have not been published by Defra in the UK since 2007. This data is considered too old to represent a reasonable baseline with respect to the generation and management of CDEW in the regional area through which the route of the Proposed Scheme will pass. To develop a baseline and future baseline for the North West region, waste generation and management data and projected trends, were taken from the adopted and emerging local plans of each of the waste planning authorities within

[163] Department for Environment, Food & Rural Affairs (2012), *Construction, Demolition and Excavation Waste Generation Estimate: England, 2008 to 2010*. Document now archived.

[164] Eurostat (2021), *Generation of waste by waste category, hazardousness and NACE Rev. 2 activity*. Available online at: http://ec.europa.eu/eurostat/web/products-datasets/-/env_wasgen.

the former North West region. These were consequently analysed (not least for consistency in the data) and the sum of each is presented in Table 42.

Table 42: Baseline and future baseline CDEW arisings and management in the North West region

Year	Waste Quantity	North West (tonnes)
2021	Landfilled	2,838,773
2021	Recovered	6,965,946
2021	**Total**	**9,804,719**
2025 - 2038	Landfilled	41,433,669
2025 - 2038	Recovered	113,968,875
2025 - 2038	**Total**	**155,402,544**

Local construction, demolition and excavation waste

15.5.5 Local CDEW arisings and management for the year 2021 (baseline) and the period 2025 to 2038 (future baseline) are presented in detail in the Route-wide waste and material resources assessment in Volume 5: Appendix WM-001-00000.

15.5.6 The local CDEW arisings and management information originates from the same information sources used to develop the regional CDEW baseline and future baseline, and contributes to the CDEW arisings and management data presented in Table 42.

Commercial and industrial waste

National commercial and industrial waste

15.5.7 Latest available information[165] reports that, in 2018, a total of approximately 37.2 million tonnes of C&I waste were produced in England according to returns made under the EU Waste Statistics Regulation[166]. C&I waste generation is extremely difficult to estimate owing to data limitations and data gaps; C&I waste estimates for England have a much higher level of uncertainty than waste from other sources. A 2011 survey by Defra[167] represents the most recently published set of detailed data regarding the national treatment and disposal routes for C&I waste. Based on the waste management methods identified in the 2011 Defra

[165] Department for Environment, Food & Rural Affairs (2020), *UK Statistics on Waste – 19 March 2020*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/874265/UK_Statistics_on_Waste_statistical_notice_March_2020_accessible_FINAL_rev_v0.5.pdf.

[166] Regulation (EC) No 2150/2002 of the European Parliament and of the Council of 25 November 2002 on waste statistics. European Parliament, Council of the European Union.

[167] Department for Environment, Food & Rural Affairs (2011), *Survey of Commercial and Industrial Waste Arisings 2010 - Revised Final Results.* Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/400595/ci-statistics-release.pdf.

survey, it is expected that of the approximately 37.2 million tonnes of C&I waste estimated to have been generated in 2018:

- 19,370,731 tonnes (52%) was reused, recycled or composted;
- 6,258,212 tonnes (17%) was diverted from landfill via various treatment and recovery methods;
- 8,755,133 tonnes (23%) was disposed to landfill; and
- the destination of 2,818,924 tonnes (8%) was unknown.

15.5.8 Estimates of waste generation by the C&I sectors in England have been calculated by Defra as part of the Waste Statistics Regulation returns, published by Eurostat. Estimates between 2010 and 2018[168] show that C&I waste generation across the UK has been fluctuating between annual decreases and annual increases, with C&I waste arisings in England estimated to have increased 16.25% between 2010 and 2018, as shown in Table 43.

Table 43: England C&I waste generation trend data, 2010 to 2018

Year	Total C&I waste generation in England
2010 (tonnes)	32,000,000
2011 (tonnes)	33,400,000
2012 (tonnes)	33,900,000
2013 (tonnes)	32,800,000
2014 (tonnes)	31,700,000
2015 (tonnes)	31,900,000
2016 (tonnes)	33,100,000
2017 (tonnes)	36,100,000
2018 (tonnes)	37,200,000

15.5.9 The Defra estimates show an average annual C&I waste increase of 2.0%. Based on this growth, the projected quantity and management of C&I waste in England during the construction phase of the Proposed Scheme (2025 to 2038), and during the first full year of operation of the Proposed Scheme (2039) has been calculated to develop the baseline and future baseline (see Table 44).

Table 44: Baseline and future baseline national C&I waste arisings

Year	Landfill (tonnes)	Diverted from landfill (tonnes)	Total (tonnes)
2021	9,283,392	30,161,148	39,444,540
2025 - 2038	160,041,818	519,965,653	680,007,471
2039	13,193,816	42,865,865	56,059,681

[168] Department for Environment, Food & Rural Affairs (2020), UK statistics on waste – 19 March 2020. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/874265/UK_Statistics_on_Waste_statistical_notice_March_2020_accessible_FINAL_rev_v0.5.pdf.

Regional commercial and industrial waste

15.5.10 Regional C&I waste arisings and management data has not been published by Defra in the UK since 2011. This data is considered too old to represent a reasonable baseline with respect to the generation and management of C&I waste in the North West region. To develop a baseline and future baseline for the North West, waste generation and management data and projected trends were taken from the adopted and emerging local plans of each of the waste planning authorities within the former North West region. These were consequently analysed (not least for consistency in the data) and the sum of each is presented in Table 45.

Table 45: Baseline and future baseline C&I waste arisings and management by region

Year	Waste quantity	North West (tonnes)
2021	Landfilled	1,501,081
	Recovered	6,447,136
	Total	**7,948,135**
2025 - 2038	Landfilled	15,820,882
	Recovered	93,962,028
	Total	**109,781,691**
2039	Landfilled	867,487
	Recovered	6,892,645
	Total	**7,760,131**

15.5.11 Table 45 indicates that approximately 81% of all C&I waste generated in the North West region is currently diverted from landfill.

Local commercial and industrial waste

15.5.12 Local C&I waste arisings and management for the baseline year 2021, the future baseline period 2025 to 2038 (for construction) and 2039 (for first full year of operation) are presented in detail in the Route-wide waste and material resources assessment in Volume 5: Appendix WM-001-00000.

15.5.13 The local C&I waste arisings and management information originates from the same information sources used to develop the regional C&I waste baseline and future baseline, and contributes to the C&I waste arisings and management data presented in Table 45.

Waste infrastructure

General

15.5.14 Latest available information at the time of writing, published by the Environment Agency for 2019[169] has been used with historic data to inform the baseline and future baseline with respect to waste infrastructure capacity within each of the county and former regional planning areas through which the route of the Proposed Scheme will pass. National waste infrastructure capacity is not provided as it is not required for use in this assessment.

15.5.15 Whilst information on waste infrastructure is available from waste planning authorities, this information may not always be presented in a way that is directly and readily comparable. Environment Agency data provides both a credible and reliable source of information that is consistent and comparable across all counties and regions. Permitted landfill capacity data from the Environment Agency has also been used to inform the significance criteria used in this assessment, as reported in the EIA SMR.

Current baseline

15.5.16 Table 46 provides baseline landfill void space capacity data for the North West region[169] through which the route of the Proposed Scheme will pass. The baseline information presented is based on permitted capacity for the year 2019, as published by the Environment Agency.

Table 46: Baseline landfill void space capacity by region, 2019

Facility type	North West (tonnes)
Inert waste landfill	8,245,500
Non-hazardous waste landfill	20,465,310
Hazardous waste landfill	9,225,000
Total	**37,935,810**

15.5.17 In relation to the information presented in Table 46, landfill capacity information is published by the Environment Agency in cubic metres (i.e. volume) but has been converted to tonnes (i.e. mass) using the following landfill density conversion factors:

- 1.5 tonnes per cubic metre for inert waste landfill;
- 0.83 tonnes per cubic metre for non-hazardous waste landfill; and
- 1.5 tonnes per cubic metre for hazardous waste landfill.

15.5.18 Table 47 provides baseline capacity and unused capacity data for waste recovery infrastructure (i.e. incineration) for the North West region[169] through which the route of the

[169] Environment Agency (2019), *Waste summary tables for England and the former planning regions 2019.* Available online at: https://data.gov.uk/dataset/d409b2ba-796c-4436-82c7-eb1831a9ef25/2019-waste-data-interrogator.

Proposed Scheme will pass, as published by the Environment Agency. Unused capacity comprises the difference between the annual inputs and the permitted capacity for the year 2019.

Table 47: Baseline waste recovery infrastructure capacity by region, 2019

Facility type	North West	
	Capacity (tonnes)	Unused capacity (tonnes)
Municipal solid waste, C&I waste incineration	1,227,000	176,555
Other incineration	793,000	357,504
Total	2,020,000	534,059

15.5.19 Table 48 provides baseline waste transfer, waste treatment and metal recycling infrastructure input data for the North West region[169] through which the route of the Proposed Scheme will pass. Waste treatment comprises of material recovery facilities, composting and other biological treatment facilities, and other facilities processing waste using physical, physico-chemical, and chemical treatment processes. The baseline information presented is based on site inputs for the year 2019, as published by the Environment Agency.

Table 48: Baseline waste transfer, treatment and metal recycling infrastructure input data by region, 2019

Facility type	North West
	Inputs (tonnes)
Waste transfer	6,185,000
Waste treatment	17,513,000
Metal recycling	2,760,000
Total	26,458,000

15.5.20 The data presented in Table 48 is based on the annual waste input quantities provided by the Environment Agency, as separate capacity information is not published. The annual waste throughput capacity of the waste infrastructure facility types is assumed to be at least equivalent to the waste input quantities provided in Table 48.

Future baseline landfill capacity

15.5.21 Considering the purpose and scope of this assessment, the future baseline for waste infrastructure capacity is primarily focussed on landfill disposal capacity. It is expected that landfill capacity will continue to be available during the period 2025 to 2038 (for construction) and in 2039 (for first full year of operation).

15.5.22 There will be some draw-down of available capacity as waste is deposited and landfill void space is used up. The rate of draw-down will be dependent on external factors, including government policy and market forces.

15.5.23 Permitted capacity data published by the Environment Agency has been used to provide an indication of projected landfill capacity for the future baseline. This method provides an

indication of projected landfill disposal capacity for each class of landfill as defined by Council Directive 1999/31/EC (the Landfill Directive). This relates to the capacity of inert, non-hazardous and hazardous waste landfill that would be available during the period 2025 to 2038 (for construction) and 2039 (for first full year of operation) within each of the regional areas through which the Proposed Scheme will pass.

15.5.24 Projected landfill capacity is based on the average percentage change in permitted landfill capacity for the years 2005 to 2019 as reported by the Environment Agency. The average percentage change has then been applied to the reported 2019 permitted landfill capacity and projected forward to 2039.

15.5.25 This method assumes that the average percentage change in permitted capacity for each class of landfill remains constant. Use of an average value taken from historical data provides a reasonable allowance for potential future increases in permitted capacity for each class of landfill, and takes account of waste generation trends driven by development in the respective regional areas. Committed developments of sufficient scale that have the potential to disrupt the general trend in available landfill capacity are assessed separately in the cumulative effects sections.

15.5.26 Waste planning authorities have a responsibility under the National Planning Policy for Waste[170], to make provision for sufficient waste infrastructure capacity based on projected waste arisings (over a defined period), including targets to divert waste from landfill and the need to take account of waste imported/exported from/to other areas for treatment and disposal. Trends in waste generation, the way in which waste is managed, and the timeline of landfill waste diversion policies, show that there is likely to be a continued demand for landfill capacity beyond the assessment period. It is, therefore likely that waste planning authorities will continue to plan for new landfill sites, both to ensure continued capacity as available landfill void space is exhausted, but also to restore former mineral workings. Subject to receipt of planning permission and other criteria stipulated by waste planning authorities, new permitted landfill capacity is likely to be provided to meet any future gaps in inert, non-hazardous and hazardous waste landfill capacity.

15.5.27 The information presented is, therefore, considered to be a reasonable scenario with respect to future landfill capacity within the North West region that forms the scope of the study area. This approach takes account of future draw-down and increases in permitted landfill capacity, as well as government policy measures to divert waste from landfill and the requirement for waste planning authorities to provide for future landfill capacity needs.

[170] Department for Communities and Local Government (2014), *National Planning Policy for Waste*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/364759/141015_National_Planning_Policy_for_Waste.pdf.

Future baseline waste treatment and recovery capacity

15.5.28 It is expected that various types of waste treatment (recycling) and recovery (incineration) infrastructure capacity will continue to be available during the period 2025 to 2038 (for construction) and in 2039 (for first full year of operation).

15.5.29 Permitted capacity data published by the Environment Agency has been used to provide an indication of projected waste recovery capacity for the future baseline. Data published by the Environment Agency relating to waste treatment infrastructure is limited to inputs (waste received) only. To derive projections of waste treatment infrastructure capacity, it has been assumed that the relationship between inputs and capacity matches that found in the waste recovery data published by the Environment Agency.

15.5.30 Waste treatment and recovery facilities are typically characterised by large annual throughput capacities; consequently, large step changes in capacity (as single facilities are commissioned) have an exaggerated impact on the historical trend. Waste treatment and recovery infrastructure capacity and unused capacity cannot, therefore, be realistically projected forward based on the average historical percentage change in permitted capacity as reported by the Environment Agency.

15.5.31 Waste infrastructure responds to market demands, and historical trends show that infrastructure is added or removed, not least to cope with changes in waste generation and management. The projected waste treatment and recovery infrastructure capacity has been based on the most recent available data, as presented in Table 46, Table 47 and Table 48, and has been projected forward by aligning growth in capacity with the forecast regional C&I waste growth rates, as presented in Table 45. The average unused capacity has been taken from the Environment Agency data over the years for which consistent data is available, and has been applied to the projected capacity.

15.5.32 This method assumes that the quantity of unused waste treatment and recovery infrastructure capacity as a proportion of the total capacity remains constant, and assumes that waste treatment and recovery infrastructure capacity will grow in direct proportion to the waste generation rates in the respective regions.

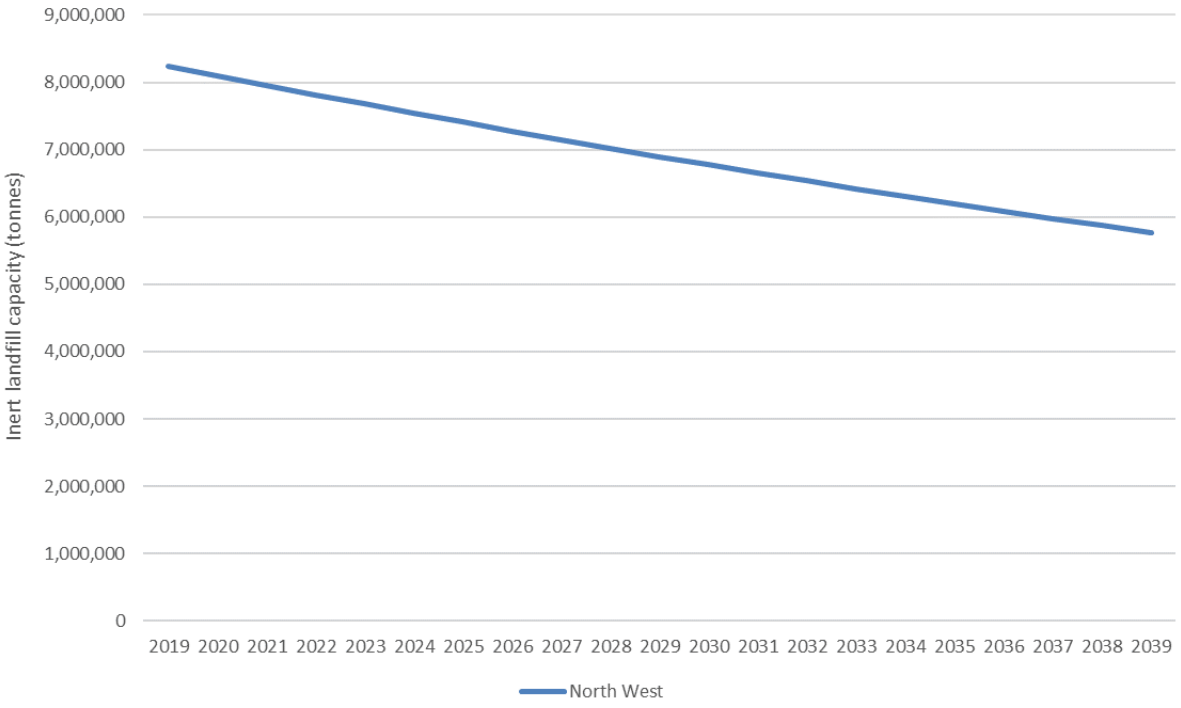
15.5.33 Waste planning authorities have a responsibility to make provision for sufficient waste infrastructure capacity based on projected waste arisings (over a defined period), including targets to divert waste from landfill and the need to take account of waste that may be imported/exported from/to other areas for treatment and disposal. Subject to receipt of planning permission and other criteria stipulated by waste planning authorities, new permitted waste recovery infrastructure capacity is likely to be provided to meet any future gaps.

15.5.34 The information presented is, therefore, considered to be a reasonable scenario with respect to future waste treatment and recovery infrastructure capacity within the North West region that forms the scope of the study area.

Inert waste landfill capacity

15.5.35 Using the latest available published data for the year 2019 as a starting point, Figure 18 shows projected inert waste landfill capacity for the future baseline period 2025 to 2038 (for construction) and the year 2039 (for first full year of operation).

Figure 18: Projected (future baseline) inert waste landfill capacity by region, 2019 to 2039

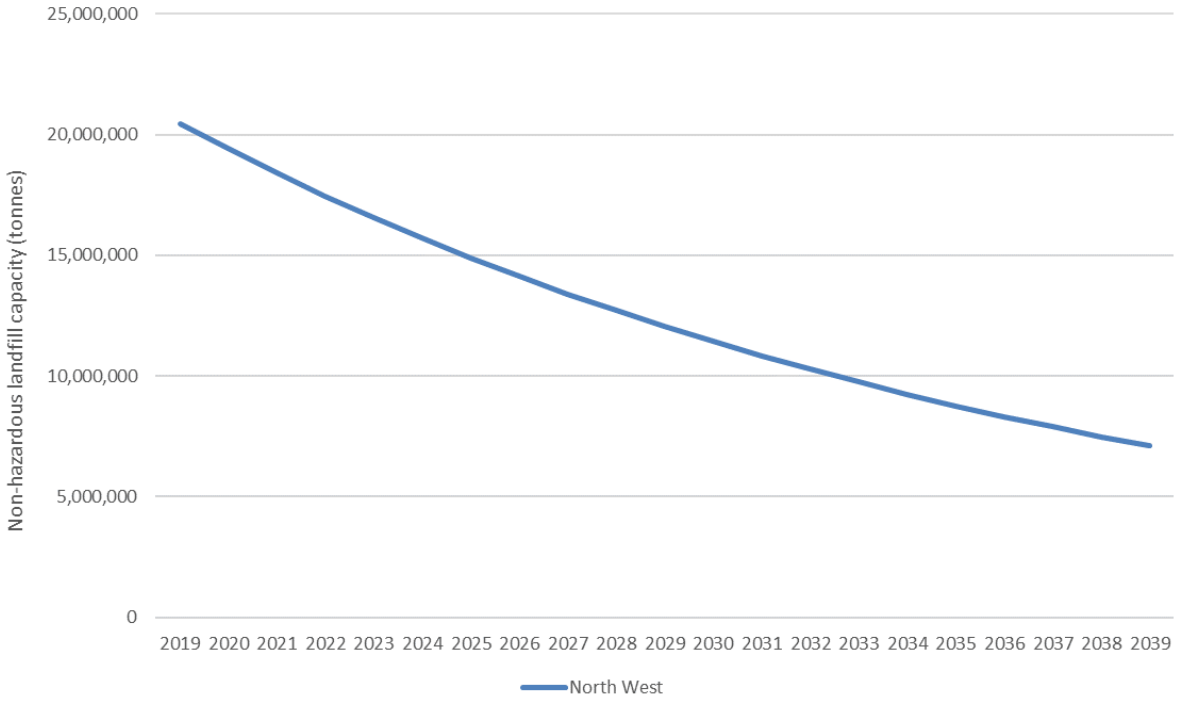


15.5.36 Figure 18 shows that, by 2039, there is forecast to be approximately 5.8 million tonnes of inert waste landfill capacity remaining in the North West region. This is a projected decrease from approximately 8.2 million tonnes of inert waste landfill capacity in 2019, which reflects a gradual decline in inert waste landfill capacity in the North West region during the period over which the historical trend has been developed (2005 to 2019).

Non-hazardous waste landfill capacity

15.5.37 Using latest available published data for the year 2019 as a starting point, Figure 19 shows projected non-hazardous waste landfill capacity for the future baseline period 2025 to 2038 (for construction) and the year 2039 (first full year of operation).

Figure 19: Projected (future baseline) non-hazardous waste landfill capacity by region, 2019 to 2039

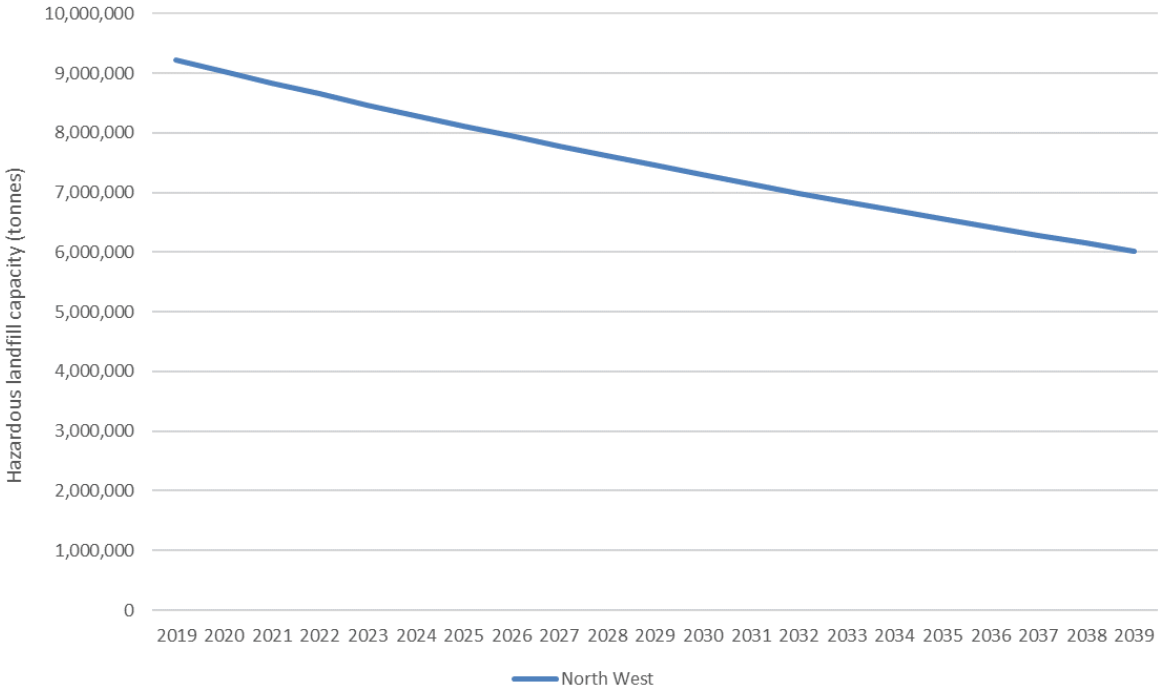


15.5.38 Figure 19 shows that, by 2039, there will be approximately 7.1 million tonnes of non-hazardous waste landfill capacity remaining in the North West region. This is a reduction from approximately 20.5 million tonnes of non-hazardous waste landfill capacity in 2019, which reflects a gradual decline in non-hazardous waste landfill capacity in the North West region during the period over which the historical trend has been developed (2005 to 2019).

Hazardous waste landfill capacity

15.5.39 Using the latest available published data for the year 2019 as a starting point, Figure 20 shows projected hazardous waste landfill capacity for the future baseline period 2025 to 2038 (for construction) and the year 2039 (first full year of operation).

Figure 20: Projected (future baseline) hazardous waste landfill capacity by region, 2019 to 2039

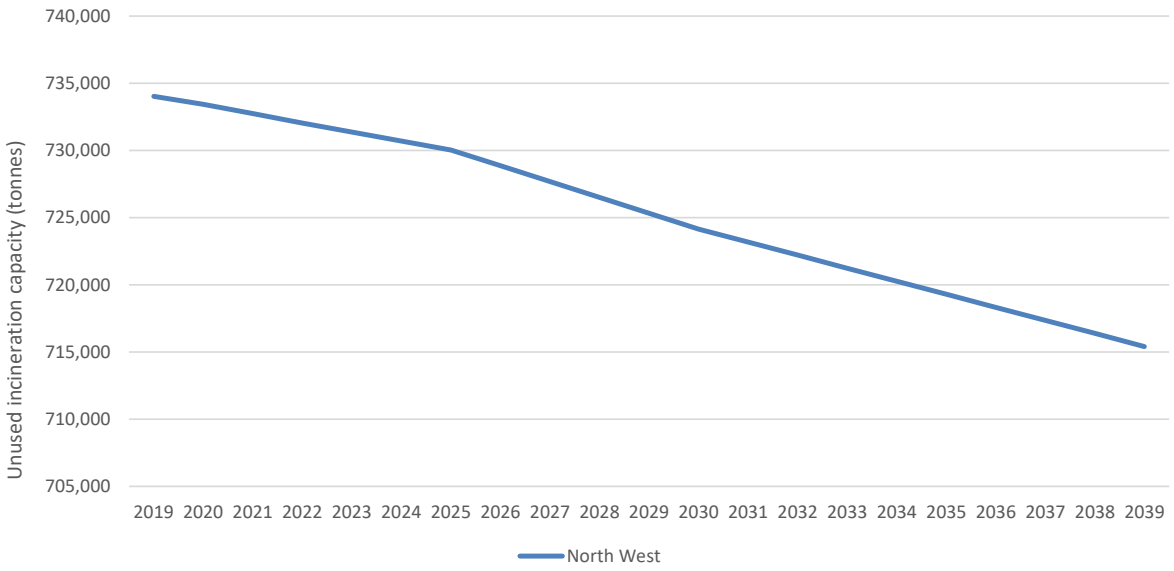


15.5.40 Figure 20 shows that, by 2039, there is projected to be approximately 6 million tonnes of hazardous waste landfill capacity remaining in the North West region. This is a decrease from approximately 9.2 million tonnes of hazardous waste landfill capacity in 2019.

Waste recovery infrastructure capacity

15.5.41 Using the latest available published data for the year 2019 as a starting point, Figure 21 shows projected unused waste recovery infrastructure capacity for the future baseline period 2025 to 2038 (for construction) and the year 2039 (first full year of operation).

Figure 21: Projected (future baseline) unused incineration waste recovery infrastructure capacity by region, 2019 to 2039

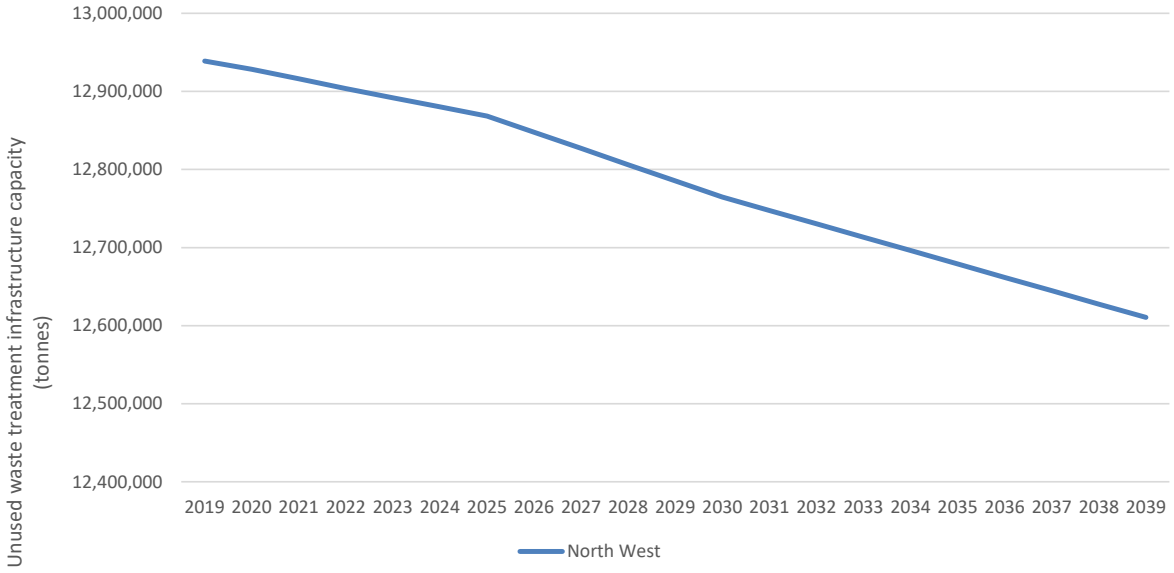


15.5.42 Figure 21 shows that, by 2039, there is forecast to be approximately 715,400 tonnes per annum of unused incineration waste recovery infrastructure capacity in the North West region. This represents approximately 36% of the total incinerator waste recovery infrastructure capacity (2 million tonnes in 2039) projected to be available. This is a decrease from approximately 734,000 tonnes of unused waste recovery infrastructure capacity in 2019.

Waste treatment infrastructure capacity

15.5.43 Using the latest available published data for the year 2019 as a starting point, Figure 22 shows projected unused waste treatment infrastructure capacity for the future baseline period 2025 to 2038 (for construction) and the year 2039 (first full year of operation).

Figure 22: Projected (future baseline) unused waste treatment infrastructure capacity by region, 2019 to 2039



15.5.44 Figure 22 shows that, by 2039, there is forecast to be approximately 12.6 million tonnes per annum of unused waste treatment infrastructure capacity in the North West region. This is a decrease from approximately 12.9 million tonnes of unused waste treatment infrastructure capacity in 2019.

15.6 Assessment of the effects of construction

Avoidance and mitigation measures

15.6.1 In accordance with the draft CoCP the nominated undertaker and its contractors will be responsible for managing the waste generated from construction activities.

15.6.2 The nominated undertaker and its contractors will comply with the requirements set out in the Borrow pit report, Volume 5: Appendix CT-008-00000 which relates to the excavation, operation and restoration of borrow pits.

Assessment of impacts and effects

Excavated material

15.6.3 Table 49 presents a route-wide summary of the forecast excavated material quantities for the Proposed Scheme. This is based on the calculated figures for the integrated earthworks design and reflects the balance of excavated material arising from the Proposed Scheme design. The nominated undertaker has an ambition to seek beneficial opportunities for the off-site reuse of surplus excavated material. However, it is difficult to make firm commitments for reuse of surplus excavated material in third party large scale schemes due

to the uncertainties of those schemes and in the scope and programme of the earthworks activities of the Proposed Scheme. For this assessment, it has been assumed as a worst-case scenario that all surplus excavated material will be disposed off-site to landfill.

Table 49: Forecast excavated material quantities for the Proposed Scheme, 2025 to 2038

Excavated material management methods	Total quantity (tonnes)	Proportion of Proposed Scheme total
Quantity of excavated material reused for engineering and environmental mitigation earthworks (including all topsoil and agricultural subsoil)	24,555,865	83.7%
Quantity of surplus excavated material for off-site disposal to landfill[171]	4,796,763	16.3%
Total	**29,352,628**	**100.0%**

15.6.4 The Proposed Scheme will generate approximately 29 million tonnes of excavated material during the period 2025 to 2038.

15.6.5 It is estimated that 84% of the excavated material generated by the Proposed Scheme will be used to satisfy the necessary requirements for fill on a route-wide basis. The fill requirement for the Proposed Scheme comprises predominantly engineering fill for rail and highways use and environmental mitigation fill for bunds, landscaping and borrow pit backfill. Excavated material used as engineering fill material and for environmental mitigation earthworks within the Proposed Scheme will include the following classes of material as defined by the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials[172]:

- Class 1 and Class 3 general railway fill;
- Class 2 general railway fill and general highway fill;
- Class 2 and 4 environmental mitigation earthworks fill;
- Class 6 selected fill;
- Treated Class U1A and Class U1B[173]; and
- topsoil and agricultural subsoil.

[171] All topsoil and agricultural subsoil generated by the Proposed Scheme is considered as a valuable material resource. The surplus excavated material reported for off-site disposal to landfill, does not include the quantity of topsoil and agricultural subsoil, which is not currently proposed for reuse in the design of the Proposed Scheme. It is expected that beneficial reuse opportunities will be found for surplus topsoil and agricultural subsoil, either within the Proposed Scheme, or off-site in nearby development projects.

[172] Department for Transport (2014), *Manual of Contract Documents for Highway Works, Volume 1 – Specification for Highways Works*. Available online at: https://www.standardsforhighways.co.uk/ha/standards/mchw/vol1/index.htm.

[173] Unacceptable material Class U1A is 'physically' unsuitable as defined in the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials sub-Clauses 2(i)(a) and 2(i)(b). Unacceptable material Class U1B is 'chemically' unsuitable as defined in the Specification for Highway Works, Series 601 Classification, Definitions and Uses of Earthworks Materials sub-Clause 2(ii)(a).

15.6.6 The estimated quantity of surplus excavated material that will not be reused within the construction of the Proposed Scheme will be approximately 16% of the overall excavated material that will be generated on a route-wide basis, based on the current level of design. This will comprise of:

- 4,564,689 tonnes of general fill and landscape fill, not required for use in the Proposed Scheme, which will require off-site disposal to inert landfill; and
- 232,074 tonnes of chemically unacceptable U1B materials[174], which cannot be treated on-site, and will require off-site disposal to non-hazardous landfill.

Borrow pits

15.6.7 The integrated earthworks design of the Proposed Scheme results in a shortfall of acceptable engineering material from the excavation of cuttings and other earthworks, for use in embankments and other applications requiring engineering fill.

15.6.8 In order to meet this shortfall, the use of borrow pits has been considered alongside alternative options including import from recycled and secondary sources and external quarries. In a number of locations along the route of the Proposed Scheme, the use of borrow pits has been chosen as the preferred solution for providing acceptable aggregates.

15.6.9 Borrow pits will be backfilled with materials generated from the construction of the Proposed Scheme which do not have acceptable characteristics for use as engineering fill. In all cases there will be a net balance of material extracted from and backfilled in borrow pits, with the result that there will be no impact on the local or regional landfill capacity.

15.6.10 Based on the current level of design, and excavation to the mineral depth required to supplement any shortfall of suitable granular and cohesive engineering fill material, it is forecast that 3,453,715 tonnes of material will be excavated from the borrow pits.

15.6.11 It is forecast that the same quantity of excavated material, 3,453,715 tonnes, generated from the Proposed Scheme, will be used to backfill the borrow pits; the quantity of surplus excavated material is reduced accordingly.

Local placement

15.6.12 As part of the design of earthworks and planning of materials movements, the scope for on-site deposit of surplus excavated material on land already required for the construction of the Proposed Scheme (local placement) was considered.

15.6.13 Local placement is the on-site placement, for disposal, of surplus excavated material to avoid causing environmental effects related to the transport of the surplus excavated material that would otherwise be associated with the off-site disposal of that material.

[174] Materials that are unsuitable for reuse by virtue of an excess concentration of contaminants that render the material 'contaminated' (as defined by statutory Regulation or HS2 project requirements) at the place and environmental setting of its final deposition.

15.6.14 Based on the current level of design, no surplus excavated material will be managed through on-site disposal in local placement.

Demolition material and waste

15.6.15 Demolition material quantities have been estimated using the Waste & Resources Action Programme 'Demolition bill of quantities estimator'[175], which uses the basic dimensions and typology of buildings to be demolished. Using this methodology, the Proposed Scheme will generate approximately 565,201 tonnes of demolition material during the construction period of 2025 to 2038.

15.6.16 Table 50 presents a summary of the forecast demolition material and waste quantities for the Proposed Scheme. More detailed demolition waste forecasts, including the source and quantities of demolition waste generated in each of the community areas along the route of the Proposed Scheme, are provided in the Route-wide waste and material resources assessment in Volume 5: Appendix WM-001-00000.

Table 50: Forecast demolition material and waste quantities for the Proposed Scheme, 2025 to 2038

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
North West	565,201	508,681	56,520

15.6.17 The quantity of demolition material that will be diverted from landfill via reuse, recycling and recovery is based on a landfill diversion rate of 90%. This rate has been selected based on a review of industry good practice landfill diversion rates from other large-scale infrastructure projects in the UK (e.g. the Elizabeth line (formerly Crossrail), London 2012 Olympics and High Speed One). Whilst HS2 Ltd is seeking, in its works contracts, to achieve a landfill diversion of demolition waste of 95%, it is acknowledged that this is an ambitious target. The landfill diversion rate of 90%, used in this assessment is consistent with the assessments carried out for previous phases of the Proposed Scheme, and has been chosen as a reasonable worst-case scenario. For this assessment, it has been assumed that the remaining 10% of demolition material will be disposed of off-site to landfill.

15.6.18 The quantity of demolition waste that will require off-site disposal to landfill during the construction period of 2025 to 2038 will be approximately 56,520 tonnes. The remaining 508,681 tonnes is expected to require management at suitable waste recovery and treatment infrastructure.

15.6.19 The Overview of Demolition Waste in the UK[176] uses waste data provided by the National Federation of Demolition Contractors to determine that approximately 91% of demolition waste is reused and recycled. This can be accounted for, in the most part, by the inert fraction of the waste. The report states that of the remaining 9% of demolition waste

[175] Waste & Resources Action Programme (2016), Net Waste Tool. No longer available online.

[176] Waste and Resources Action Programme (2009), Overview of Demolition Waste in the UK. Available online at: https://slidelegend.com/demolition-waste-wrap_5b24d5e5097c4720058b456b.html.

produced in the UK, approximately 3% is hazardous and 6% is sent to non-hazardous waste landfill. For this assessment, it has been assumed that 60% of the quantity of demolition waste requiring off-site disposal to landfill will be non-hazardous waste and 40% will be hazardous waste.

15.6.20 Based on this assumption, the class of landfill to which demolition waste will be sent for disposal is shown in Table 51.

Table 51: Quantity of demolition waste requiring off-site disposal to landfill (by class of landfill), 2025 to 2038

Class of landfill	Total quantity (tonnes)	Proportion
Quantity of demolition waste for off-site disposal to inert waste landfill	0	0%
Quantity of demolition waste for off-site disposal to non-hazardous waste landfill	33,912	60%
Quantity of demolition waste for off-site disposal to hazardous waste landfill	22,608	40%
Total	56,520	100%

Construction waste

15.6.21 Construction waste quantities have been estimated based on a waste generation rate derived from industry-wide benchmark performance data procured from the Building Research Establishment Ltd. Using this methodology, the Proposed Scheme is forecast to generate approximately 1.5 million tonnes of construction waste during the construction period of 2025 to 2038.

15.6.22 Table 52 presents a summary of the forecast construction waste quantities for the Proposed Scheme. More detailed construction waste forecasts, including the source and quantities of construction waste generated in each of the community areas along the route of the Proposed Scheme, are provided in the Route-wide waste and material resources assessment in Volume 5: Appendix WM-001-00000.

Table 52: Forecast construction waste quantities for the Proposed Scheme, 2025 to 2038

Regional area	Total quantity of waste (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
North West	1,506,631	1,355,968	150,663

15.6.23 The quantity of construction waste that will be diverted from landfill via reuse, recycling and recovery is based on a landfill diversion rate of 90%. This rate has been selected based on a review of industry good practice landfill diversion rates from other large-scale infrastructure projects, as identified for demolition waste.

15.6.24 It has been assumed, as a reasonable worst-case scenario for this assessment, that the remaining 10% of construction waste generated will be disposed of off-site to landfill. The

quantity of construction waste that will require off-site disposal to landfill during the construction period of 2025 to 2038 will be approximately 150,663 tonnes.

15.6.25 It has been assumed for this assessment that all of the construction waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill. This is based on indicative construction waste composition information published by the Building Research Establishment Ltd[177], Construction Leadership Council[178] and Waste & Resources Action Programme[179]. These sources suggest that minimal quantities of hazardous waste are generated and that construction waste to landfill is likely to comprise non-hazardous fractions, such as component packaging, insulation materials and mixed construction wastes, which are unsuitable for reuse and recycling.

Worker accommodation site waste

15.6.26 Worker accommodation site waste quantities have been forecast based on a waste generation rate derived from the average annual household waste generation in the UK, according to the number of workers to be accommodated and the duration of occupation. Using this methodology, the Proposed Scheme will generate approximately 887 tonnes of worker accommodation site waste during the construction period of 2025 to 2038, arising from the construction compounds proposed with temporary worker accommodation.

15.6.27 Worker accommodation site waste will be managed as C&I waste. More detailed worker accommodation site waste forecasts, including the source and quantities of the worker accommodation waste generated in each of the community areas along the route of the Proposed Scheme, is provided in the Route-wide waste and material resources assessment in Volume 5: Appendix WM-001-00000.

15.6.28 Table 53 presents a summary of the forecast worker accommodation site waste quantities for the Proposed Scheme.

Table 53: Forecast worker accommodation site waste quantities for the Proposed Scheme, 2025 to 2038

Regional area	Total quantity of waste (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
North West	887	488	399

15.6.29 The quantity of worker accommodation site waste that will be diverted from landfill via reuse, recycling and recovery is based on a landfill diversion rate of 55%. Waste generated

[177] Building Research Establishment (2001), *SMARTWaste case studies: reducing construction waste*. Available online at: https://www.bresmartsite.com/how-we-help/waste-management/.

[178] Strategic Forum for Construction (2011), *Waste: An Action Plan for halving construction, demolition and excavation waste to landfill, Strategic Forum for Construction*. Available online at: https://www.ciob.org/sites/default/files/Halving%20CDE%20waste%20to%20landfill.pdf

[179] Waste & Resources Action Programme (2005), *Reference document on the status of wood waste arisings and management in the UK, M.E.L Research Ltd.* Available online at: https://www.environmental-expert.com/articles/reference-document-on-the-status-of-wood-waste-arisings-and-management-in-the-uk-4584.

by occupants of worker accommodation sites will be similar in composition to household waste. As such, this rate has been selected based on a review of applicable household waste targets[180]. The quantity of worker accommodation site waste that will require off-site management through waste treatment and recovery infrastructure during the construction period of 2025 to 2038 will be approximately 488 tonnes.

15.6.30 It has been assumed, as a reasonable worst-case scenario for this assessment, that the remaining 45% of worker accommodation site waste will be disposed of off-site to landfill. The quantity of worker accommodation site waste that will require off-site disposal to landfill during the construction period of 2025 to 2038 will be approximately 399 tonnes.

15.6.31 It has been assumed for this assessment that all of the worker accommodation site waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill.

Impact of construction on future baseline waste arisings

Construction, demolition and excavation waste

15.6.32 Table 54 provides a summary of material and waste quantities forecast to be generated by excavation, demolition and construction works for the Proposed Scheme during the period 2025 to 2038.

Table 54: Summary of material and waste quantities that will be generated by excavation, demolition and construction works of the Proposed Scheme, 2025 to 2038

Source	Total quantity of material (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for on-site local placement (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Excavation	29,352,628	24,555,865	0	4,796,763
Demolition	565,201	508,681	0	56,520
Construction	1,506,631	1,355,968	0	150,663
Total	31,424,460	26,420,514	0	5,003,946
Proportion	100%	84%	0%	16%

15.6.33 Table 54 shows that the Proposed Scheme will generate approximately 31 million tonnes of excavated material, demolition material and construction waste during the period 2025 to 2038; approximately 84% of this quantity will be diverted from landfill via reuse, recycling and recovery. The proportion of demolition material and construction waste forecast to be diverted from landfill is fixed, based on rates developed through reviews of industry practice. The proportion of excavated material diverted from landfill is based on the current level of design.

[180] Aligns with municipal waste recycling target of 55% by 2025, set in the revised EU Waste Framework Directive.

15.6.34 The impact of this material and waste generation and its off-site treatment, recovery or disposal to landfill is shown in Table 55 as the percentage difference between future baseline CDEW arisings with and without the Proposed Scheme.

15.6.35 Future baseline CDEW arisings are presented as the total quantity projected to be generated during the period 2025 to 2038. This is to provide a direct comparison with the total quantity of excavated material, demolition material and construction waste that will be generated during construction of the Proposed Scheme.

Table 55: Impact of CDEW that will be generated by the Proposed Scheme, 2025 to 2038

Future baseline scenario with and without the Proposed Scheme	National change			Regional change[181]		
	CDEW arisings (tonnes)	CDEW arisings to treatment and recovery (tonnes)	CDEW arisings to off-site landfill (tonnes)	CDEW arisings (tonnes)	CDEW arisings to treatment and recovery (tonnes)	CDEW arisings to off-site landfill (tonnes)
Future baseline waste arisings 2025 to 2038 without the Proposed Scheme	2,466,266,904[182]	1,833,931,008	632,335,895	155,402,544	113,968,875	41,433,669
Proposed Scheme material and waste arisings 2025 to 2038	31,424,460	1,864,649	5,003,946	31,424,460	1,864,649	5,003,946
Future baseline waste arisings 2025 to 2038 with the Proposed Scheme	2,497,691,364	1,835,795,657	637,339,842	186,827,004	115,833,524	46,437,615
Increase in future baseline waste arisings with the Proposed Scheme	1%	0.1%	1%	20%	2%	12%

15.6.36 Table 55 shows that the total quantity of excavated material, demolition material and construction waste generated by the Proposed Scheme will be equivalent to approximately

[181] Based on future baseline CDEW arisings and CDEW to landfill for North West region.

[182] Based on the future baseline national CDEW arisings projections as set out in Table 41Table 41.

1% of national and 20% of regional future baseline CDEW arisings during the period 2025 to 2038.

15.6.37 The total quantity of surplus excavated material, demolition waste and construction waste generated by the Proposed Scheme that will require off-site disposal to landfill will be equivalent to approximately 1% of national and 12% of regional future baseline CDEW arisings to landfill during that time.

15.6.38 The total quantity of demolition waste and construction waste generated by the Proposed Scheme that will require off-site management in waste recovery and treatment infrastructure will be equivalent to approximately 0.1% of national and 2% of regional future baseline CDEW arisings managed in waste recovery and treatment infrastructure during that time.

Commercial and industrial waste

15.6.39 The impact of worker accommodation site waste generation and off-site treatment, recovery or disposal to landfill is shown in Table 56 as the percentage difference between future baseline C&I waste arisings with and without the Proposed Scheme.

15.6.40 Future baseline C&I waste arisings are presented as the total quantity projected to be generated during the period 2025 to 2038. This is to provide a direct comparison with the total quantity of C&I waste that will be generated during construction of the Proposed Scheme.

Table 56: Impact of C&I waste arisings generated by the Proposed Scheme, 2025 to 2038

Future baseline scenario with and without the Proposed Scheme	National change			Regional change[183]		
	C&I waste arisings (tonnes)	C&I waste arisings to treatment and recovery (tonnes)	C&I waste arisings to off-site landfill (tonnes)	C&I waste arisings (tonnes)	C&I waste arisings to treatment and recovery (tonnes)	C&I waste arisings to off-site landfill (tonnes)
Future baseline waste arisings 2025 to 2038 without the Proposed Scheme	680,007,471[184]	519,965,653	160,041,818	109,781,691[185]	93,962,028	15,820,882
Proposed Scheme material and	887	488	399	887	488	399

[183] Based on future baseline CDEW arisings and CDEW to landfill for the North West region.

[184] Based on the future baseline national C&I arisings projections as set out in Table 44.

[185] Based on the future baseline regional C&I arisings projections as set out in Table 45.

Future baseline scenario with and without the Proposed Scheme	National change			Regional change[183]		
	C&I waste arisings (tonnes)	C&I waste arisings to treatment and recovery (tonnes)	C&I waste arisings to off-site landfill (tonnes)	C&I waste arisings (tonnes)	C&I waste arisings to treatment and recovery (tonnes)	C&I waste arisings to off-site landfill (tonnes)
waste arisings 2025 to 2038						
Future baseline waste arisings 2025 to 2038 with the Proposed Scheme	680,008,358	519,966,141	160,042,217	109,782,578	93,962,516	15,821,281
Increase in future baseline waste arisings with the Proposed Scheme	0.0001%	0.0001%	0.0002%	0.0008%	0.0005%	0.0025%

15.6.41 Table 56 shows that the total quantity of worker accommodation site waste generated by the Proposed Scheme will be equivalent to less than 0.01% of national and regional future baseline C&I waste arisings during the period 2025 to 2038.

15.6.42 The total quantity of worker accommodation site waste that will require off-site disposal to landfill will be equivalent to less than 0.01% of national and regional future baseline C&I waste arisings to landfill during that time.

15.6.43 The total quantity of worker accommodation site waste generated by the Proposed Scheme that will require off-site management in waste treatment and recovery infrastructure will be equivalent to less than 0.01% of national and regional future baseline C&I waste arisings managed in waste treatment and recovery infrastructure during that time.

Likely significant environmental effects

Inert waste landfill capacity

15.6.44 The quantity of inert waste arising from the construction of the Proposed Scheme that will require off-site disposal to landfill during the period 2025 to 2038 is approximately 4.6 million tonnes (see Table 57). This quantity represents approximately 91% of the total waste generated during construction requiring off-site disposal to landfill. The actual quantity of inert waste that will require off-site disposal will be subject to waste acceptance criteria set

out in the Landfill Directive[186] and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills, and consequently may be subject to change.

Table 57: Quantity of waste requiring off-site disposal to inert waste landfill, 2025 to 2038

Waste source	Total quantity (tonnes)	Proportion
Excavation	4,564,689	100%
Demolition	0	0%
Construction	0	0%
Worker accommodation sites	0	0%
Total	**4,564,689**	**100%**

15.6.45 Off-site disposal of inert surplus excavated material to landfill will result in an overall reduction of inert waste landfill capacity of approximately 4.6 million tonnes.

15.6.46 This will be equivalent to a 67% reduction in inert waste landfill capacity in the North West region, according to the amount of capacity projected to be available at the end of earthworks activities in 2030 (approximately 6.7 million tonnes). On this basis, it is considered that there will be sufficient inert waste landfill capacity available in the North West region to accept the forecast quantity of inert surplus excavated material for off-site disposal to landfill, albeit with a significant decline in available capacity. Each of the waste planning authorities through which the route of the Proposed Scheme passes, have been consulted regarding this issue. This will assist the respective waste planning authorities in meeting their statutory duty to facilitate delivery of sufficient waste infrastructure capacity according to projected waste arisings.

15.6.47 The significance criteria set out in the SMR for inert landfill is based on the difficulty and complexity of replacing the lost capacity, rather than focusing on the percentage of available capacity forecast to be occupied. The significance criteria are predicated on providing new waste management capacity in addition to what is already existing in the study area. Taking into account the relevant consenting requirements, inert landfill is considered to be easier to replace than non-hazardous and hazardous landfills, and this is in turn is reflected in the higher upper threshold values for adverse effects for this landfill type.

15.6.48 Approximately 72% of the inert surplus excavated material that will be generated during construction of the Proposed Scheme, will be collected at the Crewe Rolling Stock Depot Construction Sidings and the Ardwick Construction Sidings, both of which have direct access to the UK rail network. This may enable the material to be transported off-site for disposal by rail, significantly extending the distance that the material can be practicably transported for disposal, and increasing the ease with which the material can be sent for disposal in

[186] *Commission of the European Communities (2002), Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills Pursuant to Article 16 and Annex II of Directive 1999/31/EC on the Landfill of Waste (COM/2002/0512 Final).* Available online at: http://eur-lex.europa.eu/legal-content/et/TXT/?uri=CELEX:52002PC0512.

neighbouring regions. The West Midlands region (easily accessed by rail from the Crewe Rolling Stock Depot Construction Sidings) is projected to have 13.9 million tonnes of inert waste landfill capacity at the end of earthworks activities in 2030, and the Yorkshire and Humber region (easily accessed by rail from the Ardwick Construction Sidings) is projected to have 51.4 million tonnes of capacity at the end of earthworks activities in 2030. The capacity of these two regions substantially exceeds the available capacity in the North West, and their use would mitigate the reduction in available inert waste landfill capacity in the North West.

15.6.49 The draw-down of inert waste landfill capacity as a result of the Proposed Scheme will occur over a period of several years, starting initially with enabling works followed by earthworks such as tunnelling. It is assumed that the generation of surplus excavated material will take place primarily over a 3.5 year period (2027 to 2030) during the construction of the Proposed Scheme, based upon the construction phase programme of the current design.

15.6.50 Whilst the forecast quantities of wastes requiring disposal to landfill are likely to have a considerable impact on available capacity, there are other options for its placement, including as restoration material on non-hazardous or hazardous sites and in other development projects. Waste planning authorities have a statutory responsibility to make provision for sufficient waste infrastructure capacity, and it is therefore likely, that the respective authorities will continue to plan for new inert waste landfill sites and/or to identify other suitable placement locations to enable continued capacity to be available as landfill void space is occupied.

15.6.51 All of the inert waste forecast to arise will be surplus excavated material and assuming that the earthworks take place at a constant rate of generation throughout the 3.5 year period, the total quantity of inert surplus excavated material requiring off-site disposal to landfill will be approximately 1.3 million tonnes per annum.

15.6.52 Significance criteria for inert waste landfill capacity, state that a local scale reduction in inert landfill void space capacity, and a need for additional small-scale disposal capacity of up to 2,000,000 tonnes per annum may be judged to be of low importance.

15.6.53 In accordance with these significance criteria, the likely environmental effects associated with the off-site disposal to landfill of inert surplus excavated material generated by construction of the Proposed Scheme will be minor adverse, which is not considered to constitute a significant effect.

Non-hazardous waste landfill capacity

15.6.54 The total quantity of non-hazardous waste arising from the construction of the Proposed Scheme that will require off-site disposal to landfill during the period 2025 to 2038 is approximately 417,048 tonnes (see Table 58). The majority (approximately 56%) will comprise of chemically unacceptable excavated materials, which cannot be treated on-site. Smaller quantities of non-hazardous waste will be generated by demolition, construction and worker accommodation site activities. The final quantity of non-hazardous waste that will require off-site disposal will be subject to waste acceptance criteria set out in the Landfill

Directive[186] and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills, and consequently may be subject to change.

Table 58: Quantity of waste requiring off-site disposal to non-hazardous waste landfill, 2025 to 2038

Waste source	Total quantity (tonnes)	Proportion
Excavation	232,074	55.6%
Demolition	33,912	8.1%
Construction	150,663	36.1%
Worker accommodation sites	399	0.1%
Total	**417,048**	**100%**

15.6.55 Off-site disposal of non-hazardous surplus excavated material, demolition, construction and worker accommodation site waste will result in an overall reduction of non-hazardous waste landfill capacity of 417,048 tonnes over the 14-year construction period.

15.6.56 This will be equivalent to a 6% reduction in non-hazardous waste landfill capacity in the North West region, according to the amount of capacity projected to be available at the end of construction in 2038 (approximately 7.5 million tonnes). The significance criteria set out in the SMR for non-hazardous landfill is based on the difficulty and complexity of replacing the lost capacity rather than focusing on the percentage of available capacity forecast to be occupied.

15.6.57 On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available in the North West region to accept the forecast quantity of non-hazardous surplus excavated material, demolition and construction waste for off-site disposal to landfill.

15.6.58 It is assumed that non-hazardous waste generated by excavation activities will take place at a constant rate over a 3.5 year period, that non-hazardous waste generated by demolition activities will take place at a constant rate over a 5 year period, and that non-hazardous waste generated by all other construction activities will take place at a constant rate throughout the whole 14-year construction period. The total quantity of non-hazardous waste requiring off-site disposal to landfill will be approximately 83,879 tonnes per annum.

15.6.59 Significance criteria for non-hazardous waste landfill capacity state that a local-scale reduction in non-hazardous waste landfill capacity of between 50,000 and 250,000 tonnes per annum, may be judged to be of importance in the local planning context.

15.6.60 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous surplus excavated material, construction and demolition waste generated by the Proposed Scheme will be moderate adverse, which is considered to constitute a significant effect.

Hazardous waste landfill capacity

15.6.61 The total quantity of hazardous waste arising from the construction of the Proposed Scheme requiring off-site disposal to landfill during the period 2025 to 2038 will be approximately

22,608 tonnes (see Table 59). This quantity comprises solely of hazardous waste generated by demolition activities; no Unacceptable Class U2 surplus excavated material is forecast to arise as a result of excavation works associated with the Proposed Scheme. The final quantity of hazardous waste that will require off-site disposal will be subject to waste acceptance criteria set out in the Landfill Directive[186] and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills, and consequently may be subject to change.

15.6.62 A reasonable worst-case approach has been taken in determining the quantity of hazardous waste for off-site disposal to landfill. However, detailed chemical sampling and laboratory analysis, as part of future ground investigation works, may allow the hazardous waste to be reclassified as non-hazardous waste. This would reduce reliance on hazardous waste landfill capacity.

Table 59: Quantity of waste requiring off-site disposal to hazardous waste landfill, 2025 to 2038

Waste source	Total quantity (tonnes)	Proportion
Excavation	0	0%
Demolition	22,608	100%
Construction	0	0%
Worker accommodation sites	0	0%
Total	**22,608**	**100%**

15.6.63 Off-site disposal of hazardous waste will result in an overall reduction of hazardous waste landfill capacity of approximately 22,608 tonnes throughout the construction period of 14 years.

15.6.64 This will be equivalent to a 0.3% reduction in hazardous waste landfill capacity across the North West region according to the amount of capacity projected to be available at the end of demolition works in 2030 (approximately 7.3 million tonnes). The significance criteria set out in the SMR for hazardous landfill is based on the difficulty and complexity of replacing the lost capacity rather than focusing on the percentage of available capacity forecast to be occupied.

15.6.65 It is assumed that hazardous waste generated by demolition activities will take place at a constant rate over a 5 year period. The total quantity of hazardous waste requiring off-site disposal to landfill will be approximately 4,522 tonnes per annum.

15.6.66 Significance criteria for hazardous waste landfill capacity state that a local-scale reduction in hazardous waste landfill void space capacity, or need for additional small-scale hazardous waste disposal capacity of up 20,000 tonnes per annum, may be judged to be of low importance.

15.6.67 According to the significance criteria applicable to hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of hazardous surplus excavated material, construction and demolition waste generated by the Proposed Scheme will be minor adverse, which is not considered to constitute a significant effect.

Other mitigation measures

General

15.6.68 Management of CDEW and worker accommodation site waste generated by the Proposed Scheme will be subject to the Environmental Minimum Requirements (EMR) presented within Volume 1, Section 1.

15.6.69 It is likely that a large proportion of the hazardous demolition waste will comprise asbestos containing materials. This material could be disposed of at non-hazardous landfill sites within a separate cell for Stable Non-Reactive Hazardous Waste (SNRHW) providing it meets SNRHW waste acceptance criteria in accordance with the Landfill Directive[186] and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills. This will reduce reliance on hazardous waste landfill capacity.

Waste recovery

15.6.70 The total quantity of waste arising from the construction of the Proposed Scheme that will be diverted from landfill and will require off-site management in waste treatment and recovery infrastructure during the period 2025 to 2038 is approximately 1.9 million tonnes (see Table 60). This quantity comprises waste generated by demolition, construction, and worker accommodation sites that will be diverted from landfill through segregation and recovery.

Table 60: Quantity of waste requiring off-site management in waste treatment and recovery infrastructure, 2025 to 2038

Waste source	Total quantity (tonnes)	Proportion
Excavation	0	0%
Demolition	508,681	27%
Construction	1,355,968	73%
Worker accommodation sites	488	0%
Total	**1,865,137**	**100%**

15.6.71 Recognising construction waste is the predominant source of waste requiring off-site management in waste treatment and recovery infrastructure, a constant rate of waste generation throughout the 14-year construction period has been assumed. This estimates that the total quantity of demolition, construction and worker accommodation site waste to be diverted from landfill will be approximately 133,224 tonnes per annum. Off-site management of this waste in waste recovery and treatment infrastructure, will result in an overall reduction equivalent to 1% of unused waste treatment and recovery infrastructure capacity in the North West region according to the amount of unused capacity projected to be available in the final year of construction in 2038 (approximately 13.3 million tonnes).

15.6.72 On this basis, it is considered that there will be sufficient unused waste recovery and treatment infrastructure capacity available in the North West region to accept the forecast

quantity of demolition, construction and worker accommodation site waste diverted from landfill.

Summary of likely residual significant environmental effects

15.6.73 Based on the other mitigation measures proposed, the likely residual environmental effects from construction will be:

- minor adverse in relation to inert waste landfill capacity;
- moderate adverse in relation to non-hazardous waste landfill capacity which is considered to constitute a significant effect; and
- minor adverse in relation to hazardous waste landfill capacity.

Off-route effects

Assessment of impacts and effects

15.6.74 In a small number of the instances, construction of the Proposed Scheme requires works which are geographically removed from the land immediately adjacent to the route. The location and nature of the proposed off-route works are described in Volume 4, Off-route effects, where the local environmental effects are also reported.

15.6.75 Due to the route-wide nature of the waste and material resources environmental assessment, the combined effects of the off-route and route-wide works have been assessed, and are reported here.

15.6.76 The construction of the following off-route works is considered likely to generate meaningful quantities of CDEW:

- Preston Station;
- Carlisle Station; and
- Annandale depot.

15.6.77 Due to the isolated nature of the off-route works, it is considered as a reasonable worst-case, that the waste would typically be managed within the region in which it is generated. The materials and waste generated by the proposed off-route works, have been aggregated by the region in which it is generated, and the impact of the material has been reported accordingly.

15.6.78 Table 61 provides a summary of material and waste quantities forecast to be generated by excavation, demolition and construction of the off-route works associated with the Proposed Scheme during the period 2025 to 2038.

Table 61: Summary of material and waste quantities that will be generated by excavation, demolition and construction of the off-route works associated with the Proposed Scheme, 2025 to 2038

Source	Total quantity of material (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for on-site local placement (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Excavation	1,321,647	956,071	0	365,576
Demolition	0	0	0	0
Construction	47,702	42,932	0	4,770
Total	1,369,349	999,003	0	370,346
Proportion	100%	73%	0%	27%

15.6.79 Table 61 shows that the off-route works associated with the Proposed Scheme will generate approximately 1.4 million tonnes of excavated material and construction waste during the period 2025 to 2038; approximately 73% of this quantity will be diverted from landfill via reuse, recycling and recovery. The proportion of construction waste diverted from landfill is fixed based on rates developed through reviews of industry practice. The proportion of excavated material diverted from landfill is estimated from the cut and fill balance within each of the off-route works, based on the current level of design.

15.6.80 The quantity of excavated material and construction waste forecast to require off-site disposal to landfill from the off-route works associated with the Proposed Scheme is approximately 370,346 tonnes. This comprises an additional 7.4% to the 5.0 million tonnes forecast to require off-site disposal from the route-wide works.

15.6.81 Off-route works associated with the Proposed Scheme will generate approximately 70 tonnes of worker accommodation site waste during the construction period of 2025 to 2038, arising from the construction compounds proposed with temporary worker accommodation. Worker accommodation site waste will be managed as C&I waste. The quantity of worker accommodation site waste that will be diverted from landfill via reuse, recycling and recovery is based on a landfill diversion rate of 55%. Waste generated by occupants of worker accommodation sites will be similar in composition to household waste. As such, this rate has been selected based on a review of applicable household waste targets.

15.6.82 It has been assumed, as a reasonable worst-case scenario for this assessment, that the remaining 45% of worker accommodation site waste will be disposed of off-site to landfill. The quantity of worker accommodation site waste that will require off-site disposal to landfill during the construction period of 2025 to 2038 will be approximately 31 tonnes.

North West

Impact of construction on future baseline waste arisings

15.6.83 Two of the identified off-route works are located within the North West region, an area where waste capacity is identified as being likely to be affected by the Proposed Scheme in the route-wide assessment. The off-route works located in the North West region are:

- Preston Station; and
- Carlisle Station.

15.6.84 The off-route works located in the North West region will generate approximately 11,389 tonnes of excavated material, demolition material and construction waste, of which 1,139 tonnes is forecast to require off-site disposal to landfill. The total quantity will be equivalent to less than 0.01% of regional future baseline CDEW arisings and CDEW arisings to landfill, during the period 2025 to 2038.

Inert waste landfill

15.6.85 No inert waste is forecast to be generated by off-route works in the North West region; however, the Annandale depot site in Dumfries and Galloway, is located in a Scottish region projected to have no inert waste landfill capacity during the period 2025 to 2038. Based on proximity, and the strength of available transport connections to the site, it is considered likely that all inert waste generated by the Annandale depot works will be managed within the North West England region.

15.6.86 The total quantity of inert waste arising from the construction of Annandale depot that will require off-site disposal to landfill in the North West, is approximately 365,575 tonnes. This will result in an overall reduction of inert waste landfill capacity of 365,575 tonnes over the 4.5-year construction period programmed for the Annandale depot, between 2027 and 2031.

15.6.87 The inert waste forecast to arise will be generated over the 4.5-year construction period at a constant rate of generation throughout this period, the total quantity of inert surplus excavated material requiring off-site disposal to landfill will be approximately 81,239 tonnes per annum.

15.6.88 Significance criteria for inert waste landfill capacity state that a local scale reduction in inert landfill void space capacity and a need for additional small-scale disposal capacity of up to 2,000,000 tonnes per annum may be judged to be of low importance.

15.6.89 In accordance with these significance criteria, the likely environmental effects associated with the off-site disposal to landfill in the North West, of inert surplus excavated material generated by construction of the off-route works associated with the Proposed Scheme, will be minor adverse, which is not considered to constitute a significant effect.

Non-hazardous waste landfill

15.6.90 The total quantity of non-hazardous waste arising from the construction of the off-route works associated with the Proposed Scheme that will require off-site disposal to landfill in the North West region, during the proposed construction period, 2026 to 2028, is approximately 1,139 tonnes. This will result in an overall reduction of non-hazardous waste landfill capacity of 1,139 tonnes over the proposed 2-year construction period.

15.6.91 This will be equivalent to a reduction of less than 0.01% in non-hazardous waste landfill capacity across the North West region according to the amount of capacity projected to be available at the end of construction in 2028 (approximately 12.7 million tonnes). On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity to accept the forecast quantity of non-hazardous waste.

15.6.92 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous waste generated by the construction of off-route works in the North West region will be negligible.

Hazardous waste landfill

15.6.93 No hazardous waste is forecast to be generated by the off-route works in the North West region.

Off-route combined effects

15.6.94 It is considered that for inert, non-hazardous and hazardous landfill that there will be sufficient capacity available in the North West region to accept the forecast combined quantity of waste from both the route-wide and off-route works associated with the Proposed Scheme.

15.6.95 The combined effects and the degree of significance on the available inert, non-hazardous and hazardous waste landfill capacities are considered to be as identified for the main assessment:

- minor adverse in relation to inert waste landfill capacity;
- moderate adverse in relation to non-hazardous waste landfill capacity which is considered to constitute a significant effect; and
- minor adverse in relation to hazardous waste landfill capacity.

Dumfries and Galloway

Impact of construction on future baseline waste arisings

15.6.96 The Annandale depot is identified as the only off-route works located within the Dumfries and Galloway region likely to generate meaningful quantities of waste during construction.

The Dumfries and Galloway region is an area where waste capacity is not identified as being likely to be affected by the Proposed Scheme in the route-wide assessment.

15.6.97 The off-route works located in the Dumfries and Galloway region will generate approximately 1.4 million tonnes of excavated material, demolition material and construction waste, of which 369,238 tonnes is forecast to require off-site disposal to landfill.

Inert waste landfill

15.6.98 The total quantity of inert waste arising from the construction of the off-route works associated with the Proposed Scheme that will require off-site disposal to landfill in the Dumfries and Galloway region, during the proposed construction period 2027 to 2031, is approximately 365,575 tonnes. This will result in an overall reduction of inert waste landfill capacity of 365,575 tonnes over the 4.5-year construction period programmed for the Annandale depot.

15.6.99 There are currently no licenced inert waste landfill sites in the Dumfries and Galloway region with capacity remaining; at present all inert waste generated in the region, and requiring disposal to landfill, is required to be transported to neighbouring regions in Scotland or England where inert waste landfill capacity remains. No inert waste landfill capacity is projected to be available in the Dumfries and Galloway region at the end of construction in 2031. On this basis, it is considered that there will not be sufficient inert waste landfill capacity to accept the forecast quantity of inert waste within the region. Based on proximity, and the strength of available transport connections to the site, it is considered likely that all inert waste generated by the Annandale depot works will be managed within the North West region. The assessment of impacts and effects resulting from inert waste generated by the construction of off-route works in the Dumfries and Galloway region has been undertaken in the previous North West region section.

Non-hazardous waste landfill

15.6.100 The total quantity of non-hazardous waste arising from the construction of the off-route works associated with the Proposed Scheme that will require off-site disposal to landfill in the Dumfries and Galloway region, during the proposed construction period, 2027 to 2031, is approximately 3,663 tonnes. This will result in an overall reduction of non-hazardous waste landfill capacity of 3,663 tonnes over the 4.5-year construction period programmed for the Annandale depot.

15.6.101 This will be equivalent to a reduction of 0.9% in non-hazardous waste landfill capacity across the Dumfries and Galloway region according to the amount of capacity projected to be available at the end of construction in 2031 (approximately 411,685 tonnes). On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity to accept the forecast quantity of non-hazardous waste.

15.6.102 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous

waste generated by the construction of off-route works in the Dumfries and Galloway region will be negligible.

Hazardous waste landfill

15.6.103 No hazardous waste is forecast to be generated by the off-route works in the Dumfries and Galloway region.

Cumulative effects

Proposed Scheme and Phase 2a

15.6.104 This assessment considers the cumulative effects during the period in which the construction of the Proposed Scheme overlaps with the construction of HS2 Phase 2a (Phase 2a). In the Phase 2a Construction Timetable Information Paper[187], it is assumed that construction will be undertaken during a seven year period between 2021 to 2028. Based on the construction period of the Proposed Scheme, 2025 to 2038, this presents a potential four-year period during which construction of Phase 2a and the Proposed Scheme will overlap (2025 to 2028).

15.6.105 It is considered that waste requiring off-site disposal to landfill, will be managed according to logistical and cost constraints regarding the availability of landfill capacity. These constraints limit the distance that waste will be transported by road. It is considered that waste generated by the Phase 2a scheme is only of relevance when it is generated in a geographic area in which the available landfill capacity is likely to be considered for use by both the Proposed Scheme and the Phase 2a scheme.

15.6.106 For both Phase 2a and the Proposed Scheme, the regions through which the routes pass are assumed to constitute the areas within which the various waste streams are generated, and are likely to be managed. In this assessment, it is considered that this area of overlap comprises the North West, within which the waste infrastructure capacity is likely to be affected by both schemes.

15.6.107 The following quantities of waste have been forecast to be generated by the Phase 2a construction works in the North West region, according to engineering design information used in development of the Phase 2a Supplementary Environmental Statement 2 and Additional Provision 2 Environmental Statement:

- no inert waste;
- 9,936 tonnes of non-hazardous waste (1,419 tonnes per annum); and
- 1,570 tonnes of hazardous waste (224 tonnes per annum).

[187] High Speed Two Ltd (2021), *Phase 2a information paper – D7: HS2 Phase 2a construction timetable*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/960675/D7_HS2_Phase_2a_Construction_timetable_v1.1.pdf.

15.6.108 It is considered that for inert, non-hazardous and hazardous landfill there will be sufficient capacity available in the North West region, based on the future projections as set out in Figure 18, Figure 19 and Figure 20, to accept the forecast combined quantity of waste from both the Proposed Scheme and Phase 2a.

15.6.109 The cumulative effects on the available inert, non-hazardous and hazardous waste landfill capacities are considered to be as identified for the main assessment described previously.

Proposed Scheme and other committed developments

15.6.110 The methodology used to develop the future baseline landfill capacities for the construction assessment period, takes account of waste generation trends driven by developments in the respective regional areas. It is considered in this cumulative assessment that none of the committed developments identified are of sufficient scale to disrupt these trends, and are therefore considered to comprise part of the future baseline against which the Proposed Scheme has been assessed.

15.6.111 No further effects on waste and material resources beyond those stated previously in the assessment have been identified.

15.7 Assessment of the effects of operation

Avoidance and mitigation measures

15.7.1 Outline waste segregation and storage strategies have been developed to inform the preliminary design of railway stations for the Proposed Scheme. This is to ensure that sufficient waste storage and collection access provision is incorporated early in the design process to facilitate segregation of waste and recyclable materials during operation. Measures will include:

- provision of public realm litter and recycling bins for train passengers and other users of railway stations;
- provision of secure containers for use by train operating companies and railway station tenants; and
- use of compactors and baling equipment to improve collection payloads and facilitate opportunities to derive revenue streams for recyclable material such as cardboard.

15.7.2 During operation, waste from passenger trains, rolling stock depots and infrastructure maintenance base will be managed in accordance with the waste hierarchy by the train operating company (or its fleet maintenance contractor in the case of rolling stock maintenance waste). Waste generated by track maintenance and other ancillary infrastructure will also be managed in accordance with the waste hierarchy by Network Rail and/or the train operating company.

Assessment of impacts and effects

Waste forecast

Railway station and train waste

15.7.3 Railway station and train waste refers to waste that will arise at railway stations along the route of the Proposed Scheme including Manchester Airport[188] and Manchester Piccadilly[189].

15.7.4 All stations will produce waste associated with their individual operating functions such as retail units and food and beverage outlets, but only terminus stations will produce waste from trains that is associated with their operation, such as on-board passenger litter bins and catering carriages.

15.7.5 Table 62 presents a regional and route-wide summary of forecast railway stations and train waste quantities for the Proposed Scheme in 2039. It has been assumed that railway station and train waste will be managed within the region in which it arises.

15.7.6 Railway station and train waste quantities have been estimated based on a waste generation rate of 0.085 kg per station user[190]. Recent trends in waste generation data indicate a decline in waste generation per station user; waste forecasts undertaken using this generation rate are, therefore, likely to represent a worst-case scenario. Using this methodology, the Proposed Scheme will generate approximately 5,002 tonnes of railway station and train waste during the first full year of operation in 2039.

Table 62: Forecast railway station and train waste quantities in the North West region, 2039

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
North West	5,002	3,251	1,751

15.7.7 The forecast quantity of railway station and train waste that will be diverted from landfill by reuse, recycling and recovery is based on a landfill diversion rate of 65%. Waste generated by station and train users will be similar in composition to municipal waste. This rate has consequently been selected based on the revised UK legislative proposals for waste, targeting a minimum of 65% reuse and recycling of municipal waste by weight by 2035.

15.7.8 It has been assumed, as a reasonable worst-case scenario for the purposes of this assessment, that the remaining 35% of railway station and train waste will be disposed of off-site to landfill. The quantity of railway station and train waste that will require off-site disposal to landfill in 2039 will be approximately 1,751 tonnes.

[188] MA06 Hulseheath to Manchester Airport.

[189] MA08 Manchester Piccadilly Station.

[190] Defined as number of passengers entering and exiting through ticket barriers. For further details, see Waste forecast and assessment methodology technical note, which can be found in the EIA SMR.

15.7.9 It has been assumed that for the purposes of this assessment that all railway station and train waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill. It has been assumed that the potential for hazardous waste arisings is negligible and consequently the impacts on hazardous waste landfill have not been assessed.

Rolling stock maintenance waste

15.7.10 Rolling stock maintenance waste refers to waste that will be generated by the relevant train operating company at rolling stock maintenance depots in Wimboldsley to Lostock Gralam (MA02) and Pickmere to Agden and Hulseheath (MA03).

15.7.11 Table 63 presents a regional and route-wide summary of the forecast rolling stock maintenance waste quantities for the Proposed Scheme in 2039[191].

15.7.12 Rolling stock maintenance waste has been estimated based on a waste generation rate of 0.3 tonnes per square metre per year applied to the gross floor area of the rolling stock maintenance depot areas[192]. Using this methodology, the Proposed Scheme will generate 13,052 tonnes of rolling stock maintenance waste during the first full year of operation in 2039.

Table 63: Forecast rolling stock maintenance depot waste quantities by region, 2039

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
North West	13,052	10,441	2,610

15.7.13 The quantity of rolling stock maintenance waste that will be diverted from landfill by reuse, recycling, and recovery is based on a landfill diversion rate of 80%. This rate has been selected following a review of the evidence base from Network Rail and other organisations involved in train fleet maintenance in the UK.

15.7.14 It has been assumed, as a reasonable worst-case scenario for the purposes of this assessment, that the remaining 20% of rolling stock maintenance waste will be disposed of off-site to landfill. The quantity of rolling stock maintenance waste that will require off-site disposal to landfill in 2039 will be approximately 2,610 tonnes.

15.7.15 It has been assumed for the purposes of this assessment that all the rolling stock maintenance waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill. It has been assumed that the potential for hazardous waste arisings is negligible and consequently the impacts on hazardous waste landfill have not been assessed.

[191] It has been assumed that rolling stock maintenance waste will be largely managed within the region in which it will be generated.

[192] For further details, see Waste forecast and assessment methodology technical note, which can be found in the EIA SMR.

Track maintenance waste

15.7.16 Track maintenance waste will comprise:

- ballast track and other rail components (e.g. steel railway tracks, sleepers, switches and crossings); and
- slab track, which comprises the steel rails and associated components (e.g. fastener clips and bolts and rubber dampener).

15.7.17 Both ballast and slab track will be used in the construction of the Proposed Scheme. As part of the routine maintenance activities, ballast and slab track will be periodically replaced along the route of the Proposed Scheme.

15.7.18 Table 64 presents a route-wide summary of the forecast track maintenance waste quantities for the Proposed Scheme in 2039[193].

Table 64: Forecast track maintenance (ballast and slab) waste quantities by region, 2039

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
North West	4,643	4,465	178

15.7.19 The annual quantity of ballast and slab track maintenance waste has been forecast according to the total length of rail within each community area. The annual quantity of slab track maintenance waste has been calculated using a waste generation rate of 0.05495 tonnes per metre of track per year[192].

15.7.20 The annual quantity of ballast track maintenance waste has been calculated using a waste generation rate of 8.23 tonnes per kilometre per year[192]. These are the same waste generation rates as used for Phase One and Phase 2a and are based on a reasonable worst-case scenario.

15.7.21 Using this methodology, the Proposed Scheme will generate approximately 4,643 tonnes of ballast and slab track maintenance waste during the first full year of operation.

15.7.22 In practice, the nature of the high speed track is such that very little track maintenance waste will be generated during the first few years after construction (including the operational assessment year of 2039). The largest quantity of track maintenance waste will occur as the ballast and slab track reaches the end of its service life and requires replacement. For ballast track, this is unlikely to occur until at least 25 years after construction, and for slab track this is unlikely to occur until approximately 60 years after construction, both of which are beyond the temporal scope of this assessment.

15.7.23 The methodology used to forecast ballast and slab track maintenance waste, therefore, provides a reasonable worst-case scenario in terms of waste generation for this assessment.

[193] It has been assumed that track maintenance waste will be largely managed within the region in which it will be generated.

15.7.24 The quantity of slab track maintenance waste that will be diverted from landfill by reuse, recycling and recovery is based on a landfill diversion rate of 100%. This rate has been selected based on the assumption that slab track maintenance waste consists solely of steel rails and clips, and rubber pads, all of which are fully recyclable or recoverable.

15.7.25 The quantity of slab track maintenance waste that will require off-site disposal to landfill in 2039 is zero tonnes.

15.7.26 The quantity of ballast track maintenance waste that will be diverted from landfill by reuse, recycling and recovery is based on a landfill diversion rate of 85%. This rate has been selected based on data provided by Network Rail across a range of material types for track maintenance waste. It has been assumed, as a reasonable worst-case scenario for this assessment that the remaining 15% of ballast track maintenance waste will be disposed of off-site to landfill. The quantity of ballast track maintenance waste that will require off-site disposal to landfill in 2039 will be approximately 178 tonnes.

15.7.27 It has been assumed for this assessment that all of the ballast track maintenance waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill. It has been assumed that the potential for hazardous waste arisings is negligible and consequently the impacts on hazardous waste landfill have not been assessed.

Ancillary infrastructure waste

15.7.28 Ancillary infrastructure waste refers to waste that will arise from rolling stock depots, signalling locations, operations and maintenance sites excluding track maintenance waste and rolling stock maintenance waste.

15.7.29 Table 65 presents a regional and route-wide summary of the forecast ancillary infrastructure waste quantities for the Proposed Scheme in 2039[194].

15.7.30 Ancillary infrastructure waste will be generated along the entire route of the Proposed Scheme. Quantities have been estimated based on a waste generation rate of 0.692 tonnes per kilometre of track per year[192]. Using this methodology, the Proposed Scheme will generate approximately 142 tonnes of ancillary infrastructure waste during the first full year of operation in 2039.

Table 65: Forecast ancillary infrastructure waste quantities by region, 2039

Regional area	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
North West	142	92	50

15.7.31 The quantity of ancillary infrastructure waste that will be diverted from landfill by reuse, recycling and recovery is based on a landfill diversion rate of 65%. This rate has been

[194] It has been assumed that ancillary infrastructure waste will be largely managed within the region in which it will be generated.

selected based on the revised UK legislative proposals for waste, targeting a minimum of 65% reuse and recycling of municipal waste by weight by 2035.

15.7.32 It has been assumed that, as a reasonable worst-case scenario for this assessment, the remaining 35% of ancillary infrastructure waste will be disposed off-site to landfill. The quantity of ancillary infrastructure waste that will require off-site disposal to landfill in 2039 will be approximately 50 tonnes.

15.7.33 It has been assumed for this assessment that all the ancillary infrastructure waste requiring off-site disposal to landfill will be sent to non-hazardous waste landfill. It has been assumed that the potential for hazardous waste arisings is negligible and consequently the impacts on hazardous waste landfill have not been assessed.

Impact of operation on future baseline waste arisings

15.7.34 Table 66 provides a summary of operational waste arisings for the Proposed Scheme that will be generated in 2039. This represents the total quantity of operational waste that will be generated during the first year of full operation of the Proposed Scheme.

Table 66: Summary operational waste forecast, 2039

Waste source	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Railway station and train	5,002	3,251	1,751
Rolling stock depot	13,052	10,441	2,610
Track maintenance	4,643	4,465	178
Ancillary infrastructure	142	92	50
Total	**22,839**	**18,249**	**4,589**
Proportion	100%	80%	20%

15.7.35 Table 66 shows that the Proposed Scheme will generate approximately 22,839 tonnes of operational waste in 2039, and this will be managed as C&I waste. Approximately 80% (18,249 tonnes) of this quantity will be diverted from landfill via reuse, recycling and recovery and approximately 20% (4,589 tonnes) will require off-site disposal to landfill.

15.7.36 The impact of operational waste generation and off-site disposal to landfill is shown in Table 67 as the percentage difference between future baseline C&I waste arisings with and without the Proposed Scheme.

Table 67: Impact of commercial and industrial waste arisings generated by the Proposed Scheme, 2039

	National change		Regional change	
	C&I waste arisings (tonnes)	C&I waste arisings to landfill (tonnes)	C&I waste arisings (tonnes)	C&I waste arisings to landfill (tonnes)
Future baseline waste arisings 2039 without the Proposed Scheme	56,059,681	13,193,816	7,760,131	867,487
Proposed Scheme waste arisings 2039	22,839	4,589	22,839	4,589
Future baseline waste arisings 2039 with the Proposed Scheme	56,082,520	13,198,405	7,782,970	872,076
Increase in future baseline waste arisings with the Proposed Scheme	0.04%	0.03%	0.29%	0.53%

15.7.37 Table 67 shows that the total quantity of operational waste generated by the Proposed Scheme in 2039 will be equivalent to approximately 0.04% of national future baseline C&I waste arisings and approximately 0.29% of regional future baseline C&I waste arisings.

15.7.38 The total quantity of operational waste generated by the Proposed Scheme that will require off-site disposal to landfill in 2039 will be equivalent to approximately 0.03% of national and 0.53% of regional baseline C&I waste arisings to landfill during that year.

Likely significant environmental effects

Non-hazardous waste landfill capacity

15.7.39 It has been assumed, as a reasonable worst-case scenario for this assessment, that operational waste generated by the Proposed Scheme will predominantly be non-hazardous in nature. This will be subject to waste acceptance criteria set out in the Landfill Directive[186] and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills[186].

15.7.40 The total quantity of non-hazardous operational waste requiring off-site disposal to landfill in 2039 will be 4,589 tonnes. This comprises non-hazardous waste that will be generated in railway stations and on passenger trains, and by rolling stock maintenance, track maintenance and ancillary infrastructure activities.

15.7.41 Off-site disposal of non-hazardous operational waste to landfill will result in an overall reduction of non-hazardous waste landfill capacity of 4,589 tonnes in 2039. This will be equivalent to a less than 0.07% reduction in non-hazardous waste landfill capacity across the North West region according to the capacity projected to be available in 2039 (approximately 7.1 million tonnes). On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available in the North West region to accept the forecast quantity of non-hazardous operational waste for off-site disposal to landfill.

15.7.42 Significance criteria[195] for non-hazardous waste landfill capacity state that there is unlikely to be any appreciable adverse effect where there is:

- an insignificant increase in waste arisings relative to the future baseline; or
- an insignificant reduction in landfill capacity for non-hazardous waste.

15.7.43 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous operational waste generated by the Proposed Scheme will be negligible.

Other mitigation measures

General

15.7.44 The circular economy is an alternative approach to the typical 'linear' way of using resources. By finding opportunities for repairing, reusing, remanufacturing or recycling materials and keeping them in use for longer, both resource use and waste generation can be reduced. The principles of the circular economy will be proactively considered throughout specification, design, procurement, construction and operation of the Proposed Scheme, in accordance with the HS2 Circular Economy Principles[196].

15.7.45 Recycling is a necessary component of a circular economy, though should only be considered when there are no other alternatives for repair, reuse or remanufacture to prevent the generation of waste. This is the basic premise of the waste hierarchy, which prioritises the most effective solutions to waste management. As waste is pushed up the waste hierarchy it creates greater resource efficiency and security by reducing the need to extract and import new raw materials.

15.7.46 A closed loop approach to resource recovery and waste management is based on the principle of controlling material inputs to maximise recycling and recovery of materials, minimising waste sent to landfill whilst greatly reducing the environmental footprint.

15.7.47 Implementing circular economy principles with regards to waste and material management could deliver efficiencies and benefits including:

- reduced virgin non-renewable material use; and
- reduced waste, carbon emissions, and environmental impact.

15.7.48 Some of the non-hazardous waste generated during the operation of the Proposed Scheme will also be suitable for energy recovery (i.e. incineration). This will reduce reliance on non-hazardous waste landfill capacity.

[195] Rationale for landfill significance criteria technical note, which can be found in the EIA SMR.

[196] High Speed Two (2017), *HS2 Circular Economy Principles*. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657833/hs2_circular_economy_principles.pdf.

Waste recovery infrastructure

15.7.49 The quantity of waste arising from the operation of the Proposed Scheme that will be diverted from landfill and will require off-site management in waste treatment and recovery infrastructure in 2039 is approximately 18,249 tonnes (see Table 68). This comprises non-hazardous waste that will be generated in railway stations and on passenger trains, and by rolling stock maintenance, track maintenance and ancillary infrastructure activities.

Table 68: Quantity of waste requiring off-site management in waste treatment and recovery infrastructure, 2039

Waste source	Total quantity (tonnes)	Proportion
Railway station and train	3,251	18%
Rolling stock depot	10,441	57%
Track maintenance	4,465	24%
Ancillary infrastructure	92	1%
Total	**18,249**	**100%**

15.7.50 Off-site management of the 18,249 tonnes of non-hazardous waste forecast to require management in waste recovery and treatment infrastructure in 2039, will result in an overall reduction equivalent to less than 0.002% of unused waste treatment and recovery infrastructure capacity across the North West region according to the amount of unused capacity projected to be available in the first full year of operation (approximately 13.0 million tonnes).

15.7.51 On this basis, it is considered that there will be sufficient unused waste recovery and treatment infrastructure capacity available in the North West region to accept the forecast quantity of operational waste diverted from landfill.

Summary of likely residual significant environmental effects

15.7.52 Based on the other mitigation measures proposed, the likely residual environmental effects from operation will be negligible in relation to non-hazardous waste landfill capacity.

Off-route effects

Assessment of impacts and effects

15.7.53 Operation of the Proposed Scheme will generate waste at locations beyond the route corridor at terminal stations and depots (both on or remote from the Proposed Scheme) from increased passengers travelling on the railway and from rolling stock maintenance activities. The location and nature of the proposed off-route works are described in Volume 4, Off-route effects, where the local environmental effects are also reported.

15.7.54 Due to the route-wide nature of the waste and material resources environmental assessment, the combined effects of the off-route and route-wide works have been assessed, and are reported here.

15.7.55 The Proposed Scheme is likely to generate meaningful quantities of operational waste at the following off-route locations:

- Preston Station;
- Carlisle Station;
- Annandale depot;
- Glasgow Central Station (passenger increases only);
- Crewe Station (passenger increases only);
- Milton Keynes Central (passenger increases only); and
- Lancaster Station (passenger increases only).

15.7.56 The remoteness of some of the off-route locations from the route-wide works, means that in some cases they are located in regional areas through which the route of the Proposed Scheme does not pass. It is considered as a reasonable assumption, that the waste would be managed within the region in which it is generated. The materials and waste generated by the proposed off-route works, has been aggregated by the region in which it is generated, and the impact of the material has been reported accordingly.

15.7.57 Table 69 provides a summary of waste quantities forecast to be generated by the operation of the off-route locations associated with the Proposed Scheme in 2039.

Table 69: Summary of waste quantities that will be generated by operation of the off-route locations associated with the Proposed Scheme, 2039

Source	Total quantity (tonnes)	Quantity diverted from landfill (tonnes)	Quantity for off-site disposal to landfill (tonnes)
Railway station and train	1,479	961	517
Rolling stock depot	6,044	4,835	1,209
Track maintenance	505	429	76
Ancillary infrastructure	42	28	15
Total	**8,070**	**6,253**	**1,817**
Proportion	100%	77%	23%

15.7.58 Table 69 shows that the off-route works associated with the Proposed Scheme will generate approximately 8,070 tonnes of operational waste in 2039; approximately 77% of this quantity will be diverted from landfill via reuse, recycling and recovery. The proportion of operational waste diverted from landfill, is fixed based on rates developed through reviews of industry practice.

15.7.59 The quantity of operational waste forecast to require off-site disposal to landfill from the off-route works associated with the Proposed Scheme is approximately 1,817 tonnes. This

comprises an additional 40% to the 4,589 tonnes forecast to require off-site disposal from the route-wide works.

North West

Impact of operation on future baseline waste arisings

15.7.60 Three of the identified off-route locations are sited within the North West region, an area where waste capacity is identified as being likely to be affected by the Proposed Scheme in the route-wide assessment. The off-route locations sited in the North West region are:

- Preston Station;
- Carlisle Station;
- Crewe Station (passenger increases only); and
- Lancaster Station (passenger increases only).

15.7.61 The off-route locations sited in the North West region will generate approximately 1,301 tonnes of operational waste, of which 439 tonnes is forecast to require off-site disposal to landfill. The total quantity will be equivalent to less than 0.06% of regional future baseline C&I arisings and C&I arisings to landfill in 2039.

Non-hazardous waste landfill

15.7.62 The total quantity of non-hazardous waste arising from the operation of the off-route locations associated with the Proposed Scheme that will require off-site disposal to landfill in the North West region, in 2039, is approximately 439 tonnes. This will result in an overall reduction of non-hazardous waste landfill capacity of 5,028 tonnes in 2039.

15.7.63 This will be equivalent to a reduction of less than 0.1% in non-hazardous waste landfill capacity across the North West region according to the amount of capacity projected to be available in 2039 (approximately 7.1 million tonnes). On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity to accept the forecast quantity of non-hazardous waste.

15.7.64 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous waste generated by the operation of off-route locations in the North West region will be negligible.

Off-route combined effects

15.7.65 It is considered that there will be sufficient non-hazardous waste landfill capacity available in the North West region to accept the forecast combined quantity of operational waste from both the route-wide and off-route elements of the Proposed Scheme.

15.7.66 The combined effects and the degree of significance on the available non-hazardous waste landfill capacity is considered to be negligible, and the residual significant effects reported route-wide will remain unchanged.

Dumfries and Galloway

Impact of operation on future baseline waste arisings

15.7.67 The Annandale depot is identified as the only off-route location sited within the Dumfries and Galloway region likely to generate meaningful quantities of waste during operation. The Dumfries and Galloway region is an area where waste capacity is not identified as being likely to be affected by the Proposed Scheme in the route-wide assessment.

15.7.68 The off-route location sited in the Dumfries and Galloway region will generate approximately 6,502 tonnes of operational waste, of which 1,285 tonnes is forecast to require off-site disposal to landfill.

Non-hazardous waste landfill

15.7.69 The total quantity of non-hazardous waste arising from the operation of the off-route location associated with the Proposed Scheme that will require off-site disposal to landfill in the Dumfries and Galloway region, in 2039, is approximately 1,285 tonnes.

15.7.70 This will be equivalent to a reduction of approximately 0.3% in non-hazardous waste landfill capacity across the Dumfries and Galloway region according to the amount of capacity projected to be available in 2039 (approximately 410,000 tonnes). On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity to accept the forecast quantity of non-hazardous waste.

15.7.71 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous waste generated by the operation of the off-route location in the Dumfries and Galloway region will be negligible.

Glasgow City

Impact of operation on future baseline waste arisings

15.7.72 Glasgow Central Station is identified as the only off-route location sited within the Glasgow City region likely to generate meaningful quantities of waste during operation. The Glasgow City region is an area where waste capacity is not identified as being likely to be affected by the Proposed Scheme in the route-wide assessment.

15.7.73 The off-route location sited in the Glasgow City region will generate approximately 142 tonnes of operational waste, of which 50 tonnes is forecast to require off-site disposal to landfill.

Non-hazardous waste landfill

15.7.74 The total quantity of non-hazardous waste arising from the operation of the off-route location associated with the Proposed Scheme that will require off-site disposal to landfill in the Glasgow City region, in 2039, is approximately 50 tonnes. On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity to accept the forecast quantity of non-hazardous waste.

15.7.75 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous waste generated by the operation of the off-route location in the Glasgow City region will be negligible.

South East

Impact of operation on future baseline waste arisings

15.7.76 Milton Keynes Central Station is identified as the only off-route location sited within the South East region likely to generate meaningful quantities of waste during operation. The South East region is an area where waste capacity is not identified as being likely to be affected by the Proposed Scheme in the route-wide assessment.

15.7.77 The off-route location sited in the South East region will generate approximately 126 tonnes of operational waste, of which 44 tonnes is forecast to require off-site disposal to landfill.

Non-hazardous waste landfill

15.7.78 The total quantity of non-hazardous waste arising from the operation of the off-route location associated with the Proposed Scheme that will require off-site disposal to landfill in the South East region, in 2039, is approximately 44 tonnes. On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity to accept the forecast quantity of non-hazardous waste.

15.7.79 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous waste generated by the operation of the off-route location in the South East region will be negligible.

Cumulative effects

Proposed Scheme and Phase 2a

15.7.80 A quantitative assessment of the effects associated with the off-site disposal to landfill of solid waste that will be generated by operation of the Proposed Scheme and by operation of Phase 2a has been undertaken.

15.7.81 The operational waste arisings considered in the assessment of cumulative effects from the Proposed Scheme and Phase 2a as committed development relate to those operational waste arisings that will require off-site disposal to landfill in the North West region; this being the only region through which the route of the Proposed Scheme and Phase 2a pass.

15.7.82 The cumulative effects assessment takes into account operation of the Proposed Scheme and Phase 2a at the time the Proposed Scheme becomes operational (i.e. in the year 2039), thus they will have a simultaneous requirement for landfill disposal capacity of any operational waste generated in the North West region during that year.

15.7.83 Table 70 provides a summary of the combined operational waste arisings from the Proposed Scheme and Phase 2a that is estimated to be generated in the North West in 2039. A detailed waste forecast for the combined operational waste arisings from the Proposed Scheme and Phase 2a is provided in the Route-wide waste and material resources assessment in Volume 5: Appendix WM-001-00000.

Table 70: Summary operational waste forecast Proposed Scheme and Phase 2a, 2039

Waste source	Estimated quantity of waste per annum (tonnes)	Estimated quantity of waste for off-site disposal to landfill per annum (tonnes)
Railway station and train	5,002	1,751
Rolling stock depot	13,052	2,610
Track maintenance	4,775	178
Ancillary infrastructure	160	57
Total	**22,989**	**4,596**

15.7.84 Table 70 shows that the Proposed Scheme and Phase 2a will generate approximately 22,989 tonnes of operational waste in 2039. Approximately 80% of this quantity will be diverted from landfill via reuse, recycling and recovery.

15.7.85 The total quantity of non-hazardous operational waste from the Proposed Scheme and Phase 2a requiring off-site disposal to landfill in 2039 will be 4,596 tonnes (see Table 70). This comprises non-hazardous waste that will be generated by passengers and train operators, rolling stock maintenance, track maintenance and ancillary infrastructure activities.

15.7.86 Subject to waste acceptance criteria set out in the Landfill Directive[186] and the Proposal for a Council Decision Establishing Criteria and Procedures for the Acceptance of Waste at Landfills[186], operational waste generated by the Proposed Scheme and Phase 2a will be mostly non-hazardous in nature.

15.7.87 Off-site disposal of non-hazardous operational waste to landfill will result in an overall reduction of non-hazardous waste landfill void space, in the North West region, of 4,596 tonnes in 2039. This will be equivalent to a less than 0.1% reduction in non-hazardous waste landfill capacity across the region according to the capacity projected to be available in 2039 (approximately 7.1 million tonnes).

15.7.88 On this basis, it is considered that there will be sufficient non-hazardous waste landfill capacity available to accept the forecast quantity of non-hazardous operational waste for off-site disposal to landfill.

15.7.89 According to the significance criteria applicable to non-hazardous waste landfill capacity, the likely environmental effects associated with the off-site disposal to landfill of non-hazardous operational waste generated by the Proposed Scheme and Phase 2a will be negligible.

Proposed Scheme and other committed developments

15.7.90 The methodology used to develop the future baseline landfill capacities for the assessment year for operation takes account of waste generation trends driven by developments in the respective regional areas. It is considered in this cumulative assessment that none of the committed developments are of sufficient scale to disrupt these trends, and are therefore considered to comprise part of the future baseline against which the Proposed Scheme has already been assessed.

No further effects on material and waste resources beyond those stated previously in the assessment have been identified.

16 Water resources and flood risk

16.1 Introduction

16.1.1 This section considers the likely significant route-wide effects on surface water and groundwater resources (quality and quantity) and flood risk. In general these effects, which relate to potential impacts on individual water bodies, springs and water supplies, are site-specific and localised in nature and are, therefore, scoped out of the route-wide assessment on that basis. Any local effects are described in the Volume 2, Community Area reports and where appropriate, Volume 4, Off-route effects.

16.1.2 The water resources and flood risk issues that have been considered on a route-wide basis relate to:

- the risk of accidents or spillages from trains using the Proposed Scheme during its operational phase;
- a summary of how the Proposed Scheme complies with the statutory requirements of the Water Environment (Water Framework Directive) (England and Wales) Regulations, 2017; and
- route-wide impacts of the Proposed Scheme on flood risk, with specific reference to application of the Sequential Test and Exception Test in the National Planning Policy Framework (NPPF[197]).

16.2 Scope, assumptions and limitations

16.2.1 The scope, assumptions and limitations for the water resources and flood risk assessment are set out in Volume 1, Section 8, and in the EIA Scope and Methodology Report (SMR)[2]. Section 9 of this report, reports the assessment of land contamination on groundwater and surface water.

16.2.2 The route-wide assessment made for water resources and flood risk has been undertaken on a reasonable worst-case assessment.

16.3 Water resources assessment

16.3.1 Localised impacts and effects related to pollution risk and water quality are assessed in the Volume 2, Community Area reports, Section 15. These assessments include consideration of:

- potential impacts on individual surface water and groundwater bodies, springs and water supplies resulting from rail and highway runoff;

[197] Ministry of Housing, Communities and Local Government (2019), *National Planning Policy Framework*. Available online at: https://www.gov.uk/government/collections/revised-national-planning-policy-framework.

- potential impacts of spillages during construction;
- mobilisation of existing contaminants during excavation and dewatering operations; and
- point sources of pollution such as treated wastewater effluent and fuel storage areas.

16.3.2 Assessment of these issues has, therefore, been scoped-out of this route-wide assessment.

16.3.3 During operation of the Proposed Scheme there is potential for pollution of the water environment from spillages. This risk is considered very low as trains, with the possible exception of diesel maintenance trains, will be electric passenger trains, and the Proposed Scheme will not be used to transport freight. Spillages on the route of the Proposed Scheme are only likely following derailments, collisions, or major on-board incidents, all of which are considered highly improbable. This issue is considered in Section 11 of this report.

16.3.4 If a spillage of a pollutant does occur, it will not necessarily lead to a pollution incident, as the pollutant may not reach a receiving water body, either because of prompt action by emergency personnel or as a result of pollution control measures, or because the pollutant is absorbed by soil or vegetation.

16.3.5 Specific mitigation proposed to address this risk includes:

- inclusion of shut-off valves on balancing ponds, which can be used to isolate pollutants before they enter the wider water environment. If the procedures for closing valves on these systems were not operated in time, the ponds would still significantly reduce the amount of pollutant entering the wider water environment; and
- a water resources and flood risk operation and maintenance plan will be prepared that makes specific provision for notifying the emergency and environmental services and procedures for isolating pollutants within the drainage systems. A draft of this plan is included in the Draft water resources and flood risk operation and maintenance plan in Volume 5: Appendix WR-007-00000.

16.3.6 It can, therefore, be concluded that there are not likely to be significant regional or route-wide adverse effects during operation on water resources related to route-wide accident and spillage risks.

16.4 Water Framework Directive (WFD) compliance assessment

Introduction

16.4.1 The WFD aims to protect and enhance the quality of the water environment. It takes a holistic approach to the sustainable management of water by considering the interactions between surface water, groundwater and water-dependent ecosystems.

16.4.2 Under the WFD, 'water bodies' are the basic management units and are defined as all or part of a river system or aquifer. These water bodies form part of a larger 'river basin district' (RBD), for which 'river basin management plans' (RBMP) are developed and environmental

objectives are set for all water bodies. These RBMP are produced every six years by the Environment Agency in England and by the Scottish Environment Protection Agency in Scotland, in accordance with the river basin management planning cycle[198][199][200].

16.4.3 The statutory objective of the WFD is to prevent deterioration of all water bodies at good or high status and to prevent water bodies at less than good status from deteriorating further. To ensure compliance with the WFD, decision makers must consider whether proposals for new developments have the potential to:

- cause a deterioration of a water body from its current status or potential;
- prevent future attainment of good status or potential where not already achieved;
- impact on protected or priority species and habitats; and/or
- provide opportunities to improve the water environment.

16.4.4 The Proposed Scheme has the potential to affect numerous surface water and groundwater bodies. An assessment of the Proposed Scheme's compliance against the statutory WFD objectives for each of these water bodies is therefore required.

16.4.5 The route of the Proposed Scheme will lie wholly within the North West RBD. The current status and statutory status objectives of relevance to all surface water and groundwater bodies potentially affected by the Proposed Scheme are recorded within the North West RBMP[201].

16.4.6 A route-wide WFD compliance assessment has been undertaken in Volume 5: Appendix WR-01-00000. The approach adopted is based on guidance developed in close consultation with the Environment Agency and was finalised and agreed with Environment Agency specialists. This guidance is aligned with planning advice note 18 published by the Planning Inspectorate[202]. The assessment is based on the Proposed Scheme design (as shown in the Volume 2 Map Books, Map Series CT-05 and CT-06), which includes a range of avoidance and mitigation measures included within the design.

16.4.7 A WFD compliance assessment has been undertaken separately for off-route works at the Annandale depot, which is located wholly within the Gretna Coastal catchment of the Solway-Tweed RBD that falls under the Scottish Environment Protection Agency's

[198] *The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017*. (SI 2017 No. 407). Available online at: https://www.legislation.gov.uk/uksi/2017/407.

[199] *The Water Environment (Miscellaneous) (Scotland) Regulations 2017*.

[200] *Water Environment and Water Services (Scotland) Act 2003*. Available online at https://www.legislation.gov.uk/asp/2003/3/contents.

[201] Environment Agency (2016), *North West River Basin Management Plan, North West river basin district*. Available online at: https://www.gov.uk/government/collections/river-basin-management-plans-2015#north-west-river-basin-district-rbmp:-2015.

[202] Planning Inspectorate (2017), *Advice Note 18, The Water Framework Directive*. Available online at: https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2017/06/advice_note_18.pdf.

jurisdiction. This is provided in Volume 5: Appendix WR-001-OR003 and is summarised in Volume 4.

16.4.8 The WFD assessment provides an indication of the likely compliance of the Proposed Scheme at the time the assessment was prepared. The risk of the Proposed Scheme resulting in long-term deterioration in any element used to determine the WFD status of these water bodies has been reduced insofar as is reasonably practicable within the design.

Assessment methodology and key assumptions

16.4.9 The WFD compliance assessment has been developed in accordance with the methodology and assumptions set out in the WFD compliance assessment technical note in Volume 5: Appendix CT-001-00001 and in consultation with the Environment Agency. This includes the methodology applied for assessing the effects of the Proposed Scheme on the current status and status objectives of the quality elements of water bodies. This relates to the requirement under the WFD for the consideration of whether new developments have the potential to result in:

- a deterioration in current status; and/or
- prevention of the achievement of good status/potential objectives in the future.

16.4.10 The assessment has involved a staged process, including:

- baseline assessment (screening) to identify the relevant WFD water bodies, watercourses and relevant groundwater features potentially affected by the Proposed Scheme and to assess their existing condition;
- preliminary assessment (scoping) to establish the likely impacts of the various Proposed Scheme components and associated effects on the relevant WFD status elements of the water bodies affected by the Proposed Scheme (with regard to likely effects on current status and/or the future achievement of status objectives); and
- detailed impact assessment, to establish the nature and magnitude of the effects of Proposed Scheme components on current status and status objectives of WFD quality elements at the water body scale.

16.4.11 The assessment process for determining the potential for a change of current status uses the following traffic light rating, agreed with the Environment Agency, to assign the magnitude of the effect anticipated on the quality elements of each affected water body:

- **dark blue**: beneficial effect of a scale sufficient to increase status class for the quality element at water body scale;
- **light blue**: minor beneficial effect resulting in a localised improvement, but insufficient to increase status class for the quality element at water body scale;
- **green**: no measurable change to (or effect on) status class for the quality element at water body scale;

- **yellow**: minor localised adverse effect when balanced against likely mitigation included in the design – insufficient to affect status class for the quality element at water body scale;
- **amber**: an adverse effect is possible when balanced against likely mitigation included in the design – the extent of effect is uncertain and there remains a potential to affect status class for the quality element at water body scale; and
- **red**: adverse effect of sufficient scale to impact on status class for the quality element at a water body scale.

16.4.12 Where adverse effects on quality elements are identified, with a risk of causing deterioration of status, or preventing future attainment of the objectives, the assessment identifies additional mitigation requirements and the resultant residual effect.

16.4.13 The assessments have made full use of the quantitative analyses reported in the water resources assessments (Volume 5 Appendices, reports WR-003) for each community area. Where the assessments are based on professional judgement only, a precautionary approach has been adopted.

16.4.14 Impacts on ecological receptors including protected species and designated sites, are described in the Volume 2 Community Area reports, Section 7, where resulting in significant effects.

16.4.15 Impacts to groundwater quality from existing land contamination are presented in the Volume 2 Community Area reports, Section 10, where mitigation options by way of removal or remediation are presented. Based on these land quality measures, the WFD assessment assumes that all potential impacts from land contamination will be mitigated during the construction phase.

Summary of effects

16.4.16 The assessment has identified a total of 26 WFD surface water bodies (including 22 river water bodies, three canal water bodies, and one lake water body) and four WFD groundwater bodies that are potentially affected by the Proposed Scheme.

16.4.17 The following sections summarise the anticipated adverse effects identified by the assessment that have the potential to cause a deterioration in current status and/or to prevent the future achievement of status objectives of the relevant water bodies.

Effects on current status

Surface water

16.4.18 Of the 26 surface water bodies affected by the route of the Proposed Scheme, six surface water bodies are anticipated to experience adverse overall effects, which pose a potential risk of causing a deterioration in status. These are:

- Wistaston Brook;

- Weaver (Marbury Brook to Dane);
- Puddinglake Brook;
- Wade Brook;
- Hey/Borsdane Brook; and
- Timperley Brook.

16.4.19 A summary of the relevant scheme components causing the adverse effects, impact type and the WFD quality elements potentially affected for each water body is provided in Table 71.

16.4.20 In order to avoid the necessity of seeking an exemption under the WFD regulations, additional mitigation measures are therefore required to manage the risk of status deterioration within these six water bodies. A range of mitigation measure options have been identified at this stage in consultation with the Environment Agency with the aim to ensure no residual risks of status deterioration. Potential measures include those set out in Table 71 and detailed further in Volume 5 (Volume 5: Appendix WR-01-00000).

16.4.21 Whilst it is currently anticipated that it will be feasible to develop and implement mitigation measures to ensure that there is no residual risk of deterioration in status for these water bodies, further detailed work is required to inform the best suitable solution for the following scheme components and water bodies. As such, on a precautionary basis, the potential for residual adverse overall effects from the Proposed Scheme with the risk of causing a deterioration in status of one or more quality elements is considered to remain at this stage in relation to the following water bodies and scheme components:

- Wistaston Brook – highway drainage (David Whitby Way);
- Weaver (Marbury Brook to Dane) – highway drainage (A530 Nantwich Road);
- Puddinglake Brook – highway drainage (A530 King Street); MA02 Granular Borrow Pit D;
- Wade Brook – highway drainage (A530 King Street); highway drainage (A556 Shurlach Road); highway drainage (Penny's Lane);
- Hey/Borsdane Brook – multiple culverts (Critchley culvert; Windy Bank culvert; Coffin Lane Brook culvert; Nan Holes Brook culvert; Nan Holes Brook offline culvert); and
- Timperley Brook – highway drainage (M56 East and West Link / access to Manchester Airport High Speed station/Runger Lane realignment).

16.4.22 The mitigation strategy for these scheme components will continue to be refined as the design progresses in consultation with the Environment Agency. This will be informed by further surveys, ground investigation, and assessment.

Table 71: Summary of adverse effects with risk of deterioration in status of WFD surface water bodies

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	Impact type and description	Quality element at risk of deterioration in status	Additional mitigation measures
Wistaston Brook (GB112068055280) Overall status: Bad (2015), Bad (2019) Overall status objective: Good by 2027	Basford Brook	Highway drainage (David Whitby Way)	Drainage (change in water quality due to discharge of surface water runoff to surface water body). Highway drainage runoff associated with the David Whitby Way has the potential to have a detrimental impact on water quality within the receiving Basford Brook watercourse. This, in turn, may affect biological quality elements.	Fish; Macroinvertebrates; Macrophytes; Specific pollutants (copper, zinc)	During the passage of the Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. Mitigation measures to filter solids and pollutants from water prior to discharge might include: • use of wet attenuation basins; • vortex grit separators; and • swales.
Weaver (Marbury Brook to Dane) (GB112068060460) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Tributary of River Weaver 2	Highway drainage (A530 Nantwich Road)	Drainage (change in water quality due to discharge of surface water runoff to surface water body). Highway drainage runoff associated with the A530 Nantwich Road has the potential to have a detrimental impact on water quality within the receiving Tributary of River Weaver 2 watercourse. This, in turn, may affect biological quality elements.	Fish; Macroinvertebrates; Macrophytes; Specific pollutants (copper, zinc)	During the passage of the Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. Mitigation measures to filter solids and pollutants from water prior to discharge might include: • use of wet attenuation basins; • vortex grit separators; and • swales.

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	Impact type and description	Quality element at risk of deterioration in status	Additional mitigation measures
Puddinglake Brook (GB112068060220) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Puddinglake Brook	Highway drainage (A530 King Street)	Drainage (change in water quality due to discharge of surface water runoff to surface water body). Highway drainage runoff associated with the A530 King Street has the potential to have a detrimental impact on water quality within the receiving Puddinglake Brook watercourse. This, in turn, may affect biological quality elements.	Fish; Macroinvertebrates; Macrophytes; Specific pollutants (copper)	During the passage of the Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. Mitigation measures to filter solids and pollutants from water prior to discharge might include: • use of wet attenuation basins; • vortex grit separators; and • swales.
Puddinglake Brook (GB112068060220) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Puddinglake Brook	MA02 Granular Borrow Pit D	Change in flow velocity and volume due to dewatering. The borrow pit will involve the excavation of glaciofluvial sheet deposits to a maximum excavation depth of 5m. Dewatering of the excavations during construction has the potential to lower local groundwater levels and impact upon the baseflow of Puddinglake Brook. This, in turn, may affect hydromorphological conditions and aquatic habitat along the watercourse.	Fish; Macroinvertebrates; Macrophytes; Hydromorphology	Mitigation measures have been identified to manage groundwater baseflows to Puddinglake Brook during excavation and dewatering of borrow pit. Mitigation could take the form of: • widening the buffer strip between the borrow pit and surface water feature; • recirculate abstracted water back into local watercourses to maintain flows at the appropriate locations; • installation of cut-off structures around excavations; • ensuring that cut-off structures are driven to sufficient depths to meet an underlying strata or zone of lower permeability;

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	Impact type and description	Quality element at risk of deterioration in status	Additional mitigation measures
					• promotion of groundwater recharge, such as discharging pumped water to recharge trenches around excavations to maintain baseline groundwater and surface water conditions; • incorporation of passive bypasses within the design, which could comprise a 'blanket' of permeable material, such as gravel, placed around temporary structures, allowing groundwater to bypass the below-ground works without a rise in groundwater levels on the upstream side; or • extracting material below the standing water level in the borrow pit using wet working techniques, so as not to require dewatering.
Wade Brook (GB112068060370) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Gad Brook	Highway drainage (A530 King Street)	Drainage (change in water quality due to discharge of surface water runoff to surface water body). Highway drainage runoff associated with the A530 King Street has the potential to have a detrimental impact on water quality within the receiving Gad Brook watercourse. This, in turn, may affect biological quality elements.	Fish; Macroinvertebrates; Macrophytes; Specific pollutants (copper)	During the passage of the Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. Mitigation measures to filter solids and pollutants from water prior to discharge might include: • use of wet attenuation basins; • vortex grit separators; and

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	Impact type and description	Quality element at risk of deterioration in status	Additional mitigation measures
					• swales.
Wade Brook (GB112068060370) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Wade Brook	Highway drainage (A556 Shurlach Rd)	Drainage (change in water quality due to discharge of surface water runoff to surface water body). Highway drainage runoff associated with the A556 Shurlach Road has the potential to have a detrimental impact on water quality within the receiving Wade Brook watercourse. This, in turn, may affect biological quality elements.	Fish; Macroinvertebrates; Macrophytes; Specific pollutants (copper)	During the passage of the Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. Mitigation measures to filter solids and pollutants from water prior to discharge might include: • use of wet attenuation basins; • vortex grit separators; and • swales.
Wade Brook (GB112068060370) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Tributary of Gad Brook 3	Highway drainage (Penny's Lane and A530 King Street)	Drainage (change in water quality due to discharge of surface water runoff to surface water body). Highway drainage runoff associated with Penny's Lane and the A530 King Street has the potential to have a detrimental impact on water quality within the receiving Tributary of Gad Brook 3 watercourse. This, in turn, may affect biological quality elements.	Fish; Macroinvertebrates; Macrophytes; Specific pollutants (copper and zinc)	During the passage of the Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. Mitigation measures to filter solids and pollutants from water prior to discharge might include: • use of wet attenuation basins; • vortex grit separators; and • swales.
Hey/Borsdane Brook (GB112069064520)	Multiple headwater tributaries	Multiple culverts (Windy Bank culvert; Coffin Lane Brook culvert;	Footprint (cumulative).	Fish; Macroinvertebrates;	Mitigation measures have been identified to compensate for the loss of aquatic and riparian habitat within the

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	Impact type and description	Quality element at risk of deterioration in status	Additional mitigation measures
Overall status: Moderate (2015), Moderate (2019) Overall status objective: Good by 2027	(Windy Bank Brook; Coffin Lane Brook; Tributary of Hey Brook 4; Nan Holes Brook; Windy Bank Brook)	Critchley culvert; Nan Holes Brook culvert; Nan Holes Brook offline culvert; Extension of existing WCML culvert)	Multiple culverts are proposed on several headwater tributaries of Hey Brook. Collectively, the culverts will result in approximately 217m footprint loss of existing river channel and riparian habitat.	Macrophytes; Hydromorphology	footprint of the culverts proposed on the headwater tributaries of Hey Brook. These include a range of enhancement opportunities identified along the affected watercourses immediately downstream of the Proposed Scheme, including: • in-channel or planform river restoration works; • riparian planting/improvements; • removal or softening of existing sections of hard bank protection; and • modifications to or removal of existing culverts and channels.
Timperley Brook (GB112069061260) Overall status: Moderate (2015), Moderate (2019) Overall status objective: Good by 2027	Timperley Brook	Timperley Brook inverted siphon	Footprint. A 170m inverted siphon is proposed below the footprint of the Manchester Airport High Speed station, along the upper reach of Timperley Brook. The siphon will result in the permanent loss of approximately 275m of existing open channel and riparian habitat along a wooded headwater section of the watercourse	Fish; Macroinvertebrates; Macrophytes; Hydromorphology	Mitigation measures have been identified and included within the design to compensate for the loss of approximately 275m of aquatic and riparian habitat within the footprint of the siphon. This comprises the creation of approximately 300-350m of new river and riparian habitat along a realignment of the watercourse downstream of siphon. This will include the removal of an existing culverted section of the watercourse immediately north (downstream) of Brooks Drive.

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	Impact type and description	Quality element at risk of deterioration in status	Additional mitigation measures
Timperley Brook (GB112069061260) Overall status: Moderate (2015), Moderate (2019) Overall status objective: Good by 2027	Timperley Brook	Highway drainage (M56 East and West Link /Access to Manchester Airport High Speed station/Runger Lane realignment)	Drainage (change in water quality due to discharge of surface water runoff to surface water body). Highway drainage runoff associated with the M56 East and West Links, Manchester Airport High Speed Station access road (east), Manchester Airport High Speed station access road (west) and Runger Lane has the potential to have a detrimental impact on water quality within the receiving Timperley Brook watercourse. This, in turn, may affect biological quality elements.	Fish; Macroinvertebrates; Macrophytes; Specific pollutants (copper and zinc)	Mitigation measures have been identified and included within the design to manage the water quality of surface water runoff from the proposed highway diversion in this area prior to discharge to Timperley Brook. This includes the additional of attenuation tanks, vortex grit separators and rain gardens in order to manage the risk of concentrations of sediment-bound and soluble pollutants exceeding environmental quality standards (EQS) in the watercourse.

16.4.23 Of the four groundwater bodies impacted by the route of the Proposed Scheme, two groundwater bodies are anticipated to experience adverse overall effects, which pose a potential risk of deterioration in current status. These are the Weaver and Dane Quaternary Sand and Gravel Aquifers and Lower Mersey Basin and North groundwater bodies.

16.4.24 A summary of the relevant scheme components causing the adverse effects, impact type and the WFD quality elements potentially affected for each water body is provided in Table 72.

16.4.25 In order to avoid the necessity of seeking an exemption under the WFD regulations, additional mitigation measures are therefore required to manage the risk of status deterioration within these water bodies. A range of mitigation measure options have been identified at this stage in consultation with the Environment Agency with the aim to ensure no residual risks of status deterioration. Potential measures include those set out in Table 72 and detailed further in Volume 5 (Volume 5: Appendix WR-01-00000).

16.4.26 Whilst it is currently anticipated that it will be feasible to develop and implement these mitigation measures to ensure that there is no residual risk of deterioration in status for these water bodies, further detailed work is required to inform the best solution for the MA02 Granular Borrow Pit D, located within the Weaver and Dane Quaternary Sand and Gravel Aquifers water body. As such, on a precautionary basis, the potential for residual adverse overall effects with the risk of causing a deterioration in status of one or more quality elements is considered to remain at this stage at this location.

16.4.27 The mitigation strategy for the MA02 Granular Borrow Pit D will continue to be refined as the design progresses in consultation with the Environment Agency. This will be informed by further surveys, ground investigation, and assessment.

Table 72: Summary of adverse effects with risk of deterioration in status of WFD groundwater bodies

WFD water body and current status and status objectives at RBMP Cycle 2	Relevant scheme component(s) causing risk of deterioration in status	Impact type	Quality element at risk of deterioration in status	Additional mitigation measures	Residual effect at this stage
Weaver and Dane Quaternary Sand and Gravel Aquifers (GB41202G991700) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	MA02 Granular Borrow Pit D	Lowering of groundwater levels and potential reduction in groundwater contributions to surface water bodies, GWDTE or groundwater abstractions by temporary dewatering/ permanent groundwater control	Quantitative (Dependent Surface Water Body)	Mitigation measures have been identified to manage groundwater baseflows to Puddinglake Brook during excavation and dewatering of borrow pit. See Table 71 for further details of mitigation options identified.	Potential adverse effect, with potential to deteriorate status, remains at this stage.
Weaver and Dane Quaternary Sand and Gravel Aquifers (GB41202G991700) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Manchester Ship Canal viaduct foundations	Creating or altering of pathways along which existing poor quality groundwater can migrate	Chemical Dependent Surface Water Body; General Chemical Test	Mitigation measures will be included, as necessary, either through the draft CoCP or as part of the site-specific remediation strategy implemented to address the contaminated land within the Hollins Green historical landfill site. The remediation strategy will aim to leave the site in a state such that no significant risks to groundwater quality will remain. The mitigation measures will be refined as the design progresses, following detailed site investigation (see MA04 Volume 2, Section 10 Land quality).	Minor, localised adverse. No residual risk of deterioration in status anticipated at this stage.
Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone Aquifers (GB41201G101700)	Lowton cutting	Creating or altering of pathways along which existing poor quality groundwater can migrate	Chemical Drinking Water Protected Areas (DrWPAs)	Mitigation options are being discussed with the operator of the public water supply boreholes (United Utilities Group plc) and the Environment Agency, to ensure not adverse impacts to water quality will occur during construction. These options may include the temporary variation of pumping from these boreholes and other boreholes outside of the zone of influence	Minor, localised adverse. No residual risk of deterioration in status anticipated at this stage.

WFD water body and current status and status objectives at RBMP Cycle 2	Relevant scheme component(s) causing risk of deterioration in status	Impact type	Quality element at risk of deterioration in status	Additional mitigation measures	Residual effect at this stage
Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027				of the cutting, or the installation of additional treatment facilities, to ensure a continuous, resilient water supply during the construction period. Mitigation measures will also be included, as necessary, either through the draft CoCP or as part of the site-specific remediation strategy implemented to address the contaminated land within the Lowton Sidings historical landfill site. The remediation strategy will aim to leave the site in a state such that no significant risks to groundwater quality will remain. The mitigation measures will be refined as the design progresses, following detailed site investigation (see MA05 Volume 2, Section 10 Land quality).	

Effects on future status objectives

16.4.28 WFD legislation requires consideration of whether new developments have the potential to prevent the future attainment of good status or potential objectives for water bodies (where not already achieved).

16.4.29 In addressing this the assessment has included consideration of the effects of the Proposed Scheme with regard to the potential to exacerbate key existing pressures on water body status and/or prevent the future implementation of measures required to support improvements in status; as identified by the Environment Agency and set out in the RBMP.

Surface water

16.4.30 The Proposed Scheme poses a risk of exacerbating one or more of the Reasons for Not Achieving Good (RNAG) and one Programme of Measures (PoM) identified by the Environment Agency for two surface water bodies, Hey/Borsdane Brook and Timperley Brook. A summary of the relevant scheme components causing the adverse effects, impact type and the RNAG/PoM potentially affected for each water body is provided in Table 73.

16.4.31 In order to avoid the necessity of seeking an exemption under the WFD regulations, additional mitigation measures are therefore required to manage the risk of the Proposed Scheme preventing the future achievement of the status objectives of these water bodies. A range of mitigation measure options have been identified at this stage in consultation with the Environment Agency with the aim to ensure no residual risks of preventing the future achievement of the status objectives. Potential measures include those set out in Table 73 and detailed further in Volume 5 (Volume 5: Appendix WR-01-00000).

16.4.32 Whilst it is currently anticipated that it will be feasible to develop and implement mitigation measures to ensure that there is no residual risk of preventing the achievement of the status objectives of these water bodies, further detailed work is required to inform the best solution at each site. As such, the potential for residual adverse overall effects with the risk of causing a deterioration in status of one or more quality elements is considered to remain at this stage at these locations.

16.4.33 The mitigation strategy for these scheme components will continue to be refined as the design progresses in consultation with the Environment Agency. This will be informed by further surveys, ground investigation, and assessment.

Table 73: Summary of adverse effects with risk of preventing achievement of status objectives of WFD surface water bodies

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	RNAG/PoM affected	Additional mitigation measures	Residual effect at this stage
Hey/Borsdane Brook (GB112069064520 Overall status: Moderate (2015), Moderate (2019) Overall status objective: Good by 2027	Multiple headwater tributaries (Windy Bank Brook; Coffin Lane Brook; Tributary of Hey Brook 4; Nan Holes Brook; Windy Bank Brook)	Multiple culverts (Windy Bank culvert; Coffin Lane Brook culvert; Critchley culvert; Nan Holes Brook culvert; Nan Holes Brook offline culvert; Extension of existing WCML culvert)	One RNAG relating to existing physical modification	Mitigation measures have been identified to compensate for the loss of aquatic and riparian habitat within the footprint of the culverts proposed on the headwater tributaries of Hey Brook. These include a range of enhancement opportunities identified along the affected watercourses immediately downstream of the Proposed Scheme, including: • in-channel or planform river restoration works; • riparian planting/improvements; • removal or softening of existing sections of hard bank protection; and/or • modifications to or removal of existing culverts.	Adverse effect, with potential to prevent achievement of status objectives, remains at this stage.
Timperley Brook (GB112069061260) Overall status: Moderate (2015), Moderate (2019) Overall status objective: Good by 2027	Timperley Brook	Highway drainage (M56 East and West Link/Access to Manchester Airport High Speed station/Runger Lane realignment)	Seven RNAGs relating to existing diffuse urban pollution pressures	Mitigation measures have been identified and included within the design to manage the water quality of surface water runoff from the proposed highway diversion in this area prior to discharge to Timperley Brook. This includes the additional of attenuation tanks, vortex grit separators and rain gardens to manage the risk of concentrations of sediment-bound and soluble pollutants exceeding environmental quality standards (EQS) in the watercourse.	Potential adverse effect, with potential to prevent achievement of status objectives, remains at this stage.
Timperley Brook (GB112069061260)	Timperley Brook	Highway drainage (M56 East and West Link/Access to Manchester Airport High Speed	One PoM relating to a package of measures needed to control or manage diffuse urban pollution pressures	As above.	As above.

WFD water body and current status and status objectives at RBMP Cycle 2	Watercourse(s) affected within water body	Relevant scheme component(s) causing risk of deterioration in status	RNAG/PoM affected	Additional mitigation measures	Residual effect at this stage
Overall status: Moderate (2015), Moderate (2019) Overall status objective: Good by 2027		station/Runger Lane realignment)			

Groundwater

16.4.34 The Proposed Scheme poses a risk of exacerbating one RNAG identified by the Environment Agency for the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone Aquifers groundwater body. A summary of the relevant scheme components causing the adverse effects, impact type and the RNAG potentially affected is provided in Table 74.

16.4.35 In order to avoid the necessity of seeking an exemption under the WFD regulations, additional mitigation measures are therefore required to manage the risk of the Proposed Scheme preventing the future achievement of the status objectives of this water body. Mitigation measure options have been identified at this stage in consultation with the Environment Agency with the aim to ensure no residual risks of preventing the future achievement of the status objectives. Potential measures include those set out in Table 74 and detailed further in Volume 5 (Volume 5: Appendix WR-01-00000).

16.4.36 The mitigation strategy for this scheme component will continue to be refined as the design progresses in consultation with the Environment Agency and United Utilities. This will be informed by further ground investigation and assessment. The implementation of these measures will ensure that there are no residual risks to the status objectives of this water body.

Table 74: Summary of adverse effects with risk of preventing achievement of status objectives of WFD groundwater bodies

WFD water body and current status and status objectives at RBMP Cycle 2	Relevant scheme component(s) causing risk of deterioration in status	RNAG affected	Additional mitigation measures	Residual effect at this stage
Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone Aquifers (GB41201G101700) Overall status: Poor (2015), Poor (2019) Overall status objective: Good by 2027	Lowton cutting	One RNAG relating to existing diffuse pollution pressures on Chemical Drinking Water Protected Area status	Mitigation options are being discussed with the owner (United Utilities Group PLC) and the Environment Agency to ensure no adverse effect on water quality at the licensed public water supply groundwater abstraction sources during the construction. Mitigation options may include the temporary suspension of abstraction at a groundwater source, or installation of temporary treatment for the source; with a view to ensuring a continuous, resilient water supply during the construction period.	Minor, localised adverse. No residual risk of deterioration in status anticipated at this stage.

Summary of compliance

16.4.37 The WFD compliance assessment has concluded that the Proposed Scheme has the potential to cause a deterioration in the current status and/or prevent the future achievement of status objectives of six surface water bodies and one groundwater body. Accordingly, these scheme components may give rise to the potential risk of the Proposed Scheme being non-compliant with the statutory objectives of the WFD.

16.4.38 If the residual risks of deterioration in current status and prevention of achievement of status objectives cannot be mitigated, a Regulation 19 exemption assessment will be required for each affected water body and submitted for approval by the Environment Agency (as the competent regulatory authority). The Water Framework Directive compliance assessment in Volume 5: Appendix WR-01-00000 outlines further details of the Regulation 19 exemption assessment process.

16.4.39 Whilst every effort will be made to ensure a Regulation 19 exemption assessment is not required, where unavoidable an assessment will be prepared on a route-wide and/or specific water body basis, as appropriate, in consultation with the Environment Agency and reported to Parliament during passage of the Bill.

16.5 Route-wide flood risk assessment

16.5.1 Sections of the Proposed Scheme will be located in flood zones, including numerous crossings of main rivers and ordinary watercourses and areas at heightened risk of flooding from surface water sources. The Details of these can be found in the Volume 2, Community Area reports, Section 15.

16.5.2 The design of the Proposed Scheme has been developed to avoid flood hazards, insofar as is reasonably practicable, and to help ensure that the Proposed Scheme will not increase flood risk to vulnerable receptors. Separate flood risk assessments (FRA) for each community area provide details of how these design aims will be achieved in Volume 5 (Appendices, reports WR-005). Hydraulic modelling reports are included in Volume 5 (Appendices, reports WR-006).

16.5.3 The only flood risk issue considered on a route-wide basis is how the Proposed Scheme has aligned with the Sequential Test and Exception Test policies in the NPPF.

16.5.4 NPPF states that 'the aim of the Sequential Test is to steer new development to areas with the lowest risk of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding'.

16.5.5 Avoidance of areas with a high probability of flooding was a key consideration in the original route engineering assessment and appraisal of sustainability. A wide range of potential route options was considered and flood risk was one of the environmental constraints used to inform the selection of a preferred route. Consequently, the route of the Proposed

Scheme avoids flood zones insofar as is reasonably practicable for a national linear transport route. The route of the Proposed Scheme has, therefore, been selected based on application of the sequential approach required in the NPPF.

16.5.6 The Proposed Scheme, which is essential infrastructure as defined by NPPF in the flood risk assessment guidance, inevitably has to pass through flood zones in order to cross rivers and surface water flow paths. In such circumstances, the Exception Test requires evidence to be provided that the development provides wider sustainability benefits to the community that outweigh flood risk. It also requires that a site-specific FRA must demonstrate that 'the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall'.

16.5.7 It is considered that the Proposed Scheme will provide wider sustainability benefits to the community, as demonstrated in Volume 1. The FRA for each community area demonstrates that the Proposed Scheme will be safe from flooding over its lifetime and outlines the proposed approach to ensure that flood risk will not be increased elsewhere. An allowance for climate change has been made in the assessments as set out in the SMR.

16.5.8 The potential for permanent significant adverse effects to occur related to flood risk has been identified at three locations along the Proposed Scheme:

- to commercial, industrial and residential receptors associated with the retaining walls on the north and south banks of the Manchester Ship Canal (MA04);
- to commercial, highways and residential receptors associated with the Palatine Road vent shaft at Northenden, Stenner Lane and around Palatine Road (MA07); and
- to the Mid Cheshire railway line and agricultural land due to the diversion of the Tributary of Birkin Brook 1 into the existing culvert for Tributary of Birkin Brook 2 due to the Ashley Railhead (MA06).

16.5.9 The additional mitigation proposed at these sites will ensure that flood risk issues are addressed during the detailed design of the Proposed Scheme. The Proposed Scheme is therefore considered to align with the principles of the Sequential Test and Exception Test policies in the NPPF.

16.5.10 The potential for the Proposed Scheme to have an adverse impact on the severity of major disasters, including floods, is also assessed on a route-wide basis in Section 11 of this report.

16.6 Conclusions

16.6.1 Spillage risks associated with accidental release of contaminants from trains, and the pollution risk associated with accidents, are unlikely to result in significant effects, once the relevant mitigation has been implemented in full. A draft operation and maintenance plan for water resources and flood risk, which makes specific provision for this issue, has been prepared and reported in the Draft water resources and flood risk operation and maintenance plan in Volume 5: Appendix WR-007-00000.

16.6.2 The WFD compliance assessment in Volume 5: Appendix WR-001-00000 has concluded that there are a number of scheme components which have the potential to cause a deterioration in the current status of a WFD water bodies. Accordingly, these scheme components may give rise to the potential risk of the Proposed Scheme being non-compliant with the statuary objectives of the WFD. If the residual risk of deterioration in current status cannot be mitigated, a Regulation 19 exemption assessment will be prepared on a route-wide and/or specific water body basis, as appropriate, in consultation with the Environment Agency and reported to Parliament during passage of the Bill.

16.6.3 This route-wide flood risk assessment outlines how the Proposed Scheme aligns with the principles of the Sequential Test and Exception Test as set out in the NPPF. Consequently, it has been assessed that the effects of the Proposed Scheme related to route-wide flood risk issues will not be significant.

17 Electromagnetic interference

17.1 Introduction

17.1.1 This section of the report presents an assessment of the risk of electromagnetic interference (EMI) at potentially sensitive receptors along the route of the Proposed Scheme during construction and operation.

17.1.2 Electric and magnetic fields are produced wherever electricity is used. The electric field is produced by voltage and the magnetic field by current. Electromagnetic fields (EMF), which refers to both electric and magnetic fields, can cause three types of effect:

- interference to electric and electronic equipment. This is called electromagnetic interference (EMI) and is the disturbance that affects an electrical system due to magnetic and electric fields, electromagnetic induction or electromagnetic radiation emitted from an external source;
- the potential to cause harmful effects in the human body through EMF; and
- the creation of induced voltages in metallic infrastructure where there is parallel running for a significant distance e.g. the Proposed Scheme running parallel and close to overhead electric power lines or metallic fences.

17.1.3 Electromagnetic Compatibility (EMC) is the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to other equipment in that environment.

17.1.4 This section considers where EMF associated with the Proposed Scheme could potentially have implications for human health or cause EMI to other electrical/electronic equipment (e.g. communications) or infrastructure (e.g. power lines).

17.1.5 The identified potentially sensitive receptors in each community area are presented in Volume 5: Appendix EM-001-00000.

17.2 Scope, assumptions and limitations

17.2.1 The scope, assumptions and limitations for the EMI assessment are set out in Volume 1 and the EIA Scope and Methodology Report (SMR)[2].

17.3 Policy and standards

17.3.1 There are no planning policies that specifically refer to EMI in any of the local development frameworks; however British and European standards exist which set limits and levels of disturbance for equipment and safe limits for exposure. The Proposed Scheme will comply with these standards.

17.3.2 The relevant British Standards and European Directives applicable to the emission and control of EMF comprise:

- EU Directive 2013/35/EU[203] and Control of Electromagnetic Fields at Work Regulations (CEMFAW) Statutory Instrument 588:2016[204], which enacts Directive 2013/35/EU. These specify limits for worker exposure to EMF to provide protection against known adverse health effects;
- The International Commission on Non-Ionising Radiation Protection (ICNIRP) 2010 guidelines[205], which form the basis for the limits specified in CEMFAW;
- European Commission (EC) Recommendation 1999/519/EC[206], which is based on the ICNIRP 1998 guidelines[207] and provides levels for public exposure to EMF;
- EU Directive 2014/30/EU[208], which provide guidelines on electromagnetic compatibility of equipment and systems;
- Electromagnetic Compatibility Regulations Statutory Instrument 1091:2016[209], which enact Directive 2014/30/EU. These regulations require that equipment shall be so designed and manufactured as to ensure that the electromagnetic disturbance generated does not exceed the level above which electrical and electronic equipment cannot operate as intended or allows it to operate without unacceptable degradation of its intended use; and
- BS EN 61000-6-1[210] and BS EN 61000-6-2[211], which specify the acceptable level of protection for equipment in residential and industrial environments respectively.

[203] *Directive 2013/35/EU, on the minimum health and safety requirements regarding the exposure of workers to the risks arising from the physical agents (electromagnetic fields) 2013.* European Parliament and European Council.

[204] *The Control of Electromagnetic Fields at Work Regulations* 2016. (SI 2016/588), Her Majesty's Stationery Office London.

[205] International Commission on non-ionizing radiation protection (2010), *Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1Hz to 100kHz)*, Health Physics, 99(6): pp. 818-836.

[206] European Commission (1999), EC Recommendation 1999/519/EC on the limitation of exposure of the general public to electromagnetic fields (0Hz to 300GHz).

[207] International Commission on non-ionizing radiation protection (1998), *Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300GHz)*, Health Physics, 74(4): pp. 494-522.

[208] *Directive 2014/30/EU on the harmonisation of the laws of the Member States relating to electromagnetic compatibility 2014.* Strasbourg, European Parliament and European Council.

[209] *The Electromagnetic Compatibility Regulations 2016.* (SI 2016/1091). Her Majesty's Stationery Office London.

[210] British Standards Institution (2019), *EN IEC 61000-6-1:2019, Electromagnetic compatibility Part 6.1: Generic standards- immunity for residential, commercial and light industrial environments.*

[211] British Standards Institution (2019), *EN IEC 61000-6-1:2019, Electromagnetic compatibility Part 6.2: Generic standards- immunity for industrial environments.*

17.3.3 The Proposed Scheme will be built to comply with the BS EN 50121 series of standards, Railway Applications, Electromagnetic Compatibility[212], which places limits on the maximum emissions at the railway boundary.

17.3.4 The Proposed Scheme will also comply with the BS EN 50122 series of standards, Railway Applications - Fixed installations - Electrical safety, earthing and the return circuit[213].

17.4 Assessment overview

17.4.1 A desk-top survey of the Proposed Scheme was undertaken to identify any potentially sensitive receptors within a 50m corridor either side of the centre of the nearest HS2 track and overhead line electrification, along the route of the Proposed Scheme.

17.4.2 The primary causes of EMI and EMF will come from the traction power distribution and overhead line electrification. The level of EMF diminishes rapidly with distance from the source, so the extent of any interference or harmful effects will be limited to only a short distance horizontally and vertically from the railway boundary or the boundary of any traction power sub-station or switching station. A 50m corridor was selected to identify all potentially sensitive receptors within that area to demonstrate that the level of risk will be limited to a much shorter distance than 50m from the route of the Proposed Scheme. The assessment included receptors outside of the 50m corridor which were identified as having very sensitive electrical equipment or systems, which could be at risk of EMI.

17.4.3 The identified potentially sensitive receptors are presented in Volume 5: Appendix EM-001-00000.

17.4.4 Typical receptors identified by the study include residential zones, commercial zones, the current National Grid infrastructure and existing conventional railways.

17.4.5 Infrastructure that may be susceptible to the effects of induced voltages and will run parallel to the Proposed Scheme for a substantial distance was also identified. This includes power lines and other aerial cable routes, metal fences, pipelines and motorway telecommunication cables.

17.4.6 Preliminary traction power modelling was undertaken which has identified proposed electromagnetic emissions data along the route of the Proposed Scheme. This preliminary electromagnetic emissions data has formed the basis of the EMI risk assessment for the Proposed Scheme, to identify those receptors that may be at risk of EMI.

17.4.7 HS2 data for traction current levels generated by the traction power systems is based on estimated maximum power usage at typical locations along the route of the Proposed

[212] British Standards Institution (2016, 2017), *BS EN 50121:2017 series. (Railway applications - Electromagnetic Compatibility) Parts 1 to 5.*

[213] *British Standards Institution (publication date depends on the standard in the series), BS EN 50122 series (Railway applications. Fixed installations. Electrical safety, earthing and the return circuit) Parts 1 to 3.*

Scheme. This has generated estimated EMF contour plots that show worst-case levels of EMF[214].

17.4.8 Modelling traction power is a complex process, which will continue through the detailed design stages of the Proposed Scheme. Actual levels of EMF emitted cannot be confirmed until the Proposed Scheme is operational. However, levels of emitted EMF are not anticipated to exceed those used for this assessment.

17.4.9 For receptors within the study area, the baseline data was tabulated. Once each potentially sensitive receptor had been identified, an assessment was undertaken for compliance with the ICNIRP Guidelines and applicable harmonised EMC standards to identify the potential level of risk to human health and EMI. Additionally, if required, potential mitigation for each site was identified.

17.5 Assessment of effects during construction

17.5.1 Construction machinery and plant, and associated communications (e.g. construction radios) will comply with the applicable standards for EMC. Therefore, when installed, operated and maintained correctly, the risk of this apparatus producing EMF that exceeds published limits for workers and the public or causing EMI is considered to be low.

17.5.2 Power supplies used for construction are generally not sufficient to cause a major EMI risk.

17.5.3 All construction activities will be confined to local areas. Mitigation will be controlled by adherence to British and European standards, which will be mandatory for all installation contractors. In addition, as set out in the draft Code of Construction Practice (CoCP)[1], the nominated undertaker and its contractors will consider the impacts of EMI on wireless telecommunication systems during construction of the Proposed Scheme. This will include site-specific impacts from the demolition of buildings and the installation of tower cranes, and where appropriate will employ best practice technology to ensure that levels of radio frequency interference associated with the Proposed Scheme are low and at acceptable levels.

17.5.4 It is therefore considered that there will be no significant effects on a route-wide basis associated with construction.

[214] The traction power modelling which underpins the EMF contour plots used in this assessment was for the Phase One section of the route on which a higher service level (18TPH) is proposed compared to that for the Phase 2b section (between 4 and 10 TPH). Hence this should add a further level of conservatism into the assessment.

17.6 Assessment of effects during operation

17.6.1 The primary source of EMF during operation will be the traction power supplies generated at 25kV AC; the voltage and current generated in other electrical supplies are not high enough to cause significant EMF outside the railway boundary.

17.6.2 The levels of EMF emitted by the traction power will vary along the route of the Proposed Scheme and the maximum values will last only for a few seconds at a time. The levels at any particular location depend on a number of variables, for example:

- individual train performance at any particular instant i.e. whether it is accelerating, at constant velocity, braking or at rest;
- the number of individual trains in any one electrical section; and
- proximity to a traction feeder sub-station.

17.6.3 The effects of EMF rapidly diminish with distance from the source, both horizontally and vertically.

17.6.4 Preliminary traction power modelling has been undertaken by HS2 Ltd and the worst-case values of predicted EMF have been used to estimate the levels of EMF at any particular location along the Proposed Scheme.

Effects of EMF on human health

17.6.5 The Proposed Scheme will comply with BS EN 50121 series, which places limits on the maximum emission at the railway boundary. These limits are below ICNIRP guidelines, which define acceptable levels for EMF exposure of the general public and workers to provide protection against known adverse health effects.

17.6.6 It is considered that there will be no significant EMF effects on human health on a route-wide basis associated with operation.

Effects on electrical equipment due to EMI

17.6.7 It is possible that EMI risks may affect equipment at receptors within 20m from the centre of the nearest track or receptors with very sensitive electrical or electronic equipment. This distance will depend on the localised situation, for example it will depend on whether the Proposed Scheme is on a viaduct, in a cutting or tunnel. Where an EMI risk is identified, these receptors will be further evaluated during the detailed design stage and/or at testing and commissioning. Mitigation may be applied, for example in the form of replacement with less sensitive equipment or relocation of equipment where practicable.

17.6.8 Beyond 20m from the Proposed Scheme, the estimated levels of EMI are below the threshold for electrical interference for residential, commercial and light-industrial receptors (specified in BS EN 61000-6-1) and no risk has been identified.

17.6.9 The estimated levels of EMI are below the threshold for electrical interference for industrial receptors (specified in BS EN 61000-6-2), and no risk to these receptors has been identified.

17.6.10 Three third-party receptors beyond 50m from the Proposed Scheme have been identified which have very sensitive equipment or systems. These are Pickmere Radio Telescope, Manchester Airport and The Christie NHS Foundation Hospital. The EMI technical assessment has identified a potential significant EMI risk to these receptors. Further detail about these receptors is included in Volume 5: Appendix EM-001-00000 (Section 4). In light of this, on a precautionary basis, a likely significant effect has been identified at these receptors. HS2 Ltd is undertaking on-going engagement with the owners and operators of these facilities to establish the electromagnetic sensitivity levels and risk of EMI. Any appropriate mitigation measures will be identified during on-going engagement.

17.6.11 In accordance with guidance from the Medicines and Healthcare Products Regulatory Authority, EMF generated from power lines is not considered to pose a significant risk to people with active medical implants including pacemakers[215]. Therefore, no potential significant impact on the operation of active medical implants is anticipated, provided the immunity performance is in line with the requirement of the applicable harmonised standards.

Other receptors

17.6.12 Where the Proposed Scheme will run close to an existing conventional rail route, any effects of EMC, EMI or EMF will be mitigated by complying with the BS EN 50121 and BS EN 50122 suite of standards. It may be necessary for HS2 Ltd to agree and implement specific design solutions with Network Rail to mitigate or eliminate the risk of EMI to the conventional rail network.

17.6.13 Induced voltages from the Proposed Scheme's overhead traction power could affect metallic infrastructure that runs parallel to the Proposed Scheme. For this to have a significant risk of interference, the infrastructure would have to run close to the Proposed Scheme and for a considerable distance, typically greater than 2km. Any potential interference risk identified at this stage will be considered further in the detailed design stage. It is anticipated that the interference risks would be localised.

17.6.14 Other effects, such as induced voltages, and earthing and bonding issues associated with the interface with other railways and third parties such as utilities, will be mitigated through design and construction in compliance with British, European and industry standards and best practice. Where required, HS2 Ltd will agree design solutions with affected third parties such as Network Rail, Transport for Greater Manchester, National Grid and Highways England, where reasonably practicable.

17.6.15 Cathodic protection systems as used installed on neighbouring buried utilities such as some metallic pipelines could be affected by the Proposed Scheme. These risks will be considered

[215] Medicines and Healthcare Products Regulatory Authority. Available online at: www.mhra.gov.uk.

further in the detailed design stage, and it is anticipated that the risk would be mitigated through application of British, European and industry standards and best practice.

Wildlife

17.6.16 The limited number of published studies addressing the risk of EMF to wildlife shows little or no evidence of a significant environmental impact. From current information the exposure limits in the ICNIRP guidelines for protection of human health are also protective of wildlife.

17.7 Climate change

17.7.1 The levels of generated EMF and EMI are dependent on the traction power, which has been calculated for a worst-case scenario based on the maximum trains running per hour. Any change in climate is unlikely to affect the output from the traction power and cause any significant increase in EMF or EMI.

17.8 Conclusion of assessment

17.8.1 The EMI technical assessment has identified three third-party receptors where there is a potential significant EMI risk to very sensitive equipment or systems: Pickmere Radio Telescope, Manchester Airport and The Christie NHS Foundation Hospital. Further detail about these receptors is included Volume 5: Appendix EM-001-00000 (Section 4). In light of this, on a precautionary basis, a likely significant effect has been identified at these receptors.

17.8.2 HS2 Ltd is undertaking on-going engagement with the owners and operators of these facilities to establish the electromagnetic sensitivity levels and risk of EMI. Any appropriate mitigation measures will be identified during on-going engagement.

17.8.3 No other likely significant effects have been identified in the EMI assessment.

18 Phase One, Phase 2a and the Proposed Scheme combined impacts

18.1 Summary

18.1.1 This section of the report provides a summary of the potential total impacts (individually and combined) of Phase One (Additional Provision (AP) 5 revised scheme[216]), Phase 2a (AP2 revised scheme[217]) and the Proposed Scheme which is presented in Table 75Table 74.

18.1.2 Since the Phase 2b working draft ES was published, work on the Western Leg of Phase 2b (the Proposed Scheme) is being progressed separately to the Eastern Leg. The Government's intentions for Phase 2b Eastern Leg are set out in its Integrated Rail Plan (IRP) for the North and Midlands.

Table 75: Combined impacts of Phase One (revised scheme), Phase 2a (revised scheme) and the Proposed Scheme

	Phase One AP5 revised scheme	Phase 2a AP2 revised scheme	Proposed Scheme	Overall total (Phase One AP5 revised scheme, Phase 2a AP2 revised scheme and Proposed Scheme total)
Route characteristics (km)				
Total length[218]	216	58	84.3	358.3
Tunnel	49.5	2.9	19	71.4
Cutting	74.7	28.3	13.3	116.3
Viaduct	16.3	5.5	8.0	29.8
Embankment	62.5	21.3	30.4	114.2
Property and settlements				
Demolitions (residential)	326 dwellings (218 buildings)	27 dwellings	87 dwellings	440 dwellings

[216] High Speed Rail (London – West Midlands) Supplementary Environmental Statement 4 and Additional Provision 5 Environmental Statement (2015). Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/481043/Volume_1_Introduction_and_methodology__Volume_2_Community_forum_area_reports__Volume_3_Route-wide_effects__Glossary_of_terms_and_list_of_abbreviations.pdf.

[217] High Speed Rail (West Midlands – Crewe) Supplementary Environmental Statement 2 (SES) and Additional Provision 2 (AP) Environmental Statement (2019). Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/775957/J20_Volume_3_Route-wide_effects_web.pdf.

[218] Not all route characteristics are defined here hence why the cumulative of route characteristics doesn't equal the total. Characteristics like stations, underground boxes, and tunnel portals are excluded.

	Phase One AP5 revised scheme	Phase 2a AP2 revised scheme	Proposed Scheme	Overall total (Phase One AP5 revised scheme, Phase 2a AP2 revised scheme and Proposed Scheme total)
Demolitions (community)	19 community facilities	0 community facilities	4 community facilities	23 community facilities
Demolitions (commercial/retail/manufacturing/industrial/miscellaneous)	372 units (309 buildings)[219]	68 units	159 units	599 units
Total demolitions (including residential)	546 buildings	95 buildings[220]	250 buildings	891buildings
Employment and housing				
Permanent jobs created	2,200[221]	140	4,180	6,520
Construction jobs created	14,600[222]	1,920[222]	8,800	25,320
Jobs displaced[223]	7,950	25	6,500	14,475
Noise				
Monetary valuation of noise impacts[224]	n/a[225]	£-3.12m	£-5.2m	n/a
Landscape				
AONB crossed at surface (km)	7.6	0	0	7.6
Historic environment				
Scheduled Monuments directly affected	1	0	0	1
Registered Battlefields directly affected	1	0	0	1
Grade I and II* structures directly affected	2	0	1	3
Grade II structures directly affected	17	4	6	27

[219] This figure includes some properties which also provide community resources, e.g. public houses, local services.

[220] Includes total of residential, community, commercial and miscellaneous buildings including outbuildings associated with residential properties.

[221] Indicative direct operational employment figure was estimated to the nearest 100 jobs.

[222] Number reported as an approximate equivalent of permanent full time construction jobs.

[223] Jobs displaced comprise jobs relocated elsewhere in the UK economy and jobs lost, due to land being acquired for the construction and operation of the Proposed Scheme.

[224] The monetary valuation of noise impacts is calculated using the methodology described in Section 2 'Noise Impacts' of Department of Transport (2013), *TAG Unit 3 Environmental Impact Appraisal published by the* Department of Transport. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/254128/webtag-tag-unit-a3-environmental-impact-appraisal.pdf.

The assessment utilises the latest available Department for Transport (2021), *TAG data book*. Available online at: https://www.gov.uk/government/publications/tag-data-book.

[225] The assessment method has materially changed since that used for the Phase One AP5 revised scheme ES (December 2015) and hence the levels are not directly comparable.

	Phase One AP5 revised scheme	Phase 2a AP2 revised scheme	Proposed Scheme	Overall total (Phase One AP5 revised scheme, Phase 2a AP2 revised scheme and Proposed Scheme total)
Registered Parks and Gardens directly affected	2	0	0	2
Conservation Areas directly affected	2	4	2	8
Biodiversity and wildlife				
Natura 2000 sites affected	0	0	1	1
SSSI directly affected	3	0	1	4
Ancient Woodlands directly affected	32	11	17	60
Water resources and flood risk				
Major[226] rivers diverted	8	0	1	9
Route through Flood Zone 3 (km)	12.0	2.4	1.7	16.1
Station/depot occupation of Flood Zone 3 (ha)	2.1	0.6	0.9	3.6
Cutting or tunnel through SPZ 1 or 2 (km)	6.7	0.6	0.6	7.9
Land use resources				
Active landfills crossed[227]	0	0	0	0
Grade 1 and 2 agricultural land (km)	22.0	9.9	8.7	40.6
Waste and material resources				
Excavated material (million m^3)	63.4[228]	18.9[229]	14.08[230]	n/a
Concrete (million tonnes)	13.04	2.10	5.40	20.54
Steel (million tonnes)	1.30	0.13	0.48	1.91
Carbon emissions (tCO2e) [231]				

[226] Major rivers are defined, in the context of this table, as those with a catchment area greater than 50km^2 at the point of the route crossing. This definition is set out in the Phase 2b Sustainability Statement.

[227] Waste storage facilities located deep underground (100 to 350m below ground level) within salt caverns are excluded as the Proposed Scheme will not prevent such facilities from continuing to operate.

[228] This figure is the total quantity of excavated material that will be generated from the construction of Phase One. This includes excavated material that will be reused in the construction process as well as excavated material that will be made available for use off-site or disposed of on or off site.

[229] This figure is the estimated quantity of excavated material excluding top soil and sub-soil that will be generated from the construction of the Phase 2a as reported in the SES2 and AP2 ES.

[230] This figure includes excavated material from the project's schedule for quantities for the main route, from highways foundation works and from off-route works.

[231] The combined carbon footprint of the construction and operation of Phase One AP5 revised scheme, Phase 2a AP2 revised scheme and the Proposed Scheme. Whilst it is informative to look across numbers for both phases to get an overall picture of carbon emissions, these numbers are not directly comparable. This is because the scope, assumptions and methodologies differ slightly between phases and should be used with caution. Phase One emissions are reported over the first 60 years of operation whilst the Proposed Scheme emissions are reported over a 120-year design life.

	Phase One AP5 revised scheme	Phase 2a AP2 revised scheme	Proposed Scheme	Overall total (Phase One AP5 revised scheme, Phase 2a AP2 revised scheme and Proposed Scheme total)
Construction	6,125,000	1,451,000	5,022,000	12,598,000
Operation – use stage	2,300,000[232]	315,000	5,769,000	8,384,000
Operation – benefits and loads beyond project boundaries	-5,270,000[233]	-307,000	-3,888,000	-9,465,000

[232] Phase One use stage carbon emissions are over the first 60 years of operation. It does not account for the years 61-120. This figure underestimates the 120-year impact, however the disparity in temporal scope is not expected to result in a significant underestimate given the rate and extent of the UK grid decarbonisation.

[233] Phase One benefits and loads beyond the project boundary carbon emissions are over the first 60 years of operation. It is possible that this figure underestimates the 120-year impact, however the disparity in temporal scope is not expected to result in a significant underestimate given the rate and extent of forecast electric vehicle uptake and decarbonisation or road and air journeys.

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